INTERNATIONAL CONFERENCE

System of Crop Intensification (ICSCI 2022) for Climate-Smart Livelihood and Nutritional Security

12-14 December, 2022

Indian Institute of Rice Research, Hyderabad, India

Extended Summaries

Organized by

Society for Advancement of Rice Research

Hyderabad, Telangana, India

International Conference
on
System of Crop Intensification (ICSCI 2022) for Climate Smart Livelihood and Nutritional Security

12-14 December 2022

Editorial team

Kalyani M Barbadikar, Surekha K, Sruthi K, Manasa V, Prasad Babu MBB, Sreedhar Y, P Jeyakumar, Aravind Kumar J, Satendra Kumar Mangrauthia, D. Ladhalakshmi, Fiyaz R.A, Brajendra P, Nirmala B, Tuti MD, Debashish Sen, Lucy Fisher, Francesco C Zampaolo, Subba Rao LV, Sai Prasad SV, Gangaiah B, Sreedevi B, Vidhan Singh T, Ravindra Naik, Meera SN, Abha Mishra, Jagadeeswar R, Amtul Waris, Chandra Mohan Y, Biksham Gujja, Padmavathi Ch, Mahender Kumar R and Sundaram RM

Society for the Advancement of Rice Research
ICAR-Indian Institute of Rice Research, Hyderabad, Telangana, India

Published in December 2022

International conference -ICSCI 2022

Organizing Chairman

Dr. R.M. Sundaram
President, SARR, ICAR-IIRR

Organizing Secretaries

Dr. R. Mahender Kumar
Secretary, SARR, Principal Scientist, ICAR-IIRR

Dr. Ch. Padmavathi
Principal Scientist, ICAR- IIRR

Publication Committee Chairperson

Dr. Surekha K
Principal Scientist, ICAR- IIRR

Technical assistance

Mr. Nakul D Magar, Mr. Vishal Reddy, Mrs. S Gayatri, Ms. M Shalini, Mrs. Padmaja K, B Ramesh

Citation

Kalyani M Barbadikar, Surekha K, Sruthi K, Manasa V, Prasad Babu MBB, Sreedhar Y, P Jeyakumar, Aravind Kumar J, Satendra Kumar Mangrauthia, D. Ladhalakshmi, Fiyaz R.A, Brajendra P, Nirmala B, Tuti MD, Debashish Sen, Lucy Fisher, Francesco C Zampaolo, Subba Rao LV, Sai Prasad SV, Gangaiah B, Sreedevi B, Vidhan Singh T, Ravindra Naik, Meera SN, Abha Mishra, Jagadeeswar R, Amtul Waris, Chandra Mohan Y, Biksham Gujja, Padmavathi Ch, Mahender Kumar R and Sundaram RM. 2022. International Conference on System of Crop Intensification for Climate-Smart Livelihood and Nutritional security *in:* Extended Summaries. 12-14 Dec 2022, Society for Advancement of Rice Research, Rajendranagar, Hyderabad-500030, India, p 571.

CONTENTS

Theme II: Breeding cultivars, land races, ideotypes, Management practices, pest and disease dynamics of SCI

Theme III Resource (water, nutrients, energy, labour etc.) use and conservation, in SCI (Natural Farming, Organic farming, Conservation Agriculture etc.) climate resilience and ecosystem protection

Theme IV Agro-industries/Mechanization for scaling up SCI

Theme 5: SCI adoption and their Socio-economic Impacts including gender, labour and Institutional dynamics

Theme II

Breeding cultivars, land races, ideotypes, management practices, pest and disease dynamics of SCI

Lightning talk **ICSCI2022/T2/02**

System of crop intensification in Rice-Wheat cropping system

Gurleen Kaur, Vandna Chhabra, PankushTagra and Shifali Verma
Lovely Professional University, Phagwara, Punjab,144001, India
Email: gurleenrandhawa152gmail.com

Introduction

The rice-wheat (RW) cropping system occupies 13.5 M ha area of Indo-Gangetic Plains (IGP), 10.3 M ha of which is in the Indian IGP and providing food for more than 400 million people of South Asia (Kumar *et al.* 2018). High productivity of RW system with conventional management practices in IGP is at the cost of over-exploitation of natural resources like ground water, soil, and energy (Choudhary *et al.* 2018). The ground water table in central Punjab and parts of Haryana states decreasing with a speed of ~1.0 m a^{-1} between the year 2000 and 2006 (Humphreys *et al.* 2010). Whether rice requires more water for its growth but now these days, water scarcity appears in many areas which mainly affect the production of rice. It is estimated that to produce one kilogram of rice requires 3,000-5,000 liters of water. System of Rice Intensification (SRI) is to improve the water use efficiency of the rice crop (Bouman and Tuong, 2001). The SRI method uses less amount of irrigation water, seed rate and fertilizer dose in comparison to traditional / conventional method of rice cultivation (Juanita, 2007). System of Rice Intensification (SRI) is a resource conservation methodology which aims at increasing the productivity of rice with less external inputs. It was estimated that across 50 countries around the world, about 10 million farmers have experienced SRI method on more than 4 million hectares area (Kassam *et al.*, 2011; Uphoff*et al.*, 2015). The ideas and methods of the system of rice intensification which is improving irrigated rice production are now being extended/adapted to many other crops: wheat, maize, finger millet, sugarcane, tef, mustard, legumes, vegetables, and even spices. Promoting better root growth and enhancing the soil's fertility with organic materials are being found effective means for raising the yields of many crop plants with less water, less fertilizer, reduced seeds, fewer agrochemicals, and greater climate resilience. Since the literature available regarding relationship of priming, nutrient doses, SRI technology is scanty. By keeping in view, the study is planned with the following objectives: to study the performance of wheat and rice under the system of intensification, to find out the effect of seed priming and varying nutrient doses on crop growth and yield of wheat and rice, to find the economic feasibility of all the methods used

Methodology

The field experiment entitled was conducted in *kharif* and *rabi season* of 2018-19 at Agriculture Research Station of Lovely Professional University, Phagwara, Punjab (India). The experiment was performed in Randomized Block Design and was replicated three times in both *kharif* and *rabi*season.

Results

The results of the experiment have been summarized here and revealed that the system of rice intensification (SRI) method showed significant increase in growth parameters (plant height, number of leaves, number of tillers/plant), yield contributing characters like number of panicles/plants, panicle length, panicle weight, test weight, paddy yield, straw yield, biomass yield and enhanced profit as compared to the traditional method.The results of the experiment showed that an increment of 18.9% in paddy yield was observed under SRI control than the traditional control. By comparing all the treatments in the study, paddy yield (93.9 q/ha) was found higher when fertilized with RDF primed with 1% cow urine due to more test weight (6.72 g). Maximum straw and biomass yield was under hydro primed seeds with RDF, it also showed increase in growth parameters viz. plant height, number of leaves and tillers per plant. The total production and net production of Pusa Basmati 1121 were Rs. 16,000 and Rs. 11,230.12 under SRI so the benefit cost ratio of rice obtained was 2.35.

Table 1. Details of the treatments used in experiment

S. No.	Treatment combination
***Kharif Season* (Rice)**	
T0	Traditional control
T1	SRI control
T2	100% NPK+ Hydropriming
T3	100% NPK + 1% KNO3
T4	100% NPK + 1% Cow urine
T5	100% NPK + without seed priming
T6	75% NPK + 25% Vermicompost (VC) + Hydropriming
T7	75% NPK + 25% Vermicompost (VC)+ 1% KNO3
T8	75% NPK + 25% Vermicompost (VC)+ 1% Cow urine
T9	75% NPK + 25% Vermicompost (VC)+ without seed priming
T10	50% NPK + 50% Vermicompost (VC)+ Hydropriming
T11	50% NPK + 50% Vermicompost (VC)+ 1% KNO3
T12	50% NPK + 50% Vermicompost (VC)+ 1% Cow urine
T13	50% NPK + 50% Vermicompost (VC)+ without seed priming
***Rabi Season* (Wheat)**	
T0 T1	control (Broadcasting) Conventional method (Broadcasting+ Recommended Dose Fertilizer)
T2	WP (seed without priming) Line Sowing+ Recommended Dose Fertilizer
T3	WP (seed without priming) Line Sowing+ Recommended Dose Fertilizer
T4	Primed seed (Fungicide) +Line Sowing+ Recommended Dose Fertilizer
T5	Primed seed (Fungicide) +Line Sowing+ Recommended Dose Fertilizer
T6	Primed seed (Fungicide) +Line Sowing+ Recommended Dose Fertilizer
T7	Primed seed (Fungicide) +Line Sowing+ Recommended Dose Fertilizer

The results trial of wheat during the *rabi* season indicated that the treatment having primed seeds with cow urine sown in line and applied with recommended dose of fertilizers superseded in terms of plant height, number of tillers per plant, spike length, grains in each spike, 100 grain weight, grain yield, straw, and biological yield in wheat crop. However, the treatments like T7 and T4 had also produced higher growth and yield attributes next after T5. As the benefit cost ratio is concerned T5 treatment has maximum benefit cost ratio (1.53) registered followed by T7 and T4. Thus, sowing of wheat under system of wheat intensification with bio primed seeds using cow urine with recommended dose of fertilizers can be better in terms of monetary benefits.

Conclusion

It was concluded that priming with 1% cow urine with recommended dose of NPK showed best results in SRI and produced maximum paddy yield due to highest number of panicles/plants, panicle length and test weight. Similarly, when the system of intensification was followed in wheat, it was observed that with the sowing of bio primed seeds using cow urine with recommended dose of fertilizer shows promising results in terms of monetary benefits. Thus, the system of intensification both in rice and wheat crop was found to be successful for the sustainable agriculture.

References

Bouman B.A.M and Toung T.P. 2001.Field water management to save water and increase its productivity in irrigated lowland rice. *Agricultural Water Management* **49**(2001): 11-30.

Choudhary K.M., Jat H.S., Nandal D.P., Bishnoi D.K., Sutaliya J.M., Choudhary M., Singh Y., Sharma P.C., Jat M.L., 2018. Evaluating alternatives to rice-wheat system in western Indo-Gangetic Plains: Crop yields, water productivity and economic profitability. *Field Crops Research* **218**: 1-10.

Humphreys E., Kukal S.S., Christen E.W., Hira G.S., Balwinder S., Yadav S., Sharma R.K., 2010. Halting the groundwater decline in North-West India- which crop technologies will be winners? *Advances in Agronomy* **109**: 155–217.

Juanita S., 2007. Effect of timing and levels of potassium in SRI cultivation. *Master of Science (Ag.). Thesis*, submitted to Annamalai University, Chidmbaram.

Kumar V., Jat H.S., Sharma P.C., Gathala M.K., Malik R.K., Kamboj B.R., Yadav A.K., Ladha J.K., Anitha R., Sharma D.K., McDonald A., 2018. Can productivity and profitability be enhanced in intensively managed cereal systems while reducing the environmental footprint of production? Assessing sustainable intensification options in the breadbasket of India.*Agriculture, Ecosystem and Environment* **252**: 132-147.

Lightning talk **ICSCI2022/T2/23**

Agrotechniques for guni or guli or netti cultivation of finger millet

T.S. Sukanya[1], T.E. Nagaraja[2] and C. Chaithra[3]

Project Coordinating Unit, ICAR-AICRP on Small Millets, GKVK, Bangalore-560 065, Karnataka, India

Email: tssukanya@gmail.com

Introduction

Guni method is square planting technique practiced locally in few districts *i.e.*, Kolar, Bengaluru Rural, Shimoga, Haveri, Dharwad and Tumkur districts of Karnataka and is also being practiced in few patches of Finger millet area in Hyderabad and Tamil Nadu state. There is a practice of keeping spacing from 30 cm to 60 cm as inter and intra i.e., square planting and small pit or guni or scoop is formed at intersection point for the spot application of FYM from 0.25 to 1 kg before planting and recommended dose of inorganic fertilizers is applied to the guni. It enables the panicles for better grains filling and improves the size of the ear heads and produces yield up to 18 to 20 quintals per acre.

Guni or guli or netti method (square planting) in finger millet is a traditional agronomic practice of finger millet cultivation similar to system of rice intensification (SRI). SRI is based on agro-ecological principles of harvesting sunlight through higher bio-mass production thereby enhancing more voluminous root growth and microbial population in the rhizosphere through improved aeration and more organic inputs. Like SRI, Guni-Ragi also follows almost similar agronomic practices of wide spacing, early transplanting of seedling and inter-cultivation to create more aerated soil.

It is evident that bulky organic manures will neutralize the adverse effect caused by the continuous usage of chemical fertilizers. It acts as storehouse of several nutrients. FYM play a prominent role in improving the soil physical properties. Microbial decomposition of organic manure produces polysaccharides which binds the soil particles and create a stable soil aggregate. Regular application of FYM improves the soil water holding capacity and reduces the risk of soil erosion. Besides these advantages, it also reduces seed requirement for sowing, ensures easy inter cultivation and better weed control. Therefore, guni method of planting is being practiced by good number of farmers in few finger millets growing districts of Karnataka , Andhra Pradesh and Tamil Nadu. Hence, scientific revalidation of the method is essential for further dissemination of the technology among the farming community. Hence, the present investigation was under taken with the objective of standardizing spacing, FYM and planking for sustainable production of finger millet under guni method of cultivation.

Methodology

The field experiment was conducted during *kharif* 2019-2021 at different locations of AICRP centres on Small millets i.e., Kolhapur (Maharashtra); Nandyal and Vizianagaram (Andhra Pradesh), Mandya and Bengaluru (Karnataka). The soil type of different centres was sandy loam at Kolhapur, deep vertisols at Nandyal, sandy loam at Mandya and deep red loamy at Vizianagaram. AICRP centers of Kolhapur, Nandyal, Mandya and Vizianagaram come under different agroclimatic zones (Sub- montane Zone, Scarce rainfall zone, Southern dry zone and Eastern Coastal plain, respectively), varied climates (Semi-arid, Semi- arid, Hot moist semi-arid and

Hot sub- humid to semi-arid, respectively), diverse altitude (574, 202, 697 and 61 m above MSL, respectively.) At different centres, soil pH (6.85 to 8.23), organic carbon (0.34 to 0.63%), available nitrogen (180 to 229 kg/ha), phosphorous (9.56 to 85 kg/ha), potassium (145 to 366 kg/ha) were found to be different. The experiment was laid out in a factorial RCBD design with three replications. The experiment consisted of three factors; spacing (S_1:30cmx10cm, S_2:30cmx30cm S_3:45cmx45cm), planking (P_1: Without planking, P_2:20&40 Days After Planting) and Farm yard manure (F_1:7.5 t/ha, F_2:10 t/ha, F_3:12.5 t/ha) involving 18 treatment combinations. The observations on growth parameters, yield attributes were taken on randomly selected five plants from each treatment. Growth parameters, *viz*. Plant height (cm), No. of productive tillers / plant, No. of fingers per ear head, Main ear length (cm) and Yield attributes *viz*.,1000 seed weight and yield, i.e. grain yield (kg/ha) and straw yield (kg/ ha) were recorded at harvest during both the years. Net returns were calculated by using prevailing prices of inputs and outputs during the respective crop season. Benefit: cost ratio was calculated by dividing the returns from the cost of cultivation. Available nitrogen of soil was determined by alkaline potassium permanganate method as outlined by Subbiah &Asija (1956) and was expressed in kg ha^{-1}. Available phosphorus of soil was determined by Brays-I extractant and ascorbic acid method in hydrochloric acid system by using Brays-I extractant (Jackson, 1973) and expressed in kg ha^{-1}. Available potassium ofsoilwas determined by using neutral normal ammonium acetate extractant using a flame photometer (Jackson, 1973) and expressed in kg ha^{-1}. The uptake of nitrogen, phosphorus and potassium by finger millet grain and straw was calculated separately and the sum of uptake of nutrients in grain and straw was considered as the total uptake by the crop and expressed in kg ha^{-1}. The Results are presented at 5 per cent level of significance (P=0.05) for making comparison between treatments.

Results

The data obtained from two years study (2019-20 and 2020-21) at different ACRIP centres (Bengaluru Kolhapur, Mandya, Nandyal and Vizianagaram) and their pooled mean is presented in Table1. Among different spacing adopted for study plant height remained non-significant. However, significantly higher number of productive tillers (8.64) were recorded with a wider spacing of 45cm x 45cm. Significantly higher value *viz*., grain yield (2882 kg/ha) and straw yield (4887kg/ha) is obtained in 30 cm X 30 cm spacing. Further the same spacing has resulted in higher gross returns (Rs. 79951/ha), net returns (Rs. 41800/ha) and B:C ratio (2.05). Significantly lower values were recorded in 30cm x 10 cm spacing.

Total uptake of NPK nutrient was found significantly higher at 30cm X 30 cm spacing however it was found on par with 45 cmx45 cm spacing. Significantly lower uptake of NPK nutrient was found at 30cm X10 cm spacing. Optimum spacing followed in plant is a prerequisite for exploiting the genetic potential of the crop plant. Optimum spaced plants due to favourable environment and less competition among plants provided sufficient quantity available in the rhizosphere helped the plants to uptake more nutrients ultimately leading to the formation of larger sink coupled with efficient translocation of photosynthates.

Planking operation had no significant influence on parameters like plant height, number of productive tillers, no of fingers per ear, ear length and 1000 seed weight. However, significantly higher grain yield (2755 kg/ha) and straw yield (4743 kg/ha), higher gross returns (Rs.75576), net returns (Rs.37662) and B:C ratio (2.04) were recorded due to the reason that planking operation stimulate higher number of tillers and also adventitious root system which enables the panicles to be larger and better grains filling, size and quality of the ear heads also improved due to steady and continuous available of nutrients and moisture.

Among different level of FYM application of FYM at 12.5 ton per ha has resulted in higher grain yield (2850 kg/ha) and straw yield (4939 kg/ha). However, the yield was found on par with the application of FYM at the rate10 ton/ha (2674 and 4631kg/ha, respectively). Significantly higher Nitrogen, phosphorous and potassium uptake (58.61, 23.78 and 61.71 kg/ha, respectively) were found with the application of 12.5 ton FYM/ha. Significantly lower values were found in the treatment receiving FYM at the rate of 7.5 ton per hectare. Numerically higher net returns (Rs.37662) was obtained with the application of 12.5 ton FYM per ha.

Table 1: Growth and yield as influenced by guni cultivation of finger millet (Pooled data)

Treatment details	Plant height(cm) at harvest	No. of productive tillers/plant	Days to maturity	Grain yield (kg/ha)	Straw yield (kg/ha)
Spacing					
S_1: 30 cm x 10 cm	102.26	4.26	112	2650	4791
S_2: 30 cm x 30 cm	101.38	6.58	116	2882	4887
S_3: 45 cm x 45 cm	99.09	8.64	117	2532	4328
S.Em±	3.90	0.02	1.05	55.58	132.5
C.D. (5%)	NS	0.067	2.86	159	358
Planking					
P_1:Without planking	100.73	6.27	109.43	2621	4594
P_2:20&40 aaysafter planting	101.09	6.72	109.39	2755	4743
S.Em±	3.18	0.02	0.014	45.38	57.14
C.D. (5%)	NS	NS	NS	130	160
Farm yard manure					
F_1: 7.5 t/ha FYM	100.05	6.19	109.54	2540	4436
F_2: 10 t/ha FYM	100.99	6.45	108.88	2674	4631
F^3: 12.5 t/ha FYM	101.69	6.84	109.81	2850	4939
S.Em±	3.90	0.02	0.020	142.2	151.4
C.D. (5%)	NS	0.067	0.056	384	309

The positive effect of farmyard manure in increasing the nutrient uptake resulting in higher dry matter production in plants. The increase in grain yield and its components is a result of better growth and growth components. Application of FYM could have released the nutrients slowly into the soil solution to match the required absorption pattern of finger millet..Among interactions the treatments, 30cm x 30cmspacing with planking at 20&40 days after planting and farm yard manure @ 12.5 t/ha resulted in higher growth, yield parameters and overall performance of crop elucidating the new way for enhancing productivity and higher income.

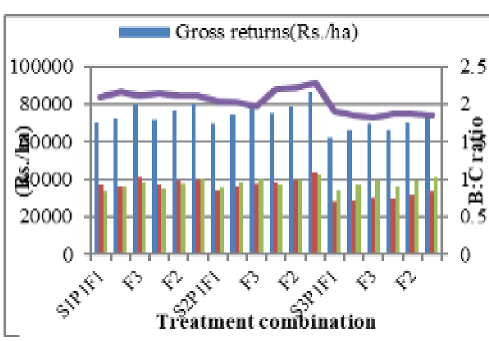


Fig.1:Economics of finger millet as influenced by guni cultivation of 2019-20 and2020-21 across different locations)

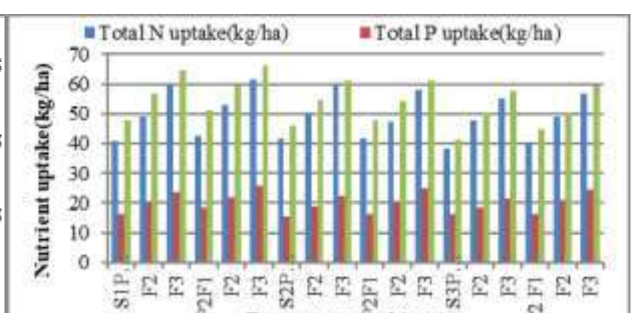


Fig.2 : Nutrient uptake by finger miller under guni cultivation finger millet (Pooled data of 2019-20 and 2020-21(Pooled data of 2019-20 and 2020 21)

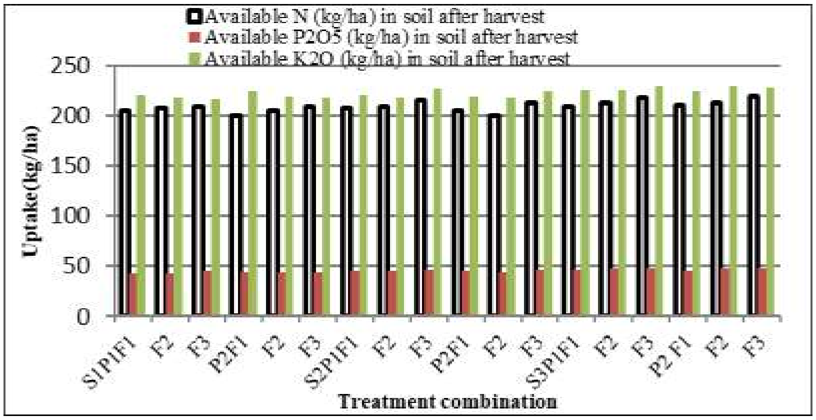


Fig.3: Available nutrient status in soil after the crop harvested under Guni cultivation (Pooled data of 2019-20 and 2020-21)

Conclusion

The treatment combination i.e., 30 cm x 30 cm spacing coupled with planking at 20& 40 days after transplanting and application of 12.5 t FYM/ha enhanced the productivity of Finger millet Guni method cultivation and the technology also emerged as the cost-effective technology for sustainable production.

References

Jackson, ML. 1973. Soil Chemical Analysis.Prentice Hall of India. New Delhi. pp. 498

Subbiah BV and Asija GL.1956.A rapid procedure for the estimation of available nitrogen in soils.Current Science.25, 259.

Lightning talk **ICSCI2022/T2/27**

System of crop intensification in finger millet

D. Anitha [1*], A. V. Nagavani [2] and V. Chandrika [3]
Assistant Professor[1], Department of Agronomy, ANGRAU, Professor[2&3]
*corresponding author: e mail: anitha.mscagro@gmail.com

A field experiment was conducted at the department of agronomy, S.V Agriculture college, Tirupathi during *rabi*, 2014- 15 to study the influence of crop geometry and age of seedlings on the growth characters, yield, nutrient uptake and post harvest nutrient status of finger millet. The experiment was laid out in randomized block design and replicated thrice. The results revealed that the growth characters i.e, plant height, leaf area index, dry matter production, total no of tillers m^{-2} were higher with transplanting of 25 days old seedlings at 15 cm × 10 cm with 2-3 seedling $hill^{-1}$.15 days old seedlings planted at 20 cm × 20 cm spacing recorded higher number of productive tillers m^{-2}, grain yield, and harvest index. Transplanting of 15 days old seedlings at 20 cm × 20 cm with single seedling $hill^{-1}$ (T_5) recorded significantly higher grain yield which was however, comparable with transplanting of 12 & 18 days old seedlings at 20 cm × 20 cm with single seedling $hill^{-1}$(T_8). This might be due to enhanced stature of yield attributes, forming larger sink size coupled with efficient translocation of photosynthates to the sink was noticed under optimum planting pattern with transplanting of young seedlings. Treatment combination of 25 days old seedlings planted at 15 cm × 10 cm spacing (ANGRAU package) recorded higher nutrient uptake followed by transplanting of 15 days old seedlings at 20 cm × 20 cm with single seedling $hill^{-1}$. From this study, post -harvest soil available NPK was not significantly influenced by crop geometry practices and age of seedlings tried.

Key words: Crop geometry, Age of seedlings, Yield traits, Nutrient uptake, Post - harvest nutrient status.

ICSCI 2022/T2/01

A new high yielding variety "GT-104" for Gujarat conditions

D.A. Chauhan, Bineetkaur S. Singh, Ronak S. Bhakta, B.K. Patel and Ami Pathak
Pulses & Castor Research Station, Navsari Agricultural University, Navsari-396 450, Gujarat
Email: pulsesnau@gmail.com

Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp.]is a versatile, stress-tolerant, and nutritious grain legume, possessing traits of value for enhancing the sustainability of dry sub-tropical and tropical agricultural systems. It is invariably cultivated as an annual crop with high protein in food, which is a major protein supplement for small holding farming families. As the global food production is compounding with the growing population and also the dietary expectations are high, moreover, there are many challenges to develop disease resistance in the crop. Considering the above mentioned constraints, the present study was conducted to develop high yielding, SMD and wilt resistance with bigger seed size and long pod length traits of pigeon pea.

Methodology

The experiment involved a cross made between GNP-357 x BSMR-853 (Vaishali) during *rabi*2009-10 at Pulses and Castor Research Station, N.A.U., Navsari. The segregating material was handled up to 2014 and a bulk having medium maturity, red flower, spreading type, indeterminate growth habit, SMD resistant was evaluated along with checks Vaishali, AGT-2, GJP-1 and BDN–2 from 2015 to 2017. All the observation was recorded for 20 different agro-morphological traits and five different quality traits. The data was also recorded for the reaction to wilt disease in the field condition with their percent infection for the reaction to SMD disease in the field and four major pest resistance reactions was done. The results for grain yield of this variety was found to be superior to checks, which was tested at 17 locations in Gujarat and found to be high yield advantage i.e. 21.9%, 21.2%, 12.5% and 27.6% over the checks *viz*., Vaishali, GJP-1, AGT-2 and BDN–2, respectively.

Results

It was found have average yield to be 1873 kg/ha which exceeded the checks. The performance of this variety was also found to be superior under AICRP network in central zone when tested with checks ICPL-87119, BDN-2 and JKM-189. Also all the quality parameters were found to be at par with the checks.

Conclusion

This developed variety was found to be resistant to SMD disease and wilt resistant. Hence, with an objective to replace the old varieties and giving alternative to farmers of Gujarat, with high yield potential along with resistant to diseases a new variety GT-104 was developed.

ICSCI 2022/T2/03

Evaluation of high yielding, early coarse rice variety with better grain quality

D.B.Prajapati, M.B.Parmar, S.G.Patel, Mr. S.S. Thorat, Dr. R.K. Gangwar and N.R. Makawana

Main Rice Research Station, Anand Agricultural University, Nawagam, Gujarat 387 540, India
Email:dbprajapati207@gmail.com

Introduction

Rice (*Oryza sativa* L.) is an important staple food crop of the state. About 90% of the area of rice is confined to Middle and South Gujarat representing the Agro-climatic Zone-I, II and III. The total rice occupying area in Gujarat is 8.0 to 8.5 lac hectares, production is 19.0 lac tons and yield is 2249 kg. per hectare (Anonymous, 2019). The coarse grain rice varieties cover major part of rice growing areas of the state. Due to preference in puffed rice (mamara) and beaten rice (poha) the coarse grain rice varieties fetches higher price. In Gujarat, Gurjari variety is most popular among farmers as well as millers due to its earliness, coarse grain quality and suitability for making puffed and beaten rice. The variety Gurjari was released in 1996 and its productivity is decreasing due to susceptibility to major diseases *viz*., leaf and neck blast and bacterial leaf blight. There is need to develop high yielding, medium tall and short bold grain type rice variety suitable for beaten rice (Poha). Accordingly, the efforts were made to develop a quality variety of rice in coarse grain segment, having earliness and resistance against major insect-pests and diseases. Hence, systematic efforts were made to evolve a superior early, coarse grain type rice variety with better cooking and milling qualities, particularly for puffed and beaten rice.

Methodology

The NWGR 15019 was developed through cross of Gurjari x CN -1223-5-4-9-2by pedigree selection method, thanitwas evaluated for yield with promising entries including check varieties, Gurjari, GNR 3 and GR 17 in different trials *viz.*, PET-E, SSVT-E and LSVT-E-C (3 years' trials) during *Kharif* season of 2017, 2018, 2019, 2020 and 2021, respectively. The experiment was framed in a Randomized Block Design with three replications. The Genotypes were grown in 4.95 meters apart with two meters' width by maintaining 20 cm ×15 cm plant spacing of individual genotype. The agronomic characteristics were measured as per Table 2. The grain and biochemical properties of NWGR 15019 were mentioned in Table 3. The data pertaining to various characters were analyzed as per the procedure of randomized block design given by Panse and Sukhatme (1978) for individual environments. Screening of rice genotypes was carried out as per methodology suggested by Kalode *et* al. (1979). The observations were recorded on the basis of 0-9 scale, when more than 90 per cent TN_1 seedling were killed by the brown plant hopper insect. The whole reaction was completed in 8-14 days after the release of insects. Observations of seedlings were taken on the basis of visual plant damage symptoms (0-9 scale) which are followed by probing mark test was carried out according to methodology suggested by Natio (1964). The test was performed on 7 days old seedlings of selected resistant genotypes.

Results

The grain yield of NWGR-15019 was recorded 5425 kg/ha which is higher over the check *viz.*, Gurjari, GNR 3 and GR 17. The yield potential of this variety is 7117 kg/ha. The NWGR-15019 was found early maturity (115 to 121 days) withcoarse grain type. The yield attributing traits of NWGR-15019 *viz,* length of panicle (24.7-24.8 cm), higher number of productive tillers/plant (8.0-10.0) were found superior over the checks (Table 2); these results are in agreement with those obtained by Sedeek *et* al. (2009). The NWGR-15019 culture is tall in plant stature (118-135 cm) and possesses 30.9-32.2 g test weight, 10.02 mm grain length with breadth 2.81mm, having Kernel length/breadth (mm) ratio of 3.77 which is enough categorised in coarse grain group of slender (Table 2). The grain quality characteristics of the NWGR-15019 were mentioned in Table 3. The amylose content of NWGR-15019(25.42 %) found *at par* with check. The milling qualities are better means 69.44 % with head rice recovery 62.51%. In case of diseases, NWGR-15019 genotype showed moderately resistance reaction against leaf blast, neck blast, bacterial leaf blight, sheath rot and grain discoloration (Table 4). In case of insect pests; the proposed culture showed resistant against white backed plant hopper, yellow stem borer and leaf folder.

Table 1. Grain yield performance of NWGR-15019

Season/ Year/ Trial	Locations	Grain yield (kg/ha)				C.D. at 5%	C.V. %
		NWGR-15019	Gurjari (C)a	GNR-3 (C)b	GR-17 (C) c		
K-2017 PET-E	NWG	2315	4630	-	-	1112	13.2
	DAB	3306	3644	-	-	754	8.7
	Mean(2)	**2811**	**4137**				
	% increase over check		**-**				
K-2018 SSVT-E	NWG	5354[a]	4698	**-**	-	569	7.7
	DAB	5332	4683	**-**	-	671	9.1
	Mean(2)	**5343**	**4691**				
	% increase over check		**13.9**				
K-2019 LSVT-E-C	NWG	5424	4882	5042	5458	1257	16.2
	DAB	4872	5192	4735	5047	921	10.0
	NVS	6257	5277	5669	5671	1039	15.0
	VYA	5710[abc]	3921	4661	4286	883	12.0
	Mean(4)	**5566**	**4818**	**5027**	**5116**		
	% increase over check		**15.5**	**10.7**	**8.8**		
K-2020 LSVT-E-C	NWG	6217[abc]	4899	3834	4480	977	13.0
	DAB	4986 [c]	4934	4670	3507	754	9.3
	NVS	5573	5198	5561	5207	915	10.2
	VYA	7117[bc]	6388	5244	5996	956	9.1
	Mean(4)	**5973**	**5355**	**4827**	**4798**		
	% increase over check		**11.5**	**23.5**	**24.7**		
K-2021 LSVT-E-C	NWG	5041	4769	4703	4866	639	7.6
	DAB	4286	3419	3974	4316	1166	12.5
	NVS	5158	4868	5072	5059	917	11.9
	VYA	4464	4472	4922	4418	958	13.5
	Mean(4)	**4737**	**4382**	**4668**	**4665**		
	% increase over check		**8.1**	**1.5**	**1.5**		

Overall Mean M_1	**5088**	**4742**	**4841**	**4859**		
% increase over check		**7.3**	**5.1**	**4.7**		
K 2019 to K 2021 overall Mean M_2	**5425**	**4852**	**4841**	**4859**		
K 2019 to K 2021 %increase over check		**11.8**	**12.1**	**11.6**		
Frequency in top non-significant group	**11/16**	**06/16**	**03/12**	**05/12**		

*a=,b=, c=indicates Significant at 5% level than resp ective check.*Figures in parenthesis indicate number of trials; NWG= Nawagam, DAB= Dabhoi, NVS= Navsari, VYA= Vyara locations.

Table 2. Mean over five years of agro morphological observations of NWGR 15019

Characters	NWGR-15019	Gurjari (C)	GNR 3 (C)	GR 17 (C)
DFF (days)	**88 (85-91)**	87 (85-90)	89 (88-91)	87 (84-89)
Days to Maturity	**118 (115-121)**	117 (115-120)	119 (118-121)	117 (114-119)
Plant height (cm)	**128 (118-135)**	120 (111-128)	122 (115-130)	118 (112-128)
Panicle length (cm)	**24.7 (24.7-24.8)**	22.7 (21.9-23.3)	23.8 (23.1-24.2)	23.5 (22.1-24.2)
No. of productive tillers/ Plant	**9 (8-10)**	8 (8-9)	9 (8-9)	9 (8-9)
No. of Grains/Panicle	**156 (141-192)**	120 (109-154)	128 (102-156)	101 (101-136)
Grain Length (mm)	**10.06 (10.0-11.0)**	10.04 (10.0-11.0)	10.06 (10.0-11.0)	10.06 (10.0-11.0)
Grain Breadth(mm)	**2.81 (2.68-2.93)**	2.77 (2.61-2.88)	2.81 (2.52-2.97)	2.76 (2.66-2.92)
L/B ratio	**3.58**	3.62	3.58	3.64
1000 grain wt. (g)	**31.70 (30.9-32.2)**	30.60 (28.6-31.9)	29.70 (26.7-31.8)	32.40 (31.1-34.4)
Lodging	**Non lodging**	Non lodging	Non lodging	Non lodging
Grain classification	**Coarse**	**Coarse**	**Coarse**	**Coarse**

Table 3.Grain quality of NWGR 15019 at MRRS, Nawagam (*Kharif* 2021)

Quality Characters	NWGR-15019	Gurjari(C)	GNR 3(C)	GR 17(C)
HULL (%)	**81.36**	80.40	80.92	81.56
Mill (%)	**79.14**	76.52	79.19	78.30
HRR (%)	**64.43**	60.02	62.77	55.77
KL (mm)	**6.72**	6.59	6.40	6.45
KB (mm)	**2.37**	2.33	2.34	2.27
L/B ratio	**2.84**	2.83	2.74	2.84
ASV	**2.0**	2.0	2.0	2.0
VER	**4.84**	4.75	4.18	4.81
KLAC(mm)	**10.08**	9.92	10.0	9.70
KER	**1.56**	1.51	1.53	1.50
AC (%)	**25.95**	25.50	24.89	25.10
WU (ml)	**345**	375	390	335
Grain Chalkiness	**VOC**	VOC	VOC	VOC
Grain Type	**LB**	LB	LB	LB

HULL: Hulling (%); Mill: Milling (%): HRR: Head Rice Recovery (%); KL: Kernel Length(mm); KB: Kernel Breadth (mm); L/B: Length and breadth ratio; Grain Chalk: Grain Chalkiness; VOC: Very Occasionally present; A: Absent; KLAC: Kernel Length after cooking; WU: Water uptake; VER: Volume expansion ratio; ASV: Alkali Spreading Value; AC: Amylose Content (%); MS: Medium Slender; SS: Short Slender.

Table 4: Mean over rating of incidence of diseases at Nawagam and Navsari centers

Table 4: Mean over rating of incidence of diseases at Nawagam and Navsari centers

Screening of advance breeding material against important diseases

Location	Varieties			
	NWGR-15019	Gurjari(C	GNR 3(C)	GR 17 (C)
Bacterial leaf blight (BLB)				
Range	1-7	1-7	5-7	5-5
SI	4.0(MR)	4.6(MR)	6.3 (MS)	5.0 (MS)
Leaf blast (LB)				
Range	2-6	5-8	5-8	3-5
SI	4.25(MR)	6.25(MS)	6.7 (MS)	4.3 (MR)
Neck blast (NB)				
Range	0-5	0-7	3-7	1-3
SI	3.25 (MR)	4.75 (MR	5.7 (MS)	2.3 (R)
Sheath rot (ShR)				
Range	0-5	0-7	3-7	3-5
SI	3.6 (MR)	4.8 (MS)	5.3 (MS)	4.0 (MR)
Grain discoloration (GD)				
Range	1-7	3-9	5-7	3-5
SI	4.2 (MR)	5.2 (MS)	6.0 (MS)	4.0 (MR)

Screening of advance breeding materials against insect-pests

Location	Varieties			
	NWGR-15019	Gurjari (C)	GNR 3 (C)	GR 17 (C)
White backed plant hopper (WBPH)				
Range	1-3	1-5	1-5	1-5
SI	1.4(R)	3.4 (MR)	3.7(MR)	3.7 (MR)
Yellow stem borer				
Range	0-5	1-5		
SI	2.8 (R)	3.8(MR)	5(MS)	5(MS)
Leaf folder				
Range	0-5	0-5	0-7	1-7
SI	2.9 (R)	2.9 (R)	2.1 (R)	2.7 (R)

Rating scale	Damage %				
	BLB(1-9)	LB (0-9)	NB (0-9)	ShR (0-9)	GD(0-9)
0	-	No lesion	0	0	0
1	1-5	Pin point lesion	< 5	< 1	< 1
2	-	1-2 mm lesion	-	-	-
3	6-12	More no. of lesions	5-10	1-5	1-5
4	-	< 2%	-		
5	13-25	2-10%	11-25	6-25	6-25
6	-	11-25%	-	-	-
7	26-50	26-50%	26-50	26-50	26-50
8	-	51-75%	-	-	-
9	51-100	76-100%	>50	51-100	51-100

SES, IRRI Scale (2014)

Damage scale

Damage scale (0-9)	**No. WBPH/ Hill**	**% Damaged leaves(Leaf folder)**	**% Whiteheads (Yellow stem borer)**
0 (HR)	0	0	0
1 (R)	<5	1-10	1-5
3 (MR)	6-10	11-20	6-10
5 (MS)	11-20	21-35	11-15
7 (S)	21-40	36-50	16-25
9 (HS)	>41	51-100	26 and above

SES, IRRI Scale (2013)

HR-Highly resistant, R-Resistant, MR-Moderately Resistant, MS-Moderately Susceptible, S- Susceptible, HS- Highly Susceptible;
#: Disease not appeared, ##: Trial was conducted at Wagahi location,
R= Resistant (1-3), MR= Moderately Resistant (3-5), MS=Moderately Susceptible (5-7)
NWG: Nawagam, NVS: Navsari, SI-Susceptibility Index, Av: Average of both location

Conclusion

The average yield of NWGR-15019 is 5425 kg/ha along with 7117 kg/ha yield potential. Considering its salient merits of NWGR 15019 *viz.,* short bold grain type, high yielding rice variety suitable for beaten rice (Poha), compact panicle, good tillering ability, early maturity, good cooking and grain qualities may suit for commercial release of variety for cultivation in Gujarat region.

References

Anonymous, 2019. Area, Production and Productivity https://www.indiastat.com

Panse, V.G. and Sukhatme, P.V. 1978. Statistical methods for agricultural workers (III *Edn*.). I.C.A.R. Publication, New Delhi.

Sedeek SEM, Hammoud SAA, Ammar MH, Metwally TF. 2009. Genetic variability, heritability, genetic advance and cluster analysis for some physiological traits and grain yield and its components in rice (*Oryza sativa* L.). J. Agric. Res. Kafr El-Sheikh Univ., 35(3),858-878.

Natio, A. 1964.Methods of detecting feeding marks of leaf and plant hopper and its application. Plant Prot. Japan, 18(12): 482-484.

Kalode, M.B., Krishna, T.S. and Gour, T.B. 1979. Studies on pattern of resistance to brown plant hopper (Nilaparvatalugens Stal.) in some rice varieties. Pro.Indian. Nat. Sci. Acad., 44: 43-48.

ICSCI 2022/T2/04

Evaluation of the performance of high yielding notified rice varieties suitable for summer season

M. B. Parmar, D. B. Prajapati, R. P. Kacha, S. G. Patel, D. J. Kacha and N. R. Makawana
Main Rice Research Station, Anand Agricultural University, Nawagam, Gujarat 387 540
Email: maheshparmar07@gmail.com

Introduction

The Main Rice Research Station, AAU, Nawagam develop different varieties of rice suitable for kharif season with transplanted conditions in Gujarat. Due to the higher productivity these varieties are being cultivated in major part of the state during *kharif* season. Some of the varieties are being cultivated in rabi-summer condition but their yield performance have not been evaluated during the rabi-summer season. Therefore, the genotypic differences in grain yield and yield contributing traits of eleven rice (*Oryza sativa* L.) varieties was studied for the irrigated transplanted condition in *rabi*-summer season at Thasara in middle Gujarat. The G × E interaction, linked with high yield suggests the suitability of variety in varying environments. In this experiment MRRS released eleven rice varieties were tested in rabi-summer condition for 2018, 2019 and 2020.

Methodology

The field experiments were conducted at ARS, AAU, Thasara, for summer season for evaluation of yield of released varieties of rice *viz,*. Mahisagar, GAR 13, GR 7, GR 101, GAR 1, GR 103, GR 6, GR 12, Jaya and Gurjari, in large scale trial during *Kharif* season of 2018, 2019 and 2020. The experiment was framed in a Randomized Block Design with three replications. The genotypes were grown in six row of 4.5 meters by maintaining 20 ×15 cm spacing of individual variety. The recommended agronomical practices were followed to raise good crop in the season. The grain yield of eleven varieties wasmentioned in Table 1 and the yield contributing traits were measured as per Table 2. The data pertaining to various characters were analyzed as per the procedure of randomized block design given by Panse and Sukhatme (1978). The data were recorded for five randomly selected plants of four middle rows in each plot for seven traits viz., plant height (cm); day of 50% flowering; panicle length (cm), number of grains per plant, 1000-grains weight (g) measured after final harvest of the plots, number of effective tillers per plant, straw yield (kg/ha), days to maturity, per day productivity kg/day/ha and grain yield (kg/ha).

Results

The present study provided an evaluation of variety and summer environmental performance of eleven varieties over three years. Numerically, three varieties viz., GAR 13 (5287 kg/ha), GAR 3 (5243 kg/ha) and GR 6 (5119 kg/ha) recorded higher yield over largely cultivated variety Gurjari (4554 kg/ha) which is 16.1, 15.1 and 12.4 per cent higher yield increment over Gurjari in summer season mentioned in Table 1. Moreover, the GAR 13 is mature in 178 days with per day productivity of 30 kg/day/ha and Mahisagar is mature in 165 days with per day productivity of 28 kg/day/ha as per Table 1. The stability analysis of variance and stability parameters *viz.*, linear regression coefficient (bi) and deviation from regression (S^2di) of genotype means over environment were computed as suggested by Eberhart & Russell (1966). Stability analysis for grain yield indicated that none of the varieties found stable performance, over the environments. Eventhuogh, GAR 3 and Gurjari are stable to some extend at greater specific to adoptable to favourable environments, except sensitive environmental changes as per Table 3 of stability analysis. The ancillary observations of mean of three years 2018-2020 was mentioned in Table 2 and among these, variety GAR 13 and Mahisagar recorded more number of effective tillers and number of grains/panicle and responsible for higher yield increment.

Table 1. Statistical analysis of rice varieties with grain yield in over three year

Treatment	Grain Yield (kg/ha)			Pooled Mean	Per day productivity (kg/day/ha)
	2018	2019	2020		
Mahisagar	7705	2930	2991	**4542**	28
GAR -13	8290	3043	4528	**5287**	30
GR-7	5099	1824	4797	3907	23
GR-101	4947	2049	4719	3905	22
GAR-1	7659	1741	6472	5291	30
GR-103	5747	1593	4414	3918	23
GR-6	6310	2715	6332	5119	28
GR-12	6419	1626	5687	4577	26
GAR-3	7572	2456	5700	5243	31
JAYA	6882	1533	3214	3876	21
Gurjari	6601	2286	4776	4554	26
G.M. (kg/ha)	6657	2163	4886	3929	
S.Em.	348	112	217	533	
CD (p=0.05)	1027	330	640	NS	
Year effect	--	--	--	Sign.	
S.Em. (YxG)	--	--	--	245	
CD (YxG)	--	--	--	694	
CV %	9.05	8.95	7.70	9.31	

Table 2. Ancillary observations of mean over three years 2018-2020

Treatment	Plant height (cm)	No. of effective tillers	Panicle length (cm)	No. of grains/ panicle	1000 Grain wt.(g)	Straw yield (kg/ha)
Mahisagar	**75**	**14**	**21**	**252**	**14**	**8217**
GAR 13	**84**	**15**	**23**	**260**	**14**	**9450**
GR 7	78	16	23	140	22	8457
GR 101	80	13	22	188	16	9319
GAR 1	80	14	22	186	16	10004
GR 103	79	15	22	175	16	9182
GR 6	81	14	24	157	21	11273
GR 12	74	16	22	180	14	9811
GAR 3	85	14	22	166	17	9732
JAYA	80	15	24	151	28	7282
Gurjari	83	13	22	138	30	7787

Table 3. Stability analysis for grain yield in rice over three years at Thasara

Varieties	Mean	bi	Test bi-0	test bi=1	S^2di	test (S^2di)
Mahisagar	4542	0.977	1.37	0.03	5168597	*
GAR -13	5287	1.117	2.62*	0.27	1798373	*
GR-7	3907	0.759	3.01*	0.96	591697	*
GR-101	3905	0.673	2.88*	1.4	496937	*
GAR-1	5291	1.352	4.6*	1.2	823877	*
GR-103	3918	0.934	11.75*	0.83	4486	NS
GR-6	5119	0.844	2.3*	0.43	1317018	*
GAR-12	4577	1.102	3.72*	0.34	837172	*
GAR-3	5243	1.143	28.77*	3.6*	-44035	NS
JAYA	3876	1.143	2.92*	0.37	1512358	*
Gurjari	4554	0.957	33.11*	1.5	-51655	NS
Over all	4565					

**indicating the significant different at 5 %= 2*

Conclusion

In this trial, a total of 11 released varieties were tested for yield potentiality in summer season. Significant differences among the varieties and environments for yield trait suggested the presence of wide variability. The trial was conducted at Thasara location during summer season from 2018 to 2020. Among these, variety GAR 13 found superior for grain yield (5287 kg/ha) and Mahisagar for earliness and grain yield (4542 kg/ha) in summer season. Among these 11 varieties, the variety GAR 13 considered due to have wider popularity and Mahisagar is due to its earliness.

References

Eberhart, S. A. and Russell, W. A. 1966.Stability parameters for comparing varieties.*Crop Science*, 6: 36–40.

Panse, V. G. and Sukhatme, P. V. 1978.Statistical methods for agricultural workers (III *Edn*.). ICAR, Publication, New Delhi.

Proximate analysis of parching sorghum genotypes as influenced by nitrogen management during rabi season

Anita B. Chorey and Nilima K. Darekar
Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MH 444 104),India
Email: nilimadarekar059@gmail.com

Introduction

Now a day's agro-tourism business is increasing in the rural areas and in the contest supplying sorghum hurda as a niche product get the more profit to the farmers and producers. Nitrogen is a primary nutrient required by crop plants for their growth and development. Nitrogen plays a key role in vegetative growth and grain production of sorghum plant. The application of nitrogen not only affects the forage yield, but also improves its quality especially its protein contents. It is reported that application of nitrogen increase fodder nutritive value by increasing crude protein and by reducing ash and fiber contents The objective of this experiment is to describe the development and characteristics of *rabi* sorghum genotype in relation to levels of nitrogen to parching sorghum for hurda purpose and at the same time for quality green fodder production.

Methodology

Parching sorghum genotypes TAK-PS-5, Sakhari Mokhari, Phule Madhur and Gulbhendi were sown at 45cm x 15cm spacing in *rabi* season with twelve treatment combinations of genotypes and nitrogen management treatment. Proximate analysis done after harvest of crop to study the quality of fodder.

Results

The proximate analysis influenced by various treatments are presented in Table 1.Proximate analysis characters such as crude protein(%), crude fibre(%), ether extract(%), total ash(%) and nitrogen free extract(%) were influenced significantly due to genotypes of *parching* sorghum. TAK-PS-5 which recorded significantly higher crude protein(8.33%) and ash content(8.24%) as compare to rest of the genotypes. Gulbhendi recorded comparable crude fibre content(29.11) and higher ether extract(1.71%). The similar findings recorded by Darekar *et al*.(2019). Proximate analysis characters such as crude protein(%), crude fibre(%), ether extract(%), total ash(5) and nitrogen free extract(%) were influenced significantly due to various nutrient management treatments. The treatment with application of 125% RDN recorded maximum proximate analysis parameters such as crude protein(8.35%), ether extract(1.73%), total ash(8.19%), nitrogen free extract(53.58%) and lowest crude fibre(28.16%). Increase in crude protein content (%) of fodder sorghum with increase in nitrogen levels have been reported by Muhammad *et al.* (2011), Nirmal *et al.* (2016) and Satpal *et al.* (2015).The interaction effect were found to be non significant.

Table 1: Proximate analysis in parching sorghum genotypes as influenced by different treatments

Treatment	Crude Protein %	Crude Fibre %	Ether Extract %	Total Ash %	NFE %
Factor A- Genotypes					
G_1=TAK-PS-5	8.33	29.04	1.70	8.24	52.69
G_2- Sakhari mokrari	8.19	29.10	1.56	8.10	53.05
G_3 - Gulbhendi	8.27	29.11	1.71	8.21	52.70
G_4 - Phule Madhur	8.11	29.03	1.62	8.12	53.12
SE(M) ±	**0.03**	**0.19**	**0.02**	**0.01**	**0.12**
CD at 5%	**0.10**	**0.56**	**0.08**	**0.04**	**0.35**
Factor B- Nutrient management					
N_1– 75%RDN	8.19	29.49	1.64	8.13	52.57
N_2– 100%RDN	8.25	28.51	1.66	8.18	53.50
N_3 – 125% RDN	8.35	28.16	1.73	8.19	53.58
SE(M) ±	**0.05**	**0.26**	**0.04**	**0.02**	**0.16**
CD at 5%	**0.14**	**0.80**	**0.11**	**0.05**	**0.50**
Interaction					
SE(M) ±	**0.07**	**0.37**	**0.05**	**0.02**	**0.23**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**
GM	**8.24**	**28.92**	**1.66**	**8.16**	**53.03**

References

Darekar NK, Chorey AB, Sawadhkar SM, Hiwale SD, Patil SC and Jane DG.(2019). Organoleptic and proximate characteristics of parching sorghum genotypes in response to management of nitrogen. International Journal of Chemical Studies; **7**(5): 3074-3077

Muhammad, A., Asif, I., Muhammad. S. Ibni. Z., Muhammad.M. and Muhammad.A. (2011). Effect of different nitrogen levels and seed rates on yield and quality of maize fodder, *Crop and environment* **2**(2): 47-51.

Nirmal, S.S., A.V.Solanke, D.D. Dudhade, and M.S. Shinde.(2016).Response of forage sorghum [*sorghum bicolor* (l). moench] cultivars to nitrogen levels.*International J. of Science, Environment and Tech.*, **5**(4): 2605 – 2609.

Satpal, Duhan BS, Joshi UN, Godara AS, Arya S and Neelam. (2015). Response of yield, quality and economics of single cut forage sorghum genotypes to different nitrogen and phosphorus levels.*Forage Research* 41 (**3**):170-175

ICSCI 2022/T2/06

Screening of rice genotypes against white backed plant hopper (*Sogatella furcifera* Horvath)

S. S. Thorat*, R. K. Gangwar, M. B. Parmar and D. B. Prajapati

Main Rice Research Station, Anand Agricultural University, Nawagam, Kheda (Gujarat)-387 540

Email: sanjuthorat2@gmail.com

Introduction

Rice is widely cultivated under the most diverse ecosystems of tropical and sub-tropical regions of the world. It is the world utmost important crop and a main food for half of the world's population. India is the second largest rice producing country in the world. Rice productivity is adversely impacted by numerous biotic and abiotic factors. In Indian environment more than 100 species of insect-pests are known to attack and about 20 are of economic importance and considered to be major insect-pests. Among them white backed plant hopper (*Sogatella furcifera* Horvath) is one of the most serious insects of rice which causes severe yield loss (Khan and Saxena, 1985). It was first reported in India from Surat, Pusa, Poona and Nagpur regions as early as 1903 and a recent report from IIRR, Hyderabad (2010). Both nymphs and adults suck phloem sap causing reduced vigour, stunting, yellowing of leaves and delayed tillering. The attacked plants become yellow and later acquire a rust-red appearance. Gravid females cause ovipositional punctures in leaf sheaths. Feeding puncture and lacerations caused by ovipositor predispose the plants to microorganisms and honeydew excretion encourages the growth of sooty mould (Rath, 2018). Under favourable conditions, it produces several generations and can cause hopper burn. Application of chemicals to this pest is not giving encouraging result and develops resistance of insects. Host plant resistance enables plants to avoid, tolerate or recover from the effects of insect-pests attack and has proved to be an effective tool against insect-pests. Using resistant varieties is an important component for integrated pest management in rice. Thus, it is necessary to find out resistant genotypes for endemic areas and donors for varietal development programme. Hence, an attempt has been made with an object to study the reaction of genotypes against white backed plant hopper (WBPH) with a view to identify the promising material for resistance.

Methodology

Total 141 rice genotypes along with white backed plant hopper (WBPH) resistant and susceptible check varieties PTB33 and TN1, respectively were evaluated under field condition at Main Rice Research Station, Anand Agricultural University, Nawagam during kharif 2020. The seed material of this genotype received from ICAR-Indian Institute of Rice Research, Hyderabad for the screening trial. The nursery of these genotypes was sown on well prepared raised beds and around Thirty days old healthy seedlings were transplanted with two seedling per hill. Each genotypes contained two rows with 20 plant and after two row of test entry one row of local susceptible check GR 11 were transplanted and after nine row of test genotype alternatively a resistant and susceptible check were transplanted. Transplanting was done at a spacing of 10 × 10 cm. No plant protection treatment was applied and more nitrogenous fertilizer were applied in the screening trial to create ideal condition for WBPH development. All the entries were artificially inoculated by releasing the WBPH adults and nymphs collected from other severely infected field and whole experimental area was covered with plastic barriers to restrict the movement of WBPH. Incidence of WBPH was recorded on randomly selected 10 hills per culture. Based on the damage rating and scale the status of rice culture was determined by the IRRI Standard Evaluation System (SES) for rice.

Results

Total of 141 cultures including resistance and susceptible checks were screened for their reactions against infestation of plant hoppers under field conditions at MRRS, AAU, Nawagam during kharif, 2020. Among all the tested genotypes, 68 genotypes were found to be resistant and recorded damage score “1”. However, 65 genotypes were found to be moderately resistant and recorded damage score “3” and remaining cultures were found moderately susceptible to WBPH. The resistance genotype PTB33 was found resistant and recorded damage score “1” and susceptible genotype TN 1 and GR 11 were found moderately resistant and recorded damage score “5” against WBPH.

Table 1: Reaction of different entries against WBPH.

Scale (0-9)	No. of Genotypes	Name of Genotypes	Status
0	0	-	-
1	68	PTB33, CB15801, CulM4, CulM8, CulM9, PTB18, PTB21, CRCPT7, CRCPT8, HWR-1-IR83784-5-28-B, HWR-16-IR73382-80-9-3-13-2-2-1-3-B, HWR-24-IR73382-7-12-1-1-3-B, IBT-BPHM2, IBT-BPHM5, IBT-BPHM6, IBT-BPHM7, IBT-BPHM8, IBT-BPHM9, JGL34789, JGL34993, JGL34997, JGL34999, JGL35071, JGL35076, JGL35085, JGL35158, JGL36160, JGL36181, JGL36189, JGL36191, KNM7715, KNM7660, KNM6871, KNM10207, KNM10067, KNM10080, KNM10081, KNM10104, KNM10125, MCM103, MCM109, MCM125, RP2068-18-3-5, RDR1162, RDR1199, RDR1200, RDR1221, RDR1210, RNR28360, RNR28399, RNR29086, RNR29176, RNR29197, RNR31477, MO1, RNR31479, RNR31498, RNR31599, RNR31668, RP179-3-9-1, RP-711-10-5-1-2, RP-123-7-5-1-2, RP-896-24-6-3-3, RP-76-5-8-3-2, RP-156-89-15-3-2, WGL-1505, WGL-1506 and WGL-1608	Resistant
3	65	BPT2824, BPT2938, BPT3031, BPT3025, BPT3060, BPT2787, CB16101, BPT3033, CB16118, CB17135, CB16142, CB16217, CB16644, CB16533, CB16574, CB16687, CB14514, CB16680, CB16785, CB13801, CB16672, CB16629, Cul7, HWR-6-IR65482-4-136-2-2-B, HWR-7-IR65482-7-216-1-2-B, HWR-8-I54751-1-2-44-15-2-3-B, RP2068-18-3-5, HW-10-IR65483-118-25-31-7-1-5-B, HWR-15-IR75870-5-8-5-B-5-B, HWR-17-IR75870-5-8-5-B-2-B, HWR-21-IR71033-121-15-B, HWR-26-IR73382-85-9-1-2-3-B-1-B, HWR-27-IR73681-11-4-1-2-4-1-B, HWR-32-IR80340-23-B-13-2-B-B, HWR-33-IR75870-8-1-2-B-6-1-1-B, HWR-39-IR77390-6-2-18-2-B, ISM-107, ISM-108, ISM-52, IBT-BPH1, IBT-BPHM3, IBT-BPHM4, IBT-BPHM10, JGL34828, KNM7786, KNM10156, KNM10220, MCM132, MCM133, RMS-ISM-BPh33-1, RNR28373, RNR29092, RNR29325, RNR31509, RNR31671, RNR31679, RNR31721, RNR31741, RP-29-12-5-3, WGL-1510, WGL-1523, WGL-1524 and KNM7629	Moderately Resistant
5	4	BPT3082, TN1, HWR-31-IR77384-12-17-3-18-2-B and GR11	Moderately Susceptible
7	0	-	-
9	0	-	-
NG*	4	RNR29326, RNR29330, RNR31763 and RP221-3-5-2	-
Total	141	-	-

NG*-Seeds were not germinated, IRRI (2013) Standard Evaluation System

Conclusion

Based on the screening results, it can be concluded that those genotypes showed resistant against WBPH, can be used as donor for varietal developmental programme against white backed plant hopper in rice.

References

Khan, Z. R. and Saxena, R. C. 1985. Behavioural and physiological responses of *Sogatella furcifera* (Horvath) (Delphacidae: Hemiptera) to selected resistant and susceptible rice cultivars. *Journal of Economic Entomology*, 78(6): 1280-1286.

Rath, P. C. 2008. Evaluation of rice genotypes against white backed plant hopper (*Sogatella furcifera* Horvath). *Oryza*, (45) 4: 331-332.

IRRI 2013. Standard Evaluation System for rice (SES), International Rice Research Institute (IRRI), Philippines pp. 1-55.

ICSCI 2022/T2/07

Screening of genotypes against bacterial leaf blight of rice under artificial inoculation condition

V. A. Patil, P. B. Patel, K.S. Mungra and P. D. Ghoghari
Main Rice Research Centre, Navsari Agricultural University, Navsari 396 450 Gujarat, India
vijay.patilagri@gmail.com, vapatil_swm@nau.in

Introduction

Rice bacterial blight (BB) is a known epidemic disease in the few pockets of perennial canal irrigated area of Southern Gujarat, that causes huge quantitative and qualitative losses. Bacterial blight (BB) is one of the major important disease of rice and occurs in more or less intensity causing considerable loss in yield under favourable weather conditions. The BB caused by *Xanthomonas oryzae* pv. oryzae was reported by Srinivasan et al. (1959) from Maharashtra state in India. It is a typical vascular disease, systemic in nature, the disease causes infection in nursery at seedling after transplanting and later at booting or heading stage. The 'Kresek' phase occurring at seedling stage is most destructive (Chahal, 2005). The use of resistant varieties is an economical alternative which also provides a satisfactory eco-friendly control of BLB disease. There is a pressing need to develop rice varieties with desirable traits and inbuilt resistance to important disease.

Methodology

Use of high yielding and identification of resistant/tolerant genotypes/entries is the most viable, environmentally safe and economically sound technique for the management of the disease. Hence, the present investigation was undertaken to find out resistant sources against bacterial blight of rice under artificial condition. Twelve genotypes + two checks were screened under field condition. The screening trial was conducted during *Kharif*- 2019, 2020 and 2021 at Main Rice Research Centre, NAU, Navsari. Two row of 2.1 meter length for each entry, the susceptible check TN-1, Resistant check (I. samba mahsuri) and state susceptible check GR-11 were planted after every 5th test entry. The local susceptible check GR-11 was also planted around the screening nursery. The artificial inoculation of *Xoo* was done by standard clip inoculation technique after 30 days of transplanting. The observation on bacterial leaf blight was taken from five hills from each genotype were randomly selected and considering for grading the severity of disease on standing plants. The labelled plants were observed for disease rating by using 1-9 scale as per SES scale (IRRI, 2013) as mentioned below.

Disease Scale	Description (affected lesion area)	Reaction categorization
1.	1 - 5 %	Resistant
3.	6 - 12 %	Moderately Resistant
5.	13 - 25 %	Moderately Susceptible
7.	26 - 50 %	Susceptible

9.	51 - 100%	Highly Susceptible

Result and Discussion

During *Kharif*- 2019, 2020 and 2021 consistent resistant reactions were observed in five entries *viz.*, IRBB-51, IRBB-60, IRBB-66, NVSR-335, NVSR- 706 and Improved Samba Masuri were showed moderately resistant reactions against bacterial blight disease over susceptible check, three entries *viz.*, IRBB-13, IRBB-53 and NVSR-331 were showed moderatly susceptible reactions while, three entries showed *viz.*, IRBB-1, IRBB-3, and IRBB-63 were showed susceptible reaction and state susceptible check GR-11 and national check TN-1 showed highly susceptible reaction against bacterial blight of rice (Table:1). Screening of rice genotypes against *Xoo* was carried out on different varieties by earlier workers. Mahajan et al. (2020) screened sixteen germplasm among them, not a single germplasm was found immune or resistant to the disease, four germplasm were showed moderately resistant. However, Jaya was found to be susceptible to *Xoo* under field condition. The results obtained in this experiment are close with the work of Rao et al. (2007) reported RP Bio-226 variety was resistant to BB. IRBB-21, IRBB-50, IRBB-55, IRBB-56 and IRBB-60 have disease scale 3 (Anon.,2008). The some of the new genotypes screened in the present study, so no specific information available related to screening with respect to bacterial blight of rice.

Table No. 1: Screening of rice entries against bacterial leaf blight disease during *Kharif* – 2019, 2020 and 2021 (Standard Evaluation System scale 1 – 9).

Sr. No	Genotype / Variety	Gene combination/cross	Bacterial blight *(1 - 9)						Final Reaction
			Year						
			2019		2020		2021		
			Disease scale	Reaction	Disease scale	Reaction	Disease scale	Reaction	
1	IRBB - 1	*Xa1*	7	S	7	S	7	S	S
2	IRBB - 3	*Xa3*	7	S	7	S	7	S	S
3	IRBB - 13	*xa13*	3	MR	3	MR	5	MS	MS
4	IRBB - 51	*Xa4+xa13*	3	MR	3	MR	3	MR	MR
5	IRBB - 53	*Xa5+Xa13*	5	MS	3	MR	3	MR	MS
6	IRBB - 60	*Xa4+Xa5+Xa13 +Xa21*	3	MR	1	R	3	MR	MR
7	IRBB - 63	*Xa5 +Xa7 + xa13*	7	S	3	MR	5	MS	S
8	IRBB - 66	*Xa4 + xa5 + Xa7 + xa13 + Xa21*	3	MR	3	MR	3	MR	MR
9	NVSR -331	IET -19384 x NVSR-177	3	MR	5	MS	5	MS	MS
10	NVSR -335	IET -19384 x NVSR-177	3	MR	3	MR	3	MR	MR
11	NVSR-706	JGL-11470 x P-206	3	MR	3	MR	3	MR	MR
1	Improved	*Xa5+xa13+Xa2*	1	R	3	MR	3	MR	MR

2	Samba Masuri (Resistant check) BLB	*1*								
13	GR-11 (State Susceptible Check)	Z-31 x IR-8-45	9	HS	7	S	9	HS	HS
14	TN-1 (National Susceptible Check)	Dee Geo Woo Gen/Tai-Yuan-Chan	7	S	9	HS	7	S	HS

***Note :** Screening was done under artificial inoculation conditions.
R – Resistant **MR –** Moderately Resistant **MS-** Moderately susceptible. **S-** Susceptible
HS – Highly Susceptible.

Conclusion

Considering the consistent resistant reactions observed in five entries *viz.,* IRBB-51, IRBB-60, IRBB-66, NVSR-335, NVSR- 706 and Improved Samba Masuri were showed moderately resistant reactions against bacterial blight disease over susceptible check, three entries *viz.,* IRBB-13, IRBB-53 and NVSR-331 were showed moderatly susceptible reactions while, three entries showed *viz.,* IRBB-1, IRBB-3, and IRBB-63 were showed susceptible reaction. against the bacterial blight. These moderately resistant entries will be used for further breeding programme.

References

Anonymous (2008). Annual Report, National Agricultural Research Project, Pathology., Gujarat Agricultural University, Navsari, p: 71.

Chahal, S. S. (2005). Disease scenario in rice during post green revolution era in Punjab. Plant Diseases Research, 20(1): 2-3.

IRRI (2013). Standard Evaluation System for Rice. INGER. Genetic Resources Centre, IRRI, Manila, Philippines, pp: 20-21.

Mahajan, S., Aryan, P., Kaur, A., Mahajan, D., and Kumar, D. (2020). Screening and management of rice germplasm against *Xanthomonas oryzae* pv. *oryzae*. Journal of Pharmacognosy and Phytochemistry, 9(6): 327-332.

Rao, Y. R.; Laha, G. S.; Veni, D. K. and Reddy, C. S. (2007). Evaluation of breeding lines against three major diseases of rice. Journal of Mycology and Plant Pathology, 37(3): 586.

Srinivasan, M. C.; Thirmulachar, M. J. and Patel, M. K. (1959). Bacterial blight of rice. Current Science, 28(1): 469-470.

ICSCI 2022/T2/08

Comparative efficacy of some novel insecticides against BPH, *Nilaparvata lugens* infesting rice in the Gangetic basin of West Bengal

Anirban Sarkar[1]* and Suvash Ch. Bala [2]
[1]AICRP on Potato, [2]AINP on Agril. Acarology,
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal-741252, India,
Email : asarkar1920@ gmail.com

Introduction

Cultivation of high yielding rice varieties in India with indiscriminate use of toxic insecticides, mostly in medium and low land situations favours high pest incidence. About 100 insects were recorded as pests on rice crop, of them 20 are designated as major pests (Pathak and Dhaliwal, 1981). Indiscriminate use of broad-spectrum chemicals also reduces the biodiversity of natural enemies, reduce the natural control and induce outbreak of secondary pests and contaminate eco-system (Sing, 2000) result in resurgence of brown planthopper. As, the resistance to existing insecticides is an on-going problem that requires the development of new insect control tools (Whalon *et. al*, 2008) so there is a need to evaluate the new groups, new formulations of insecticides and their combinations for their target and non-target effects. Therefore, the present investigation was carried out to evaluate new insecticide molecules against BPH infesting rice.

Methodology

The present experiment was conducted at 'C' unit farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal ($22^0$58'52" N; $88^0$26'30"E, 10 m above sea level) during the period of *kharif'* 2018 and *kharif'* 2019 crop season to evaluate the bio-efficacy of some novel insecticide against brown plant hopper, *Nilaparvata lugens*infecting rice. Two rounds of spraying were done during the crop season by using 500 liters of spray solution per hectare with a high-volume knapsack sprayer fitted with hollow cone nozzle. In case of Brown Plant Hopper (BPH) observations on total number of populations per 20 hills, randomly selected from each plot, were recorded one day before spray and subsequently post treatment observations were taken on 1, 3, 7, 10 and 14 days after spaying. Based on these data per cent reduction of pest population per hill were calculated.

Results

The efficacy of different treatment schedule against brown plant hopper after 1st and 2nd round of spray has been presented in table 1. Pooled data of two years showed all the treatments were effective in reducing the population of BPH over control.

Table-1: Pooled data on bio-Efficacy of some novel insecticides against BPH in rice during *kharif* 2018 and *kharif* 2019

Treatment	Dosage (g a.i / ha)	Pre-treated population per hill	% reduction of BPH population over control after 1st round spray						% reduction of BPH population over control after 2nd round spray					
			1 DAS	3 DAS	7 DAS	10 DAS	14 DAS	Mean	1 DAS	3 DAS	7 DAS	10 DAS	14 DAS	Mean
Bupro=T_1	800	34.20	28.92 (31.66)	67.9 1 (60.81)	81.32 (70.94)	82.51 (71.46)	35.15 (34.66)	**59.15**	24.81 (30.30)	84.24 (67.16)	81.12 (64.75)	73.95 (59.74)	34.79 (36.53)	**59.78**
Spine=T_2	45	24.93	27.47 (31.97)	68.32 (62.66)	66.75 (61.58)	57.92 (55.84)	38.74 (31.97)	**51.84**	29.57 (33.35)	76.81 (77.03)	73.19 (59.24)	68.49 (56.25)	36.64 (37.63)	**56.94**
Triflu=T_3	**25**	24.37	50.66 (39.87)	95.23 (77.25)	95.13 (74.19)	88.67 (74.99)	53.72 (39.37)	**76.47**	61.84 (57.04)	93.62 (76.25)	91.64 (73.97)	87.92 (70.29)	55.39 (50.46)	**78.08**
Aceta=T_4	100	25.67	39.75 (35.33)	89.73 (75.03)	85.62 (72.38)	80.18 (70.49)	37.72 (39.33)	**66.81**	44.28 (36.22)	90.12 (72.37)	87.07 (69.53)	75.33 (60.66)	40.35 (39.81)	**67.43**
Fipro=T_5	75	25.27	49.73 (39.63)	93.55 (75.83)	91.82 (75.28)	86.49 (72.02)	50.71 (34.63)	**74.45**	59.96 (56.82)	91.71 (74.03)	89.48 (71.76)	83.93 (66.60)	50.57 (48.54)	**75.13**
T_6	Control	25.53	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	**-**	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	**-**
S. Em. ±		--	1.61	1.88	1.59	0.98	1.14		1.59	1.97	2.02	2.11	1.40	
CD(0.05)			3.97	3.76	3.89	4.03	3.58		3.92	3.09	3.68	3.65	4.27	

* Values in the parentheses are angular transformed, DAS: Days after spray

Conclusion

From the result it was observed that T_3 i.e. Triflumezopyrim 10.6% SC @ 25 g a.i./ha showed highest percent (95.23) of population reduction which was statistically *at par* with T_5 i.e. Fipronil 5% SC @ 75 g a.i./ha at 3DAS. So far as mean percent reduction in pest population is concern T_3 gave best result (76.47%) followed by T_5 accounting 74.45% population reduction. Almost similar trend was observed in 2nd round spray.

References

Pathak, M. D. and Dhaliwal, G. S. 1981.Trends and strategies for rice insect problems in Tropical Asia.IRRI Res. Pap. Ser., 64, 5-6

Singh, S. P. 2000. Bio-intensive approach helpful. The Hindu Survey of Indian Agriculture. 159-163

Whalon, M.E., Mota-Sanchez, M. R. and Hollingworth, M. 2008.Analysis of global pesticide resistance in arthropods. Global Pesticide Resistance in Arthopods. Michigan State University, USA. 5-3

ICSCI 2022/T2/09

Screening of medium slender rice genotypes for bacterial leaf blight (BLB) disease resistance

Vishal Reddy[1], K. Mahantashivayogayya[2], D. Pramesh[2], Kalyani M. Barbadikar[3]

[1]*Dept. of Genetics and Plant Breeding, University of Agricultural Sciences, Raichur, Karnataka*

[2]*All India Co-ordinated Rice Improvement Project, Agricultural Research Station, Gangavati, Karnataka*

[3]*Indian Institute of Rice Research, Rajendranagar, Hyderabad*

Email: mahant.shivayogayya2@gmail.com

Introduction

Rice is a central staple food crop of most of the world's population and is among the three most important food crops, with maize and wheat being the other two. More than 3.5 billion people use rice as their staple food, which translates to at least half of the people worldwide (Rajkumar *et al.,* 2022). Due to climatic changes, the increasing temperature increases rice's susceptibility to *Xoo* and also provides favorable conditions for the growth of other pathogens, hence creating considerable challenges for BLB management A previous report showed that rice was severely affected by BLB due to heavy rainfall in tropical areas and particularly in Asia.Bacterial leaf blight (BLB) caused by *Xoo* is one of the key devastating diseases in rice farming, mostly in tropical Asia. *Xoo* is a vascular pathogen that enters rice leaves through wounds and hydathodes. It enters into xylem vessels after initial multiplication in the epithem, and it further multiplies in xylem tissue, spreads all throughout the leaves, and blocks water transport. BLB was reported for the first time in Japan during 1884–1885, which then spread and was reported in other rice-growing countries (Gnanamanickam, 2009). Xoo, being the causative agent of BLB, causes a severe loss of rice yield, and the disease it brings is broadly prevalent among diverse genotypes of rice worldwide (Singh et al., 2015).

Methodology

A set of 22 advance breeding lines (medium slender grain type) and susceptible check (TN–1) were obtained from AICRIP- Rice Breeding, Agricultural Research Station, Gangavati and were evaluated phenotypically for BLB disease reaction during *kharif 2019* in BLB evaluation nursery at Agricultural Research Station (ARS), Gangavati located at latitude of 150 43' N and longitude 760 53' E and an altitude of 406 meters above mean sea level (MSL) and comes under the Northern Dry Zone of Karnataka with the annual rainfall of 523 mm. The Standard layout was followed as per IRRI guidelines using TN-1 as a susceptible check and each entry was planted in two rows of 2m length following standard IRRI method for BLB evaluation. Laboratory grown virulent strain of *X. oryzae* pv. *oryzae* was inoculated by leaf clipping method to all twenty-two entries after thirty days of post transplanting and BLB disease reaction was recorded using 0-9 SES scale (IRRI,2013).

Results

The results of the evaluation are presented in table 2. The Standard layout was followed as per IRRI guidelines using TN-1 as a susceptible check and each entry was planted in two rows of 2m length following standard IRRI method for BLB evaluation.

Fig. 1. Clip Inoculation of rice plant by virulent strain of bacterial leaf blight

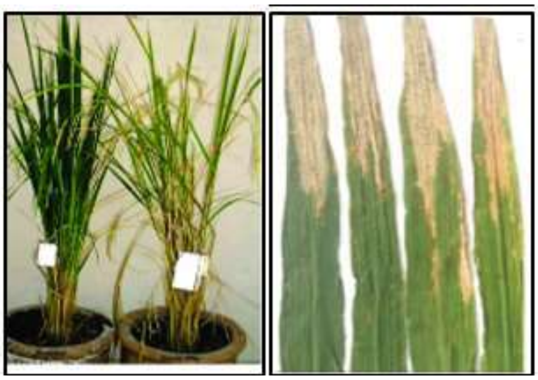


Fig.2. Symptoms of BLB 1 week after clip inoculation

Sl. No.	Genotypes	Phenotypic score	Disease Reaction	Sl. No.	Genotypes	Phenotypic score	Disease Reaction
1	GNV-1905	7	S	12	BPT mutant 1804	7	S
2	GNV-1906	7	S	13	BPT mutant 1805	9	HS
3	GNV-1907	5	MR	14	BPT mutant 1806	9	HS
4	IET-27904	3	R	15	BPT mutant 1809	9	HS
5	IET-27416	7	S	16	BPT mutant 1811	7	S
6	IET-27870	7	S	17	RNR - 15048	7	S
7	IET-26241	5	MR	18	Gangavati sanna	7	S
8	IET-27438	9	MS	19	RP-Bio 226	3	R
9	IET-25520	3	R	20	GNV 10-89	5	MR
10	BPT mutant 1801	7	S	21	GGV-05-01	7	S
11	BPT mutant 1802	9	HS	22	BPT-5204	7	S
Susceptible check					TN-1	9	HS

Laboratory grown virulent strain of BLB pathogen *Xoo* was clip inoculated to all twenty-two entries after thirty days of post transplanting as shown in figure1 and BLB disease reaction was evaluated using 0–9 SES scale as per (IRRI,2013), when the susceptible spreader TN 1 was completely killed. After 25–30 DAS (1 week after inoculation) the test entries were scored based on BLB severity following SES scale. Based on the BLB severity, the reactions of the lines are categorized into different categories of resistance and susceptibility (Table 1). Among the 22 medium slender genotypes, 3 (17 %) were resistant (with a score 3), 3 (14 %) were found to be moderately resistant (score of 5), while 11 (50 %) were susceptible (score of 7) and 5 (23%) were highly susceptible. Disease severity varied from lesions infecting 6-12 % (resistant) to more than 51-100 % (highly susceptible) of leaf area.

Conclusion

From the above findings three genotypes were resistant (with a score 3), three were found to be moderately resistant (score of 5), while 11 were susceptible (score of 7) and 5 were highly susceptible. Disease severity varied from lesions infecting 6-12 % (resistant) to more than 51-100 % (highly susceptible) of leaf area affected.

References

Kauffman, H. E., Reddy, A. P. K., Hsieh, S. P. Y., Merca, S. D., (1973). An improved technique for evaluating resistance of rice varieties to *Xanthomonas oryzae*. Plant Diseases 57(2): 537–541.

Rajkumar, D., Rao G. S., Tirupathi, B., Rodriguez, G. H., (2022). Activities of Antioxidant Enzymes in Six Rice (*Oryza sativa* L.) Varieties at Seedling Stage under Increasing Salinity Stress. International Journal of Economic Plants 9(1): 049–058

Singh, S., Chand, S., Singh, N. K., Sharma, T. R., (2015). Genome-wide distribution, organisation and functional characterization of disease resistance and defense response genes across rice species. PLoS ONE 10: 59–64.

Genetic diversity of indica tropical japonica derived lines in rice

K. Sruthi[1], K.B. Eswari[2], Ch. Damodhar Raju[2], M. Sheshu Madhav[1], A. Dhandapani[3], M. Bala Satya Sree[1], K. Srikrishna Latha[1], P. Koteswararao[1], M. Sadath Ali[1], Divya Balakrishnan[1], P. Senguttuvel[1], P. Revathi[1], K.B. Kemparaju[1], Ch. Suvarna Rani, M.B. Kalyani, R.M. Sundaram[1] and A.S. Hari Prasad[1]*

[1]Crop Improvement Section, ICAR-Indian Institute of Rice Research, Hyderabad-500030, Telangana, India.
[2]College of Agriculture, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Hyderabad-500030, Telangana, India.
[3] National Academy of Agricultural Research Management (NAARM), Hyderabad-500030, Telangana, India.
Email:hariprasad34@gmail.com

Introduction

To develop inter sub specific hybrids, the most efficient approach would be using tropical japonica germplasm or intermediate parental lines having both indica and tropical japonica mixed back ground in hybrid rice breeding, This will help in broadening the genetic base of hybrid parental pool (Both R and B line) which may greatly enhance the heterosis levels. In the present study, to breed intermediate parental lines, a set of 106 indica tropical japonica derived lines were developed from potential indica hybrid parental lines and tropical japonica germplasm. These 106 indica tropical japonica derived lines have been characterized for yield attributing traits and also by using micro satellite markers to understand the genetic variability and diversity of the material.

Methodology

A total of 150 genotypes including 106 indica tropical japonica derived lines, 34 parents and 10 checks were characterized for 14 yield and its attributing traits by adopting alpha lattice design in three replications during kharif 2018. For molecular characterization 50 SSR markers were used which were shortlisted by IRRI for diversity studies. Molecular diversity parameters were calculated by using POWERMARKER Ver3.25 (Liu and Muse 2005), molecular clustering was performed by using DARwin software ver 6.0.010 (Perrier and Jacquemoudcollet 2006) and Population structure was performed by using STRUCTURE software ver 2.3.4 (Pritchard et al. 2000).

Results

Based on yield data, it was observed that IJD2 (86 days) was the earliest genotype, IJD39 (75.80 cm) was the shortest genotype, IJD77 (27. 86 cm) was found to be with the longest panicle, IJD68 (341) was identified with a maximum number of filled grains, IJD51 (94.99 %) with highest spikelet fertility per cent, IJD83 (32.42 g.) with highest thousand grain weight, IJD44 (SPY-23.84 g; BM-37.71 g; PDP-59.31 kg ha^{-1}) with high single plant yield, biomass and per day productivity and IJD41 (69.65 %) was observed with highest harvest index. Mehalanobis D^2 statistics grouped 150 genotypes into 10 clusters and number of unfilled grains and single plant yield were considered as major forces for differentiation at genotypic and inter cluster level. From molecular characterization, a total of 306 alleles were amplified by 50 polymorphic markers across 149 lines. Allele number per locus generated by each marker ranged from 2 (RM495) to 13 (RM536) with an average of 6.12 alleles per locus. The value of major allele frequency, gene diversity, heterozygosity and PIC was ranged from 0.32 (RM316) to 0.75 (RM431), 0.41 (RM431) to 0.77 (RM316 and RM552), 0.00 (RM277, RM552,

RM484, RM284, RM454, RM133, RM178, RM431, RM237, RM312, RM283 and RM452) to 0.24 (RM144) and 0.35 (RM133) to 0.74 (RM552 and RM124), respectively. The cluster pattern generated by DARwin software resolved 149 lines into 3 groups. The structure analysis revealed that total 149 lines divided into two main groups based on optimum K value at 2.

Conclusion

From the present study, it can be concluded that the breeding material developed through intersubspecific hybridization has captured considerable genetic diversity and variation for various yield attributing traits.

References

Liu K, Muse SV (2005) PowerMarker: an integrated analysis environment for genetic marker analysis. Bioinformatics 21(9):2128–2129.

Perrier X, Jacquemoud-Collet JP. DARwin software (2006) http:// darwin.cirad.fr/Accessed 30 Sept 2015.

Pritchard JK, Stephens M, Donnelly P (2000) Inference of population structure using multilocus genotype data. Genetics 155(2):945–959.

ICSCI 2022/T2/11

Agronomic management for yield maximization in wet direct seeded rice

G. Senthil Kumar

Department of Rice, Tamil Nadu Agricultural University, Coimbatore- 641 003, Tamil Nadu, India
E mail: senthilkolathur@gmail.com

Introduction

Direct seeded rice is gaining popularity because of its low-input demand. It offers certain advantages *viz.*, it saves labour, requires less water, less drudgery, early crop maturity, low production cost, better soil physical conditions for following crops and less methane emission, provides better option to be the best fit in different cropping systems (Jagmohan Kaur and Avtar Singh, 2017). Direct seeding includes both the dry and wet seeding of rice, practiced depending on water availability in the region. Sowing of sprouted rice seed or wet-seeded rice in puddled soil though becoming increasingly important as a method of crop establishment under lowland rice is beset with weed problems, particularly grassy weeds besides other management practices. Weeds emerge at about the same time that the rice seeds germinate, and therefore the yield losses caused by weeds will become greater with the trend towards wet seeding. Effective weed control is one of the key issues and major requirements to ensure a successful wet-seeded rice crop. Wet direct seeding method in the past has received relatively less attention than transplanting. Rice farmers in the tropics practice wet seeding by broadcasting or line seeding of germinated seeds on the puddled soil surface. There is a possibility of intercropping green manures during early stage of rice crop with less interference on the crop growth. This situation can effectively be capitalized upon by raising *dhaincha* (*Sesbania aculeata*) as a green-manure crop conjointly with wet-seeded rice, and incorporating it at 35-40 days of growth using cono weeder. Hence, the present study was constituted to study the time and methods of sowing to assess the cost effective agronomic management practices to enhance the production of wet direct seeded rice.

Methodology

A field experiment was conducted during *Kharif*, 2020 and 2021 at the department of Rice, Tamil Nadu Agricultural University, Coimbatore, to study the time of sowing and methods of sowing under wet seeded rice. Treatments comprising of time of sowing in main plot *viz.*, normal sowing time of first fortnight of July (M_1), delayed sowing of second fortnight of July (M_2). In sub-plot, method of sowing *viz.*, broadcasting method (S_1), line sowing method (S_2), paddy drum seeder method (S_3), paddy + dhaincha drum seeder method (S_4) and direct planting method (S_5). The variety chosen for this study was CO 51 and the experimental trial was laid out in split plot design with three replications. In sub plot, for broadcasting method seeds were broadcasted and in line sowing method, sowing was done by using the manual labour with a spacing of 20 cm apart. In drum seeder method, paddy drum seeder was used maintain a row spacing of 25 cm apart and in paddy + dhaincha drum seeder method, one row of paddy and one row of dhaincha sowing was done alternatively. Intercropped dhaincha was incorporated *in-situ* at 35 days after sowing using conoweeder. The row-to-row spacing was 25 cm between rice with one row of dhaincha in the middle. In direct planting system, seeds were broadcasted manually at 20 DAS, by using conoweeder 25 cm row to row spacing was maintained by incorporating seedlings in to the field. The recommended doses of 150:50:50 kg/ha of N:P:K in the form of urea (326 kg /ha), single super phosphate (312.5 kg/ha) and muriate of potash (83.3 kg/ha) were applied. Nitrogen and potassium were applied in four equal splits at 21 DAS, active tillering, panicle initiation and heading, whereas the entire dose of P was applied basal before sowing. A very thin film of water was maintained at the time of sowing. For the next 8-10 days, irrigation and drainage were alternated to enable germination of seeds and establishment of seedlings. Thereafter, the crop was irrigated to 5 cm depth at required intervals when the water was completely drained, and irrigation was withheld 10 days before the harvest. The recorded data were pooled analysed statistically as per the method suggested by Gomez and Gomez (1984). \

Results

Based on the two years of experimental study, the results revealed that first fortnight of July sowing by using Paddy + Dhaincha drum seeder method recorded higher number of panicles/m^2 (349) and panicle weight (2.98 g) whereas, broadcasting method recorded lesser number of panicles/m^2 (259) and panicle weight (1.94 g). This may be due to decrease in weed competition decreased the nutrient removal by weeds, which provided a competition-free environment for rice. These results were in conformity with the findings of Mani sankar *et al.,* (2019). Sowing of wet direct seeded rice during first fortnight of July month by using Paddy + Dhaincha drum seeder method recorded higher grain yield of 5707 kg/ha (Table 1) which resulted 33 per cent higher yield than that of broadcasting method. Growing of dhaincha between paddy rows smothering the weed growth in early stages and incorporation of dhaincha at 30 days after sowing by using cono weeder which accelerates root aeration and also adds organic nutrients in to the soil. This may be due to decrease in weed competition decreased the nutrient removal by weeds, which provided a competition-free environment for rice. Rice + dhaincha increased the grain yield substantially due to the effective suppression of weeds, restriction of nutrient drain by weeds and increase in nutrient uptake by the crop. Peak release of NH_4-N from dhaincha coincided with panicle initiation stage signifying N availability at critical stage (Parameswary *et al.,* 2015).

Table 1. Effect of treatments on Grain yield (kg/ha) of wet direct seeded rice

Time of Sowing	Grain Yield (kg/ha)			
	Normal sowing (Ist fortnight July)		Delayed sowing (IInd fortnight of July)	Mean
Broadcasting method (S_1)	3801		3655	3728
Line sowing method (S_2)	5195		4816	5006
Paddy drum seeder method (S_3)	5476		4952	5214
Paddy + Dhaincha drum seeder method (S_4)	5707		5010	5359
Direct planting method (S_5)	4780		4465	4623
Mean	4992		4580	
	M	S	M at S	S at M
S.Ed	23	49	65	69
CD(0.05)	73	100	144	142

Conclusion

From this study it can be concluded that, wet direct sowing during the first fortnight of July month by using Paddy + Dhaincha drum seeder method is more suitable for enhancing the grain yield under wet direct seeding of rice cultivation during *Kharif* season in Tamil Nadu.

References

Jagmohan Kaur and Avtar Singh. (2017). Direct Seeded Rice: Prospects, Problems / Constraints and Researchable Issues in India. Current Agriculture Research Journal. 5(1), 13-32.

Gomez KA, Gomez AA. Statistical Procedure for Agricultural Research. John Wiley and Sons, New York, 1984.

Manisankar, G. Ramesh, T. Rathika, S, Janaki, P. Balasubramanian, P. (2019). Evaluation of sequential herbicide application on transplanted paddy under sodic soil. The Pharma Innovation Journal. 8(5): 633-638.

Parameshwari, Y.S., Srinivas, Prakash, T.R. Narendar, G. (2015). Effect of different crop establishment methods on rice (*Oryza sativa* L.) growth and yield - A review. Agricultural Reviews. 35(1): 74-77.

ICSCI 2022/T2/12

Evaluation of short duration varieties of rice in Namsai condition (Arunachal Pradesh)

***Abhisekh pradhan, V. S. Devadas[1]**
**[1]Arunachal University of Studies, Namsai, Arunachal Pradesh-792103*
Email: gudu.pradhan007@gmail.com

Introduction

Rice is the major field crop of Arunachal Pradesh. Most of the farmers cultivate traditional varieties with long duration during kharif season (June – December) and leave the field fallow during the rest of the year. Under this circumstances, an experiment was conducted at the agricultural research farm of Arunachal University of Studies, Namsai. With an objective of identifying short duration rice varieties, suited for growing in two or three crop seasons.

Methodology

Three short-duration rice varieties of Assam agricultural university (Kolong, Luit and Disang) were grown under two cultivation methods (direct sowing and transplanting).The six treatment combinations were evaluated in a factorial RBD during kharif season (June-December) 2019. Growth and yield parameters were recorded and analysed as per standard procedures.

Results

Results obtained from the experimental data showed no significant difference between direct sowing and transplanting with respect to crop duration and number of tillers per hill. The yield of transplanted crop was significantly higher in transplanted crop (1.64 kg/plot of 4.5 m^2) compared to direct sown crop (1.19 kg/plot).

The overall performance of the three varieties differed significantly for crop duration and yield. The shortest crop duration (94 days) and the highest yield (1.75 kg /4.5 m^2) was recorded by variety Luit whereas Kolong and Disang were at par with each other, having a higher duration (103-104 days) and lower yield (1.25 kg/4.5 m^2). The varieties tested did not differ significantly for number of tllers.

Conclusion

Interaction effects of the methods of cultivaton and varieties were significant for yield, crop duration and tillers/hill. Among the different treatments of cultivation, transplanting of variety Luit out yielded (1.92kg/4.5 m^2 with an yield of 4.27 t/ha) a crop duration of 98 days, indicating the possibility of taking two or three crops in an year.

ICSCI 2022/T2/13

Genetic variability and correlated response of traits in exotic bread wheat accessions under early sown, irrigated and high fertility conditions

SV Sai Prasad[1], Manohar Patidar[2], JB Singh[2] and Divya Ambati[3]
1ICAR-Indian Institute of Rice Research, Hyderabad
2ICAR-Indian Agricultural Research Institute – Regional Station, Indore – 452 001 (MP)
3ICAR-Indian Agricultural Research Institute – Regional Station, Indore – 452 001 (MP)
Email: sprasad98@gmail.com

Introduction

In India, wheat is one of the most durable and dependable cereal crops after rice, grown under diverse agro-climatic conditions, occupying nearly 31.5 million ha. with a record production of ~109 million tons during 2021-22 and provides 20% of the total food calories of human requirement. It provides more calories and protein to human diet than any other crop. A good success for increasing yield potential of bread wheat in India has been achieved by developing high yielding varieties. To confront the rising temperatures and water scarcity expected in South Asia; and to maintain or increase the productivity of wheat based systems, it is better to foster the spread of early planting especially in month of October, which is an important adaptation mechanism for coping with contemporary and projected climate extremes. Most of the irrigation sources in warmer areas dry out by December-January, and hence, farmers tend to sow wheat early during October first week for the maximum utilization of available irrigation water. Suitable genotypes with high grain yield under these conditions are lacking. Grain yield is the complex trait involving many yield components and influenced by genotype and agro-ecological conditions and contributed mainly by spike length, tillers per plant, grains per spike and seed mass (size). In any selection programme, emphasis on yield and its component characters lies solely on their heritability and genetic advance. A successful selection for grain yield depends upon the information on the genetic variability and selection indices. Hence, in this investigation, exotic bread wheat genotypes were used and an attempt was made to generate information on genetic variability and correlated response and their implication in development or improvement of cultivars to make them suitable for early sown irrigated high fertility conditions.

Methodology

A total of 132 exotic wheat varieties along with 3 check varieties *viz.*, PBW 343, HI 1544 and HD 2932, were evaluated ina randomized block design with two replications for two years; and each test plot is represented by two rows of 2.5 m long and 23 cm apart under early sown, irrigated and high fertility conditions. Recommended package of practices were followed for the genotypes, so as to make them to express their full potential. The data of 9 characters *i.e.*, grain yield and its contributing components were collected on 5 randomly selected plants from each of the replication. The mean replicated data on various biometric traits were subjected to analysis of variance, PCV, GCV, broad sense heritability, expected genetic gain and correlations among characters as per the standard statistical and biometrical procedures.

Results

Significant mean sum of squares was observed by anova of 132 exotic wheat genotypes along with check varieties *viz.*, hi 1544, pbw 343 and hd 2932 for 9 characters indicated the presence of an appreciable amount of variability among the genotypes. The values of phenotypic coefficient of variation were higher than that of the genotypic coefficient of variation for all the characters (table: 1). the phenotypic coefficient of variation was estimated to be high for biomass/plot (19.0) followed by grain yield/plot (16.9), harvest index (12.0) and spike length (10.7). Genotypic coefficient of variation also showed the similar trend for some of the traits; and was observed to be high for spike length (9.2) followed by days to heading (5.2) indicating high degree of genetic variability offering great scope for selection of these characters. Difference between the pcv and gcv was high for biomass/plot followed by grain yield/plot, harvest index and no. of tillers/m indicating the presence of environmental influence on the expression of these traits. Substantial diversity for early vigour, biomass, 1000 grain weight, harvest index and days to heading were present in the genotypes to make them suitable for early sowing under high fertility conditions. heritability in broad sense was observed to be high for days to maturity (0.88) followed by days to flowering (0.84); while, moderate for plant height (0.76) and spike length (0.72); and low for grain yield/plot (0.12) and biomass/plot (0.06). genetic advance is high for biomass/plot (40.0) followed by grain yield/plot (16.9), whereas, genetic advance as percentage of mean was found to be highest for spike length (15.9) followed by days to heading (9.9), 1000 grain weight (7.2) and plant height (5.5) (table 1). High to moderate heritability coupled with high to moderate genetic advance as percentage of mean was exhibited for traits *viz.*, days to flowering, days to maturity, plant height, 1000 grain weight and spike length, which indicates that predominance of additive gene action in the expression of these characters and consequently greater chance of improving these traits through simple.

Genotypes *viz.*, 47th ibwsn 303, 45th ibwsn 1180, 32nd sawsn 260, 46th ibwsn 1180 and 47th ibwsn 616 showed early maturity, while, 44th ibwsn 1169 and 44th ibwsn 1170 expressed late maturity. genotypes *viz.*, 30th sawsn 3047, 31st sawsn 3046, 29th sawsn 3140, 44th ibwsn 1045 and 29th sawsn 3125 expressed high tillering/m, while, genotypes viz., 47th ibwsn 715, 44th ibwsn 1022, 47th ibwsn 770, 31st sawsn 3202 and 47th ibwsn 642 showed high 1000 grain weight in comparison to check varieties. Genotypes *viz.*, 30th sawsn 3093, 29th sawsn 3125, 30th sawsn 3036, 29th sawsn 3058 and 44th ibwsn 1196 showed high biomass/plot, while, genotypes *viz.*, 45th ibwsn 1315, 45th ibwsn 1181, 29th sawsn 3125, 29th sawsn 3036 and 47th ibwsn 410 showed high grain yield/plot in comparison to check varieties (table 2). Grain yield/plot shows significantly positive correlation with days to heading (r = 0.19*), plant height (r = 0.16*), spike length (r = 0.22**), no. of tillers/m (r = 0.33**), 1000 grain weight (r = 0.17*), biomass/plot (0.77**) and harvest index (0.24**) (Table 3, Fig. 1.). Days to maturity exhibit positive and significant correlation with plant height (0.47**), spike length (0.30**) and biomass/plot (0.20*), while negative and significant correlation with harvest index (-0.17*). Spike length showed significant positive association with 1000 grain weight (0.39**), biomass/plot (0.16*) and grain yield/plot (0.22*), whereas, number of tillers/m exhibit positive and significant relationship with biomass/plot (0.36**) and grain yield/plot (0.33**); and showed significant negative correlation with 1000 grain weight (-0.25**). 1000 grain weight showed significant positive correlation with biomass/plot (0.18*) and grain yield/plot (0.17*). Biomass/plot showed significant positive correlation with grain yield/plot (0.77**); while, negative correlation with harvest index (-0.41**). Positive correlation was observed between grain yield/plant and harvest index (0.24**).

Table 1: Estimates of genetic variability for various characters of wheat.

Character	Mean	Min	Max	PCV	GCV	H^2(b)	GA	GA over mean	CV %
Days to heading	75	58	88	5.7	5.2	0.84	7.4	9.9	2.31
Days to maturity	137	130	145	2.5	2.3	0.88	6.1	4.5	0.87
Plant height (cm)	98	88	108	3.5	3.1	0.76	5.4	5.5	1.71
No. of tillers/m	81	69	97	9.1	2.3	0.18	0.3	0.3	9.09
Spike length (cm)	10.4	7.9	13.0	10.7	9.2	0.72	1.7	15.9	5.63
1000 grain weight (g)	46.3	37.9	55.0	5.7	4.5	0.59	3.3	7.2	3.74
Biomass/plot (g)	1622	1120	2045	19.0	4.8	0.06	40.0	2.5	18.42
Grain yield (g)	628	424	789	16.9	4.7	0.12	16.9	2.7	12.03
Harvest index (%)	39.2	29.8	46.5	12.0	2.1	0.23	1.1	2.9	11.21

Table 2: Superior genotypes for various traits under early sown irrigated high fertility conditions.

Trait	Genotypes
Early maturity	47th IBWSN 303, 45th IBWSN 1180, 32nd SAWSN 260, 46th IBWSN 1180 and 47th IBWSN 616
Late maturity	44th IBWSN 1169 and 44th IBWSN 1170
Tillering/m	30th SAWSN 3047, 31st SAWSN 3046, 29th SAWSN 3140, 44th IBWSN 1045 and 29th SAWSN 3125
1000 grain weight	47th IBWSN 715, 44th IBWSN 1022, 47th IBWSN 770, 31st SAWSN 3202 and 47th IBWSN 642
Biomass/plot	30th SAWSN 3093, 29th SAWSN 3125, 30th SAWSN 3036, 29th SAWSN 3058 and 44th IBWSN 1196
Grain yield/plot	45th IBWSN 1315, 45th IBWSN 1181, 29th SAWSN 3125, 29th SAWSN 3036 and 47th IBWSN 410

Table 3: Correlation coefficient of 132 exotic accessions of wheat.

Parameters	Days to heading	Days to maturity	Plant height	Spike length	No. of tillers/m	1000 gr. weight	Biomass/ plot	Harvest index
Days to maturity	0.79**							
Plant height (cm)	0.40**	0.47**						
Spike length (cm)	0.55**	0.30**	0.40**					
No. of tillers/m	-0.11	0.07	0.19*	-0.15				
1000 grain weight(g)	0.22**	-0.01	0.32**	0.39**	-0.25**			
Biomass/ plot (g)	0.13	0.20*	0.15	0.16*	0.36**	0.18*		
Harvest index (%)	0.06	-0.17*	-0.01	0.06	0.01	0.13	-0.41**	
Grain yield/ plot (g)	0.19*	0.08	0.16*	0.22**	0.33**	0.17*	0.77**	0.24**

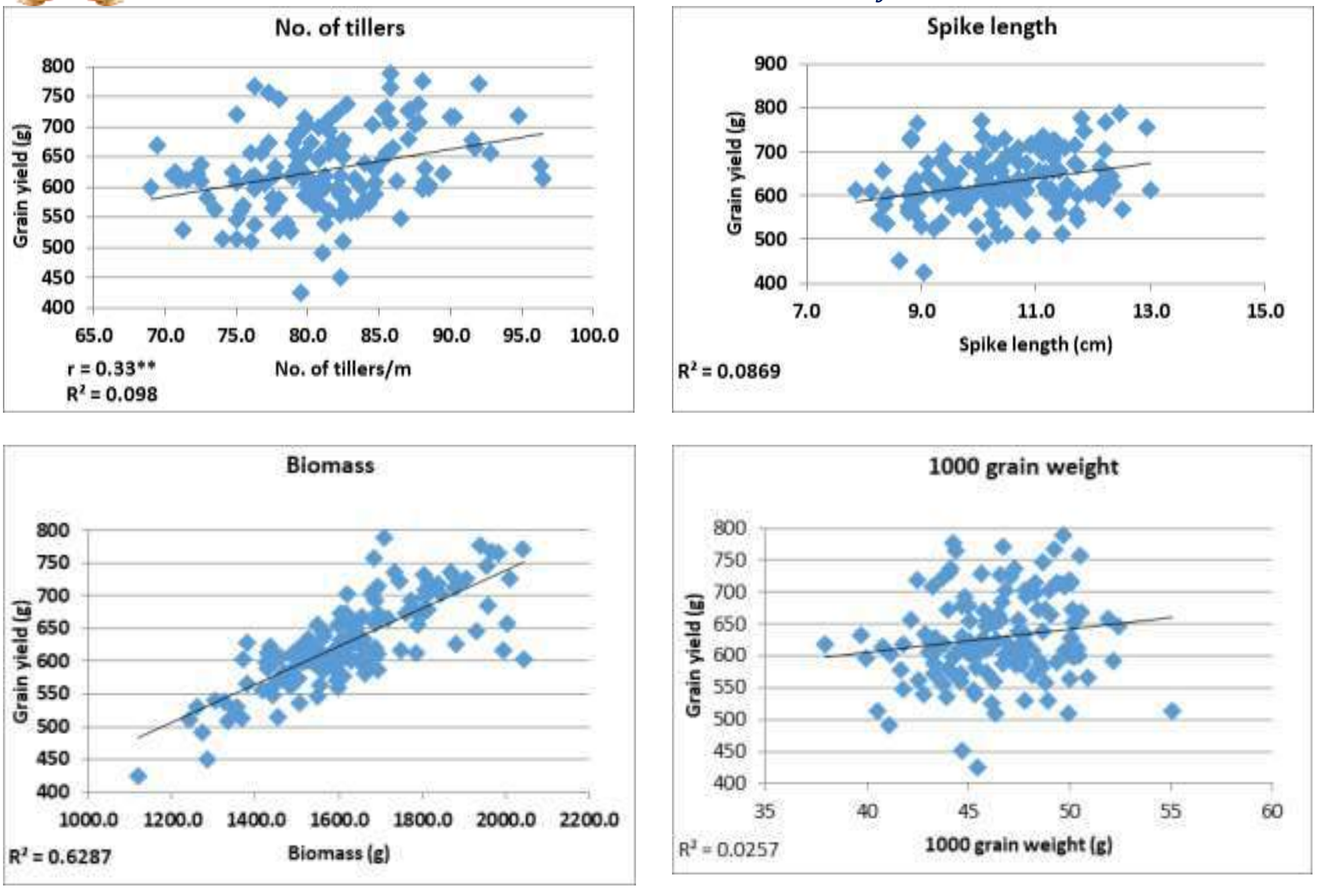


Fig. 1: Graphical representation of relationships of yield contributing traits with grain yield.

Conclusions

The tendency of positive correlation between morphological traits, in spite of wide range of genetic diversity in exotic wheat genotypes, could effectively be utilized to develop new wheat varieties. Simultaneously more selection pressure could be applied on more number of tillers, more spike length and larger grain size in segregating generations to maximize grain yield. More emphasis should be given for characters based on association analysis *i.e.*, spike length, no. of tillers/m and 1000 grain weight, during selection for early sown with high fertility and irrigated conditions. As a whole, genotypes *viz.*, 45th IBWSN 1315, 29th SAWSN 3125 and 30th SAWSN 3036 showed high grain yield along with superior yield contributing traits, hence, they can be utilized as potential donors for improving grain yield in future breeding of wheat varieties under early sown, irrigated and high fertility conditions under warmer temperatures.

References

Riaz-Ud-Din G.M.S., Naeem, A., Makhdoom, H. and Rehman, A.U. 2010.Effect of temperature on development and grain formation in spring wheat.*Pak. J. Bot*. **42**(2): 899-906.

Varsha, Priyanka Verma, Pooja Saini, Vikram Singh and Shikha Yashveer 2019. Genetic variability of wheat (Triticum aestivum L.) genotypes for agro-morphological traits and their correlation and path analysis Journal of Pharmacognosy and Phytochemistry 8(4): 2290-2294.

Nutrient management in conservation agriculture based intensification in rice - maize system for higher productivity, energy conservation and farm profitability

J.S. Sudha rani[1], B. Sreedevi[2], P.C. Latha[2], M. Venkata Ramana[1]and M. Yakadri[1]

Department of Agronomy, [1]Professor Jayashankar Telangana State Agricultural University qnd [2]ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad – 500030, Telangana, India.
Email: sudharaniscientist@gmail.com

Introduction

The development of short duration rice varieties suitable for aerobic ecosystem coupled with high yielding maize hybrids provide an opportunity for increasing the area under Rice–Maize cropping under conservation agriculture system in India. Rice-Maize system is also gradually gaining importance in canal and tank irrigated areas of Telangana. Timsina *et al.* (2010) hypothesized that sowing maize under reduced or no tillage conditions by retaining crop residues and adopting improved nutrient management and establishment methods could help to conserve soil organic matter and maintain soil fertility. Cropping of two nutrient exhaustive cereals like rice and maize would drain a substantial quantity of nutrients from soil during continuous cropping round the year, envisaging the need for adoption of efficient nutrient management practices for sustained soil health and improving system productivity (Surekha et al., 2016). Hence the present study was conducted with the following objective to assess the influence of nutrient management on, system productivity, energetics and economics of the aerobic rice – zero till maize system.

Methodology

The experiment was conducted at ICAR-Indian Institute of Rice Research, Hyderabad, Telangana (11◦000 N; 77◦000 E, 427 m above sea) during *kharif* and *rabi* seasons of 2017-18 and 2018-19. with a sub-tropical and semi-arid climate. Experiment was laid out in split plot design comprising of four main treatments as organic sources of nutrients and four sub treatments as fertility levels, replicated thrice. The layout was not disturbed during second season to study residual effects of the main treatments and direct and cumulative effect of sub treatments.

Table 1: Treatment details

Treatment	*Kharif* season (Aerobic rice)	*Rabi* season (Zero till maize)
Main treatment		
M_1	Neem leaf manure 6 t ha^{-1}	Residual effect
M_2	Vermicompost 2 t ha^{-1}	Residual effect
M_3	Goat manure 5 t ha^{-1}	Residual effect
M_4	Microbial consortia [seed treatment 4g kg^{-1} + soil application 4 kg ha^{-1}]	Residual effect
Sub Treatment		
S_1	Control	Control
S_2	50 % RDF	50 % RDF
S_3	75 % RDF	75 % RDF
S_4	100 % RDF (120-60-40)	100 % RDF (180:60:60)

Results

System productivity of aerobic rice - zero till maize (REY):

The influence of various nutrient sources and levels imposed in *kharif* rice followed by zero till maize during *kharif* 2017, 2018 and *rabi*2017-18 and 2018-19 (Table 2). Nutrient sources and nutrient levels exhibited a significant variation on gross returns, net returns and system productivity and B:C ratio. Organic sources of nutrients *viz;* goat manure 5 t ha^{-1} or Vermicompost 2t ha^{-1} and 100% RDF among the nutrient level resulted in higher system productivity, However, interaction effect of nutrient sources and levels did not exert any significant effect of rice-maize cropping system.

Energy dynamics of aerobic rice - zero till maize:

Application of nutrient sources as goat manure 5 t ha^{-1} or vermicompost 2 t ha^{-1} and 100% RDF among the nutrient levels resulted in higher gross energy output, net energy, Energy use efficiency and Energy productivity in rice-maize cropping system. Nutrient rich bulky organic manures and higher level of nutrient availability favoured higher yield, resulting in higher energy output organic manures and higher nutrient levels attributed congenial environment for the enhancement of rice, maize output and achieved superiority of energy output compared to other treatments as noted by Naganjali (2022).

System Gross returns, net returns and B-C ratio:

Pooled mean values depicted (Table 2) that, significantly higher system gross returns and net returns and B:C ratio was recorded in goat manure 5 t ha^{-1}which was at par with vermicompost 2 t ha^{-1} and net returns and B:C ratio. While, significantly lower gross returns and net returns and B:C ratio was recorded by neem leaf manure 6 t ha^{-1} as mulch and microbial consortia ST 4g kg + SA 4 kg ha^{-1}].

S_4 100% RDF in zero till maize resulted in significantly higher values for economics in rice-maize cropping system *i.e.*, system gross returns system net returns and B:C ratio while lowest system gross returns, system net returns and B:C ratio.

Table. 2: System productivity, Economics and Energy dynamics of rice-maize system of aerobic rice-maize system as influenced by organic nutrient sources and inorganic nutrient levels (pooled mean of kharif 2017 and 2018).

Treatment	System productivity (kg ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C Ratio	Energy output (MJ ha^{-1})	Net energy (MJ ha^{-1})	Energy use efficiency (%)	Energy productivity (kg MJ^{-1})
Organic nutrient sources (M)								
M_1: Neem leaf manure 6 t ha^{-1}	8155	126397	72376	2.34	267201	204453	9.30	0.28
M_2: Vermicompost 2 t ha^{-1}	9898	153415	90394	2.43	322560	271301	12.52	0.39
M_3: Goat manure 5 t ha^{-1}	9979	154667	93645	2.53	323428	271276	12.40	0.38
M_4: Microbial consortia 4g /kg seed & 4kg ha^{-1} SA	8099	125532	72512	2.37	265541	214922	10.42	0.32
Sem±	139	2159	2159	0.05	2974	2974	0.106	0.003
CD (*P=0.05*)	482	7472	7472	0.14	10291	10291	0.366	0.011

Inorganic nutrient sources (S)								
S_1: 0% RDF	5355	82998	32505	1.64	196985	154357	9.89	0.27
S_2: 50% RDF	8942	138606	81644	2.43	291821	238966	11.43	0.35
S_3: 75% RDF	10506	162836	102638	2.70	335468	277406	11.88	0.38
S_4: 100% RDF	11327	175571	112139	2.77	354455	291223	11.44	0.37
Sem±	142	2198	2198	0.05	3154	3154	0.12	0.006
CD (*P=0.05*)	414	6415	6415	0.13	9206	9206	0.35	0.016
Interaction								
CD (*P=0.05*)	NS	NS	NS	NS	NS	NS	NS	NS

Conclusion

Application of goat manure 5 t ha^{-1} or vermicompost 2 t ha^{-1} and 100% RDF to both aerobic rice and Zero till crops resulted in higher productivity, Energy Conservation and Farm Profitability.

References

Naganjali.K, K. P Vani and M Madhavi. 2021. Nutrient and weed management practices in semi dry rice based zerotillage maize cropping system” *Thesis submitted to Professor Jayashankar Telangana State Agricultural University Rajendranagar.*

Surekha, K.V. Rao, N. Shobha Rani, P.C. Latha and R.M. Kumar. 2016. Evaluation of Organic and Conventional Rice Production Systems for their Productivity, Profitability, Grain Quality and Soil Health *Agrotechnologyl, S11, DOI: 10.4172/2168-9881.1000S11-006.*

Timsina J, Mangi L, Jat, Kaushik Majumda. Rice-maize systems of South Asia: current status, future prospects and research priorities for nutrient management Plant *Soil. 2010;335:65–82 DOI 10.1007/s11104-010-0418.*

ICSCI 2022/T2/16

Development of semidwarf and high yielding black scented rice, *Chakhao* (*O. sativa* L.) varieties of Manipur

Konsam Sarika, Tensungbam Basanta Singh, Ngangkham Umakanta Singh, Elangbam Lamalakshmi Devi, Yengkhom Rajen Singh, Thokchom Repahini Chanu, Nongmaithem Radhakishore Singh, Irengbam Meghachandra Singh

ICAR Research Complex for NEHR Manipur Centre, Lamphelpat, Imphal West 795004, Manipur

Email: konsams@gmail.com

Introduction

Rice is one of the principal cereal crops consumed by over half the world population mainly in Asia. Although mainly consumed as white rice, there are different pigmented cultivars (black, red and purple) of rice. Black scented rice locally known as *Chakhao* (*Chak* - rice; *ahaoba* – delicious) in Manipur state of India is particularly famous for its mild nutty taste and a special aroma. *Chakhao* has black colour outer bran layer but once cooked, it usually turns into deep purple. The dark colour due to the high concentration of anthocyanin, flavonoids (antioxidants) are able to prevent oxidative stress (Yawadio et al. 2007). It usually takes longer to cook 40 to 43 minutes due to the presence of fibrous bran layer and higher crude fibre content. Its special aroma and flavor owe to the soil condition and pristine environment of Manipur. It has been cultivated over centuries and used by the traditional medical practitioners of Manipur. Black rice has been eaten throughout Asia for thousands of years and has a significant history especially in Southeastern Asia.

Chakhao is still a niche rice product of Manipur, recently endowed GI tag and not cultivated currently on a commercial scale, but its popularity seems to be growing in the US, Europe and other parts of the world. The traditional cultivars of Manipur are poor yielders (1.5 – 2.0 tonnes/ha) with shortcoming of tall height (>150 cm) and incomplete grain filling and thus chaffy grain. Therefore, the present study was to develop improved high yielding semi-dwarf black scented *Chakhao* with high anthocyanin content of Manipur, India.

Methodology

Plant materials

Evaluating materials in the present study consisted of advanced breeding lines of F_8 generations derived from the cross, *Chakhao amubi* × RCM 9.

Measurement of plant height, 1000 seed weight, grain length to breadth ratio, days to maturity, effective tiller/hill, panicle length, no. of filled and unfilled spikelet per panicle and panicle weight

All the characters are measured in three replications. Length and breadth of 10 grain each of the advanced lines were measured using caliper instrument in cm and ratio of the mean length and mean breadth was calculated. Percentage of unfilled spikelet per panicle is calculated by the formula (Number of unfilled spikelet per panicle × 100) / (Number of filled spikelet per panicle + unfilled spikelet per panicle)

Aroma tests

Cooking and Chewing method were used to determine aroma with sample score as 1 to 10 based on the intensity of aroma (IRRI 2009) (Yang et al. 2003).

Determination of gelatinization temperature

Gelatinization temperature (GT) was determined based on alkali spreading and clearing test (Little et al. 1958).

Estimation of amylose content

Amylose content of the advanced breeding lines was estimated as per protocol followed in Sompong et al. (2011) measuring the absorbance at 620 nm using UV-Vis Spectrophotometer (Merck Spectroquant Pharo 100).

Determination of total anthocyanin content

The total anthocyanin content (TAC) was determined by the pH-differential method (Hosseinian et al. 2008) with some modifications.

Statistical analysis

Morphology and biochemical quality traits of advanced lines were measured or analysed in triplicate. One-way ANOVA analysis was performed in excel with significant difference and critical difference at $p< 0.05$. The multivariate analysis and construction of dendrogram for similarity study was carried out using software *DARwin* 6.0.18. and performance and stability analysis across the years by R software.

Results

Of the 33 advanced breeding lines from the cross, *Chakhao amubi* × RCM 9, 18 lines were found to be black in kernel colour; remaining 16 were white rice. Among the eighteen lines, 14 were semi-dwarf with plant height below 110 cm. All the black scented *Chakhao* cultivars possess a unique aroma and mild nutty taste before (by chewing the uncooked grains) and after cooking which could be observed in eight lines of 14 semi-dwarf advanced lines. All eight lines were medium maturing having 127 - 129 days to maturity significantly differing from the late maturing *Chakhao* cultivars of >140 days. Number of effective tillers per hill ranged from 8 - 14 significantly improving over the parental 5 tillers.

Line 1, 3, 4, 6 and 7 have higher ASV of more than 5 significantly improving the cooking quality as compared to 2 in the case of *Chakhao amubi*. The rice varieties with high ASV had lower GT and thus better cooking quality. The time of cooking is determined by gelatinization temperature (GT) and GT is highly correlated with alkali spreading value (ASV), which reflects the disintegration of milled rice in dilute KOH (Little et al. 1958).

Multivariate analysis of quality traits was carried out to evaluate the similarity among identified advanced improved lines with the parent *Chakhaoamubi*. The data of different units were standardized and un-weighted variable pair group method of the average linkage cluster analysis (UPGMA) dendrogram was constructed with software *DARwin* 6.0.18 with a bootstrapping of 9000. The first three principal components explained a total of 94.15 % variability. Line 1, 3 and 4 were grouped with *Chakhao amubi* showing a closed similarity in terms of desirable traits like anthocyanin content and aroma (Figure 1). From the study, it could be observed that Line 3 showed to be a promising line with aroma score of 8, low amylose (11 %) and high anthocyanin content (623.7 mg/kg powder). Line 1 and 4 also showed to be promising with aroma score 9, very low amylose and high anthocyanin content (Figure 1).

Performance and stability across the years (two preliminary yield trials during 2019 and 2020) and one advanced station yield trial in 2021) were analysed based on the weighted average of absolute scores in R. Three lines MC-66-1-1-28 (Line 1, G3), MC-66-1-1-21-16 (Line 3, G4) and MC-66-1-1-27-25 (Line 4,) were identified to be superior across the years with a yield of 5 tonnes/ha or more (Figure 2).

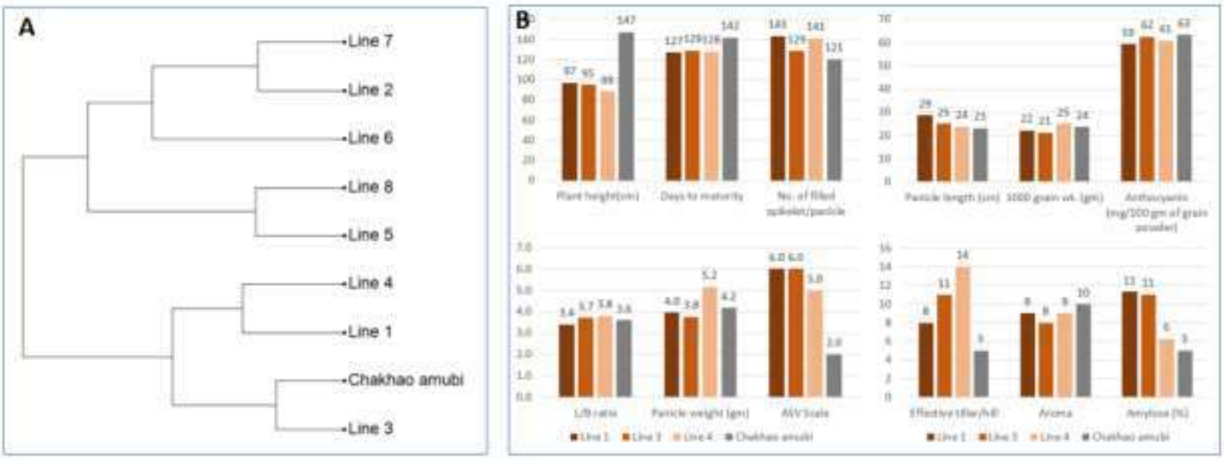


Figure 1. (A) UPGMA based Dendrogram constructed based on the targeted desirable traits (B) Variation and similarity of different morphological and quality traits of identified Line 1, 3 and 4 advanced breeding lines or varieties with the parent *Chakhao amubi*.

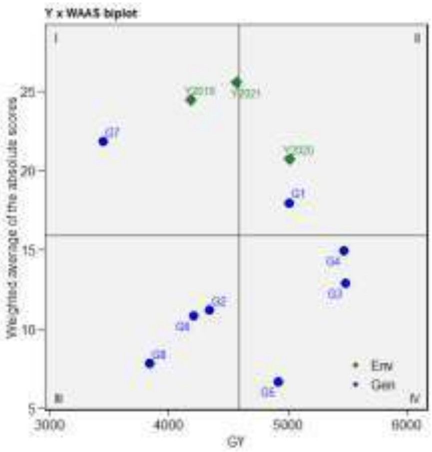


Fig. 2.Weighted average of absolute scores (WAASB) and mean grain yieldbiplot of breeding lines. Line 1 (G3, MC-66-1-1-28), Line 3 (G4, MC-66-1-1-21-16) and Line 4 (G5, MC-66-1-1-27-25)

Conclusion

After analysing all the traits and their performance for the last three years in preliminary and advanced station yield trials, the Lines 1, 3 and 4 were selected and subjected for conducting multilocation trials in Manipur state during *kharif* 2022. These lines have less than 100 cm, effective tiller/hill of 11 and anthocyanin content of 608 mg/kg grain powder on average. The present study was first ever attempted in the country to breed for semi-dwarf improved black scented *Chakhao* rice varieties of Manipur with desirable amylose %, high anthocyanin content and better cooking quality.

References

Hosseinian FS, Li W, Beta T. 2008. Measurement of anthocyanins and other phytochemicals in purple wheat. Food Chem 109:916–924

Little RR, Hilder GB, Dawson EH. 1958. Differential effect of dilute alkali on 25 varieties of milled white rice. Cereal Chem 35:111-126

Yang DS, Lee KS, Jeong OY, Kim KJ, Kays SJ. 2003. Characterization of volatile aroma compounds in cooked black rice. J Agric Food Chem 56:235–240

Yawadio R, Tanimori S, Morita N. 2007. Identification of phenolic compounds isolated from pigmented rices and their aldose reductase inhibitory activities. Food Chemistry 101:1616-1625

ICSCI 2022/T2/17

Volatolomics to decrypt the monophagous nature of a rice pest, *Scirpophaga incertulas* (Walker)

Totan Adak*, Arabinda Mohanty, Somanatha Jena, Basana Gowda Gadratagi, Naveenkumar Patil, Govindharaj Guru-Pirasanna-Pandi, Mahendiran Annamalai, Prasanthi Golive, Prakash Chandra Rath

ICAR-National Rice Research Institute, Cuttack, Odisha, India-753006

Email: Totan.Adak@icar.gov.in&totanadak@gmail.com

Introduction

Scirpophaga incertulas (yellow stem borer, YSB) is a monophagous insect pest which causes significant yield loss in rice. Semiochemical based pest management is being sought as an alternate to chemical pesticides. We hypothesized differential release of volatiles from host rice and two companion non-host weeds, *Echinochloa colona* and *Echinochloa crus-galli* could be responsible for oviposition and biology of YSB and these chemicals could further be used for YSB management.

Methodology

S. incertulas were reared in laboratory conditions on rice plants at 26±2 °C and RH of 65±5%. The oviposition preference was carried out in plant growth chamber by releasing 10 adult insects both on host (TN1, *Oryza sativa*) and non-host plants (*Echinocloa colona* and *E. cruss-galli*) separately in no-choice method. The data on number of egg masses laid and number of larvae hatched from each egg mass, were counted. Percent dead heart formed was counted. Volatiles from rice plant, weed species were collected using dynamic headspace sampling technique with pull and push system (Michereff *et al.* 2019). Behavioral experiments were performed using a glass Y tube olfactometer as per the protocol given by Fand *et al.* (2019). HS-SPME analysis was carried out using the GC-MS (Trace 1300-TSQ9000), Thermo Scientific, USA) equipped with HS-SPME auto sampler (TriPlus RSH, Thermo Scientific, USA) and a capillary column (TG-5MS; 30 m*0.25 mm, film thickness: 0.25 µm, Thermo Scientific, USA). To find out similarities/ differences between the volatolome profiles of different leaves, MS-DIAL program (http://prime.psc.riken.jp/compms/msdial/main.html) was used.

Results

Number of eggs laid, and number of larvae hatched were significantly higher in rice plant as compared to weeds. YSB could only form dead hearts in rice plants. YSB significantly preferred host-plant volatiles compared to the non-host plants both in choice and no-choice tests in an olfactometer. 2-Hexenal, hexanal, 2,4-hexadienal, benzaldehyde, nonanal, methyl salicylate and decanal were found in the leaf volatolomes of both the host and non-host plants in HS-SPME-GC-MS. Pentene-3-one, 2-pentyl furan, 2,4-heptadienal, 2-octenal, 2-octenol and menthol were present only in the non-host plants. Fourteen rice unique compounds were also detected. The built-in PCA and PLS-DA analysis in the MS-DIAL tool showed that the volatiles emitted from TN1 formed a cluster distinct from *Echinochloa* spp. and 2-octenal was identified as a unique compound.

Conclusion

The results indicate that the rice unique compounds along with other volatile compounds could be responsible for higher preference of YSB towards rice plants. Similarly, the non-host unique compounds could possibly be responsible for lower preference and defence against YSB. Unique compounds further could be manipulated for non-chemical pest management of YSB.

References

Fand BB, Amala U, Yadav DS, Rathi G, Mhaske SH, Upadhyay A, Ahammed Shabeer TP and Kumbhar DR 2019. Bacterial volatiles from mealybug honeydew exhibit kairomonal activity toward solitary endoparasitoid *Anagyrus dactylopii*. J Pest Science,93:195–206

Michereff MFF, Magalhaes D, Hassemer MJ, Laumann RA, Zhou JJ and Paulo E *et al.* 2019.Variability in herbivore-induced defence signalling across different maize genotypes impacts significantly on natural enemy foraging behaviour. J Pest Science, 92:723–736

ICSCI 2022/T2/18

Callus mutagenesis, effectiveness, and usefulness in genetic improvement of local aromatic rice (*Oryzasativa* L.)

Subhashree Das[1], Banshidhar Pradhan[1], Rajesh Kar[1], Sanghamitra Samantaray[2]
[1]*Department of Plant Breeding & Genetics, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, 751003*
[2]*Crop Improvement Division, ICAR-National Rice Research Institute, Cuttack, Odisha, 753006*
E-mail: subhashreedas@gmail.com

Introduction

Mutagenesis using ethyl methanesulphonate (EMS) has been proved to have improved agronomically important traits in crop plants specially in rice as it was found to induce a mutation rate of 1.4 to 2.9 mutations per Mb (Awais *et al*., 2019). As the degree of mutation depends on the plant tissue used for mutagenesis along with dosage and time of exposure to the mutagen (Desai *et al*., 2021), *in vitro* mutagenesis where in the parenchyma cells located on the surface of the embryogenic callus cells are more exposed to mutagens is found to be more effective than seed treatment also the combined methods of chemical mutagen induction and in vitro culture may result in a higher mutation rate than the conventional methods. Callus initiated from mature embryos of rice when treated with EMS at 0.2% for 2 hours was found to be effective in generating a whole rice mutant population with a high mutation rate i.e., one mutation in every 451 Kb (Serrat *et al*., 2014). On the basis of these facts this experiment was taken up to analyze EMS induced biological effects on effectiveness and efficiency of *in vitro* mutagenesis in four local aromatic rice genotypes and then compared induced variability for quantitative and qualitative traits in M_4 generations to identify the desirable mutants (Rajarajan *et al*., 2014).

Methodology

MS media with 2.0 mg/l 2,4-D was used for callus induction of 4 local aromatic rice landraces (Basumati, Gangabali, Kalikati and Karpurajeera). Half strength MS medium with 2 mg/ l BAP was used for shoot regeneration. MS medium with 125mg/l ascorbic acid, 125 mg/l citric acid, 0.5 mg/l NAA, 0.1 mg/l BAP,100 mg/l myo- inositol, sucrose at 3% (w/v) and EMS (0.2%) was used for *in vitro* mutagenesis. Twenty-five calli (0.2mm size) from 4 aromatic rice genotypes were treated for 2 hours, 4 hours and 6 hours each maintaining the control. Calli then transferred to regeneration medium after rinsing and incubating for 7 days, the procedure performed two times for each treatment and the M_1 plantlets were obtained. In the M_2 plants the chlorophyll mutation spectrum was observed the mutation rate was determined on the basis of number of mutants per 100 M_2 plants in each treatment and each genotype. Mutagenic effectiveness = M (percentage of M_2 mutant seedlings)/ t (period of treatment with chemical mutagen in hours) c (concentration of the chemical mutagen in terms of milimoles/%). Mutagenic efficiency = M/ L (percentage of lethality) (Konzak *et al*., 1965).Nine quantitative and three qualitative characters (aroma level, alkali spreading value and amylose content) were subjected to statistical analyzes using RBD and CRBD respectively with three replications per treatment for each genotype adopting standard analysis of variance (ANOVA). The pattern of variation in the M_4 population was examined through frequency curves. Statistical analysis for frequency curve was performed in Microsoft 2009 (Microsoft corp., Redmond, WA, USA). Possible deviation from normality was examined through estimates of skewness and kurtosis for M_4 generation of the four aromatic rice genotypes.

Results

The mutagenic frequency, effectiveness and efficiency was calculated on the basis of chlorophyll mutants observed in M_2 seedlings.

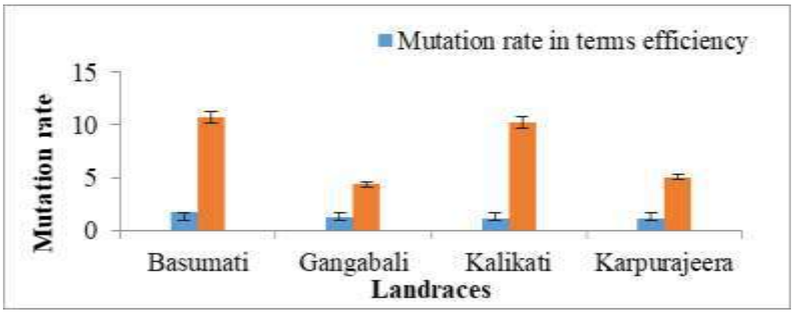
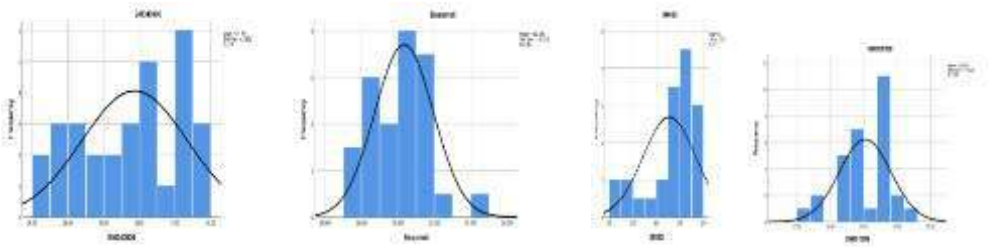
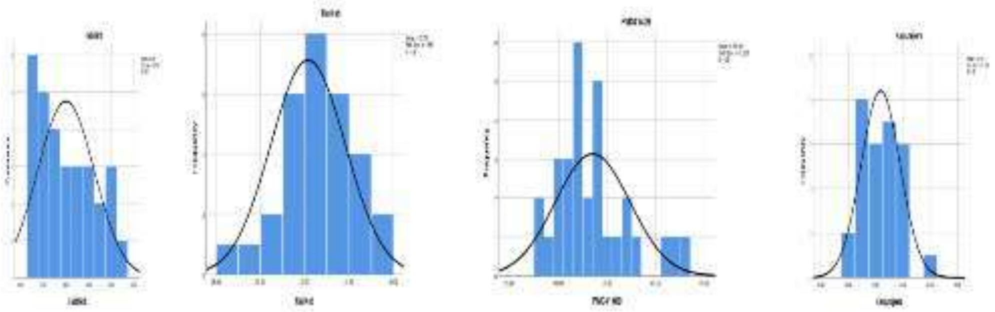


Fig. 1 Mutation rate in terms of effectiveness and efficiency in four aromatic rice landraces

In the present study out of the four genotypes Basumati (10.68) was found to be more responsive to mutation followed by Kalikati (10.25), Karpurajeera (4.45) and Gangabali (4.17) on the basis of mutation rate obtained in these genotypes in terms of effectiveness and Basumati (1.78) followed by Gangabali (1.28), Kalikati (1.18) and Karpurajeera(1.08) in terms of efficiency (Fig.1).



a. BM-4-9-6 b.Basumati (Parent) c. GM-4-18-2 d. Gangabali (Parent)



e. KM-4-19-14 f. Kalikati (Parent) g. PM-4-14-9 h. Karpurajeera (Parent)

Fig. 2 Pattern of variation in the mutants and parents for single plant yield

Estimates of skewness and kurtosis which are the measure of deviation from normality for mutants and parents showed wide variations and improvement in terms of yield in the mutants compared to parents (Fig. 2).

Conclusion

EMS induced mutation in the *in vitro* technique in aromatic rice genotypes leads to more effective mutagenesis consuming less time and labour giving desirable mutants with reduced plant height upto 18.78%, increased tillers per plant by 134.4% and increased yield by 118.2%.

References

Awais A, Nualsri C and Soonsuwon W.2019.Induced mutagenesis for creating variability in Thailand's upland rice (Cv. Dawk Pa-yawm and Dawk Kha 50) using ethyl methane sulphonate (EMS). Sahad J Agriculture. **35**(1): 293-301.

Desai, S., Jadhav, A., Ramteke, A., Dhole, V., Bapat, V and Gaikwad, N. 2021. Genetic improvement of two Indian non-basmati aromatic rice landraces through physical and chemical mutagenesis. International Journal of Radiation Biology. 18: 1-8.

Konzak CP, Wagner RA, Nilan J and Foster RJ.1965. Efficient chemical mutagenesis. Radiation Botany.**5**: 49-70.

Rajarajan D, Saraswathi R, Sassikumar D and Ganesh SK. 2014. Effectiveness and efficiency of gamma ray and EMS induced chlorophyll mutants in rice ADT (R) 47. Global J Biology, Agriculture & Health Sciences**. 3**(3): 211-218.

Serrat X, Esteban R, Guibourt N, Moysset L, Nogues S and Lalanne E.2014. EMS mutagenesis in mature in mature seed-derived rice calli as a new method for rapidly obtaining TILLING mutant populations. Plant methods**.10**: 5.

ICSCI 2022/T2/19

Genome engineering of rice *cv.* ASD16 for sheath blight disease resistance

P Vignesh[1,2], K. Prudhvi Raj Kumar[1], A. Shanthinie[1], E, Kokiladevi[1], D. Sudhakar[1], and S, Varanavasiappan[1]

[1]Department of Plant Biotechnology, Centre for Plant Molecular Biology & Biotechnology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India – 641 003

[2]Department of Plant Pathology, Centre for Plant protection studies, Tamil Nadu Agricultural University,Coimbatore, Tamil Nadu, India – 641 003

Email:varanavasiappan.s@tnau.ac.in

Introduction

Rice (*Oryza sativa* L.) is a prominent food crop all over the world and holds the second position in terms of both area and productivity. Sheath blight, which is one of the three major diseases of rice, caused by infection with *Rhizoctonia solani* and accounts for severe yield losses. The scope of breeding sheath blight resistance elite rice varieties is limited primarily due to non-availability of well characterized resistant cultivar within the crossable gene pool. The NPR proteins function as transcriptional co-repressors and negative role in SA mediated disease signaling events. In rice, there are five NPR1-like proteins NPR1 homologs 1-5 encoded by six genes in genome. Our current study aims to target the negative regulators involved in immune signaling through CRISPR/Cas9 technology based gene editing to impart sheath blight disease resistance in popular elite local cultivar ASD16. Hence we targeted the close homologs of *Arabidopsis* NPR3/NPR4 genes in rice, namely *OsNH2*to generate *InDels*. The objectives of present study were 1. Development of gene editing construct for creating mutations in *OsNH2* through CRISPR/Cas9 mediated genome editing 2. Generation of *OsNH2*-ASD16 genome-edited mutants *viaAgrobacterium*-mediated rice genetic transformation.

Methodology

Design of short-guide RNAs specific to *OsNH2* gene constructs using CRISPR P v2.0 online tool. Development of gene constructs: Selected *gRNA*s will be synthesized and cloned into suitable CRISPR/Cas9 vector system. Presence of guide sequence in the vector is confirmed by restriction digestion analysis, PCR followed by Sanger sequencing of recombinant clones. Mobilization of recombinantplasmid into*Agrobacterium*strain LBA4404 and further confirmed by colony PCR analysis (Xie*et al*., 2013). *Agrobacterium*-mediated genetic transformation of rice cultivar ASD16 (Hiei and Komari, 2008).

Results

Agrobacterium-mediated transformation of rice *cv.* ASD16 using the construct pRGEB32-*OsNH2* resulted in 14 independent transgenic events (Plate 1). Molecular characterization by PCR analysis for the presence of *hpt* and *Cas9* genes was carried out for all the events. Expected amplification of 686 bp and 478 bp was observed. These PCR positive putative mutants were subjected to PCR amplification of the target region encompassing the *sgRNA* sequence and amplification of 704 bp was observed in mutants.The Sanger sequencing Results revealed the occurrence of18 bp deletions in the target region in one particular event.

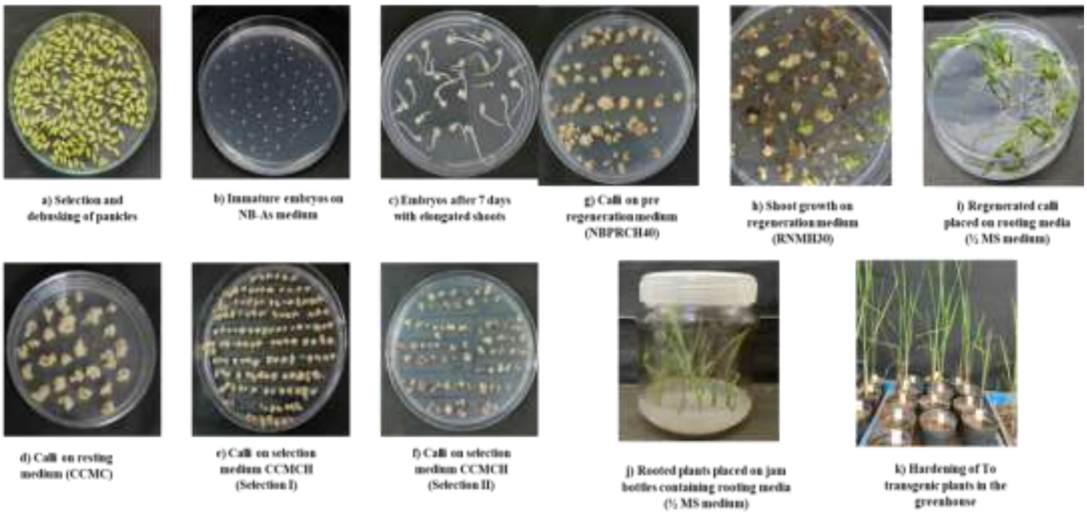


Plate 1. Stages of *Agrobacterium*-mediated transformation in rice.

Conclusion

Pathogenicity analysis of T_0 plants of ASD16 with Sheath blight pathogen will be carried out further to establish the role of*OsNH2 gene* in immune signaling and disease susceptibility.

References

Hiei, Y., and T. Komari. 2008. "*Agrobacterium*-mediated transformation of rice using immature embryos or calli induced from mature seed." *Nature protocols* 3 (5):824-834.

Xie, K., and Y. Yang. 2013. "RNA-guided genome editing in plants using a CRISPR-*Cas* system." *Mol Plant* 6(6):1975-1983. doi: 10.1093/mp/sst119.

ICSCI 2022/T2/20

Weed management options in drum seeded wetland rice

Gayathri P, Nimmy Jose, Jyothi Sara Jacob, Ambily AK and Surendran M.
Rice Research Station, Moncompu, Kerala Agricultural University, 688502, Kerala, India
Email: nimmy.jose@kau.in

Introduction

Broadcasting using pre-germinated paddy seeds in puddled soil offers faster and easier crop establishment, reduces labour and irrigation water requirements. But, heavy weed infestation is a major constraint for its adoption, as emerging seedlings in DSR are less competitive with concurrently emerging weeds and the initial flush of weeds cannot be controlled by maintaining water immediately after seeding. Moreover, 2-3 manual weedings by engaging more than 120-150 person days per hectare is required to keep the weed population below the threshold level in DSR. Therefore, herbicide-based weed control or combination of herbicide and mechanical weeder are considered as alternatives to manual-weeding (Sanjoy Saha, *et al*., 2019). Huge seed requirement together with the chances for high incidence of pests and diseases in broadcasting at seed rate of 100-125 kg/ha has necessitated the option for mechanization in rice cultivation. Drum seeding has advantages like less seed cost, optimum plant population, less requirement of fertilizers and plant protection chemicals and labour requirement, and ease of operation, thus rendering it as an economically and technologically viable practice in wet DSR (Muralidharan *et al*., 2015). With this background, a study was conducted to identify suitable and cost effective agronomic management practices to enhance the productivity of drumseeded rice and to maximise its resource use efficiency.

Methodology

The experiment was conducted at Rice Research Station, Moncompu, Kerala Agricultural University during the *kharif* 2020-21 and *rabi* 2021-22, with eight treatments and three replications in a randomized complete block design. The treatments included broadcasting of seeds + manual weeding once, drum seeding + application of post-emergent herbicide, broadcasting + application of post-emergent herbicide, drum seeding + conoweeding twice, drum seeding + application of post-emergent herbicide followed by conoweeding once, drum seeding + application of post-emergent herbicide followed by conoweeding once with four split application of N, drum seeding + application of pre-emergent herbicide followed by post-emergent herbicide and drum seeding + conoweeding once followed by application of post-emergent herbicide. Uma (MO 16), the most popular rice variety of the state was used in the experiment. Observations on plant height, tiller count, total dry matter production, weed count and weed dry weight were recorded at 30, 55, 80 and 110 DAS of the crop. Yield attributes, grain and straw yield were also recorded at harvest.

Results

The experimental data showed that there was significant difference between treatments in plant population at 30 DAS and 55 DAS during both the seasons. In broadcasting, application of post-emergent herbicide recorded highest plant population at 30 DAS and 50 DAS and was on par with broadcasting of seeds with one manual weeding. Though the plant population in drum seeding was significantly lower in all treatment combinations, tiller count at 55 DAS was on par in all drum seeded plots except for conoweeding twice without herbicide application and the treatment with pre-emergent followed by post-emergent herbicide application without conoweeding. The weed dry weight was significantly influenced by weed control treatments and it was significantly lower in drum seeding with post emergence herbicide application followed by conoweeding and on par with broadcasting with hand weeding showing the advantage of conoweeding in drum seeding. Weed dry weight at 50 DAS in the treatments, drum seeding with conoweeding once followed by application of post-emergent herbicide, drum seeding with application of post-emergent herbicide alone, drum seeding with conoweeding twice and drum seeding with application of pre-emergent followed by post-emergent herbicide were on par and significantly higher than the best treatments (Table 1 and 2). The experiment proved that conoweeding alone cannot control weeds in drum seeding technique and combination of post-emergence herbicide application followed by conoweeding performed well for weed management in drum seeding. As conoweeding cannot control weeds within the plants in a row, application of herbicides becomes necessary. The experiment proved that application of herbicides must be done at 15 DAS so as to control the emerged weeds and the later emerged ones in the inter spaces can be controlled by conoweeding at 30 DAS. Results also proved the efficiency of conoweeding in enhancing the tiller production in drum seeding. Sheeja *et al*. (2015) has reported that conoweeding alone fail to control weeds effectively in drumseeding, but influences crop growth and yield by stimulating aeration and root growth.

During both the seasons, grain yield in drum seeding with post-emergence herbicide application followed by mechanical weeding was significantly higher and on par with broadcasting of seeds with hand weeding and broadcasting of seeds with post-emergence herbicide application alone (Table 1 and 2).

Table 1. Growth and yield of rice and weed dry weight in the experimental field during *kharif*, 2020-21

Treatment	**Plant population, Number/ m2**		**Weed dry weight, g /m^2**		**Grain yield, t/ha**	**Straw yield, t/ha**
Crop establishment methods	30 DAS	55 DAS	30 DAS	55 DAS		
T1	112	23	0.0	21.6	6.3	7.1
T2	69	13	16.0	96.0	5.6	6.9
T3	129	26	4.4	23.3	6.5	8.0
T4	75	13	30.0	90.1	5.4	8.1
T5	69	13	17.1	11.1	6.5	8.5
T6	68	14	16.4	38.9	5.6	6.0
T7	69	16	24.0	55.9	5.5	6.6
T8	75	14	67.9	67.1	5.9	8.4
CD(0.05)	11.01	1.73	13.5	36.36	0.7	1.4
CV	7.54	6.00	35.29	41.1	6.60	10.62

Table 2. Growth and yield of rice and weed dry weight of the experimental field during rabi, 2021-22.

Treatment	**Plant population, Number/ m2**		**Weed dry weight, g /m^2**		**Grain yield, t/ha**	**Straw yield, t/ha**
Crop establishment methods	**30 DAS**	**55 DAS**	**30 DAS**	**55 DAS**		
T1	101	65	13.6	48.5	3.2	5.7
T2	40	26	65.3	115.9	1.6	2.7
T3	109	42	9.5	125.3	3.2	6.3
T4	41	31	32.3	264.8	2.5	4.2
T5	43	39	13.6	84.8	3.0	5.0
T6	43	35	51.9	104.5	2.5	4.0
T7	51	27	62.5	220.0	1.6	3.6
T8	41	33	78.8	198.5	2.2	3.6
CD(0.05)	11.3	17.5	26	37	0.52	1.67

CV	10.98	26.98	36.34	14.4	11.87	21.53

T1	broadcasting of seeds + manual weeding once
T2	drum seeding + application of post emergent herbicide
T3	broadcasting + application of post emergent herbicide
T4	drum seeding + conoweeding twice
T5	drum seeding + application of post emergent herbicide + conoweeding once
T6	drum seeding + application of post emergent herbicide + conoweeding once + four splits application of N
T7	drum seeding + application of pre-emergent herbicide + post emergent herbicide
T8	drum seeding + conoweeding once + application of post emergent herbicide

Conclusion

The experiment conducted to identify suitable and cost-effective agronomic management practices to enhance the productivity of drum seeded wetland rice revealed drumseeding as a viable crop establishment method in wet seeded puddled rice, for reducing the seed requirement, pest and disease infestation and sustaining yield. Weed management option found feasible in drum seeding was post-emergence application of herbicide at 15 DAS followed by conoweeding at 30 DAS for getting on par yield with broadcasting with herbicide application.

References

Muralidharan P, Rajeev MS, Anand R and Anjali R N. 2015.Short communication. Drum seeding for enhanced profitability of paddy cultivation in Kuttanad region of Kerala. *Journal of Tropical Agriculture*, 53 (1): 66-69.

Raj SK, Jose N, Mathew R and Leenakumary S. 2013.Influence of Stand Establishment Techniques on Yield and Economics of Rice Cultivation in Kuttanad.*International Journal of Scientific and Research Publications,* 3 (4): ISSN 2250-3153.

Saha S, Nayak AK, Tripathi R, Shahid M, Mohanty S, Panda BB, Vijayakumar S, Mohapatra SD, Priyadarsini S, Sarangi DR, Nagothu US and Pathak H. 2019. Weed Management in Dry Direct-sown Rice. *Resilience*, Technology Brief No. 7.

ICSCI 2022/T2/21

Identification of moderately resistant rice genotypes for bacterial leaf blight disease

Bhuvaneswari[1] V, Raju[1] MRB, Krishnam Raju[2] S, Ravi Kumar[3] BNVSR, Ramana Rao[3] PV, Lalitha D, Vasavi S, Mohan Ganesh B, Srinivas[3] T and G. Jogi Naidu[4]

[1]Department of Plant Pathology, RARS, Maruteru [2]Professor, Department of Plant Pathology, Agricultural College, Rajamahendravaram [3]Department of Plant Breeding, RARS, Maruteru [4]Associate Director of Research, Regional Agricultural Research Station, Maruteru – 534122, Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India

Email: bhuvanavk2001@gmail.com

Introduction

Rice (*Oryza sativa* L.) is the most important staple food crop for a larger part of the world's population and is important for global food security. Among diseases, Bacterial leaf blight caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) is the most devastating disease especially in the irrigated and lowland ecosystems which reduces rice production by 20%-50% (Singh *et al*, 2011). During 2020, 2021 seasons, low to moderate incidence of bacterial leaf blight was recorded on most of the varieties in Godavari delta. In order to hinder loss of yield, breeding for disease resistant varieties remains very effective and economical in controlling the bacterial leaf blight (BLB) of rice. Keeping in this view, the study was taken up with an objective to screen the entries to identify the stable resistant cultures for bacterial leaf blight in rice.

Methodology

For effective management of bacterial leaf blight use of resistant varieties is the most ideal strategy. So, attempts were made to screen the entries using standard protocols (SES, 2014) to identify the stable resistant cultures for bacterial leaf blight during *kharif* 2020, 2021 seasons.

Results

The results revealed that 11 entries viz., NLR- 23, 27, 95, 104, 155, 164, 212, 213, 277, 318, 347 recorded 3, 5 scores, respectively and found moderately resistant to bacterial leaf blight for two consecutive seasons during *kharif* 2020, 2021 seasons. While, single entry i.e., IBT-GM-26 have recorded scores 5, 3, respectively during *kharif* 2020, 2021 seasons. Similarly, 83 entries recorded scores 5, 5 respectively during both seasons. During *kharif*, 2021, two entries i.e., 441-1-3-2, 353-2-2-2 recorded score 1 and found resistant to bacterial leaf blight. While, 36 entries viz., RP 6238-RV/RIL-RV 270, RP Bio-226, KNM-11496, RP Bio-Patho-2, RP Bio-Patho-3, RP Bio-Patho-9, RP Bio-Patho-10, RP Bio-Patho-13, 251-2-2-2, 3-5-2-2, 160-3-1-2, 56-1-3-2, 450-3-1-2, 382-3-2-2, 251-3-3-2, IBTR-GM-2, JBT-GM-17, VP-R-12, 19345, RS-OYT-6, HRI-202, IRBB-60, IRBB-64, IRBB-66, ISM, IRRB-52, IRRB-56, IRRB-65, ISM, Rasi, RP 6501-MAID-95-14-5-3-1-1-1, CSR 27 SM 132, RP-Bio-226, RS-OYT-6, RS-OYT-15 and RS-OYT-22 have recorded score 3 and found resistant to bacterial leaf blight.

Conclusion

During both seasons, 12 entries *viz.*, NLR- 23, 27, 95, 104, 155, 164, 212, 213, 277, 318, 347 and IBT-GM-26 recorded 3, 5 scores and found moderately resistant to bacterial leaf blight for two consecutive seasons under hot spot situations and these entries could be used in breeding programmes for development of resistant varieties to bacterial leaf blight.

Table 1: Identification of moderately resistant rice genotypes for bacterial leaf blight disease

Entries/Designation	2021 Score	2020 Score
NLR- 23, 27, 95, 104, 155, 164, 212, 213, 277, 318, 347	3	5
IBT-GM-26	5	3
IBT-GM-3, IBT-GM-7, IBT-GM-9, IBT-GM-12, IBT-GM-23, NLR-25, 29, 30, 33, 35, 38, 39, 50, 51, 52, 60, 61, 64, 65, 67, 69, 70, 73, 78, 85, 101, 103, 105, 106, 117, 130, 131, 133, 140, 148, 152, 153, 154, 155, 159, 160, 161, 165, 166, 167, 172, 180, 184, 199, 202, 203, 208, 227, 231, 233, 235, 256, 258, 265, 273, 282, 287, 288, 292, 293, 294, 297, 316, 318, 320, 322, 323, 328, 329, 330, 334, 346, MIL-S3-1, PAU 3832-196-4-1-3, ISM, RMS-R-17, IHRT-ME-3121 (NK -5251++), IRBB-58	5	5
441-1-3-2, 353-2-2-2	1	
RP 6238-RV/RIL-RV 270, RP Bio-226, KNM-11496, RP Bio-Patho-2, RP Bio-Patho-3, RP Bio-Patho-9, RP Bio-Patho-10, RP Bio-Patho-13, 251-2-2-2, 3-5-2-2, 160-3-1-2, 56-1-3-2, 450-3-1-2, 382-3-2-2, 251-3-3-2, IBTR-GM-2, JBT-GM-17, VP-R-12, 19345, RS-OYT-6, HRI-202, IRBB-60, IRBB-64, IRBB-66, ISM, IRRB-52, IRRB-56, IRRB-65, ISM, Rasi, RP 6501-MAID-95-14-5-3-1-1-1, CSR 27 SM 132, RP-Bio-226, RS-OYT-6, RS-OYT-15, RS-OYT-22	3	
RNR-28393, RNR-28400, RNR-29320, RNR-29322, KNM-11532, RPBio-Patho-15, RP Bio-Patho-16, ISM, C101A51, 160-2-1-2, 441-1-3-2, 353-3-1-2, 56-4-3-2, 35-3-1-2, Tella, VP-R-145, VP-R-157, VP-R-158, VP-R-261, VP-R-278, VP-R-295, VP-R-297, VP-D6, 19284, 19007, MS-1, MS-ISM-Mono, MS-ISM-DGI-1, MS-ISM-DGI-5, AE-1211, AE-1214, AE-1218, BE-772, BE-627, BE-629, BE-634, BE-645, BE-599, BE-480, RS-OYT-12, RS-OYT-22, NICRA PYT 11, L-672, L-635, ADW-265, PHI-20108, MEPH-159, NDR-359, HRI-204, PH1-20109, PHI-20101, CR-374-1-13-1-1-2, AD 16105, Improved Samba Mashuri, RP 5964-82, RP-5972-13-1-6-67-129-266, RP-6530-RMS-1778-54-32-44, RP 6971-RMS-18-30-82, RP 6471-RMS-87-10-100, RP-Bio-226, IRBB-13, IRBB-53, IRBB-55, IRBB-56, IRBB-57, IRBB-58, IRBB-59, IRBB-62, IRBB-63, IRBB-65, IRRB-50, IRRB-51, IRRB-53, IRRB-54, IRRB-55, IRRB-57, IRRB-58, IRRB-59, IRRB-60, IRRB-61, IRRB-62, IRRB-63, IRRB-64, IRRB-66, RL-401, RL-3868, CRR 749-109-B-B-1, R 2341-289-1-344-1, Gontra Bidhan-3 (NC), TRC 42N 2010-13-13-4-1, RP 6471-87-12-48, Swarnadhan	5	

References

Singh UD, Gogoi R and Mondal KK 2011.Molecular approach for augmenting disease resistance in cereals: Rice and maize. Plant Pathol Ind, 20, pp. 21-30.

ICSCI 2022/T2/22

Genetic analysis of yield and quality attributes in 2015- 14- 8- 9- 3 rice cultures

Gawai, M.P., Umate, A.T., Bedse, T. J., Kunkerkar, R. L and Waghmode B.D
Regional Agriculture Research Station, Karjat (Dr. BSKKV), India
Email: mahendragawai76@gmail.com

Introduction

Rice is the life and the prince among cereals as this unique grain helps to sustain two-thirds of the world's population. Asia is the biggest rice producer, accounting for 90 per cent of the world's production and consumption of rice. It is considered as the main staple food for more than 65 per cent of the world's population. Among the rice-growing countries of the world, India ranks first in area and second in production. Rice is grown in 114 countries across the world. The United State Department of Agriculture (USDA 2021) estimated that the world rice production was 497.7 million metric tons of global rice during (2020-21) and constituting the world's cultivated land more than 90 % of the world's rice is produced and consumed in Asia where it is an integral part of culture and tradition. It is one of the oldest and second most intensively grown cereals crop. During 2020-21 rice production of India was around 118.87 million metric tons from an area of 43.66 million hectares. In Maharashtra, rice is the second important food crop next to sorghum, ranks thirteenth in production is cultivated over an area of 15.39 lakh hectares with an annual production of 29.53 lakh tons with an average productivity of 1.92 tons per hectare in 2020-21. (Anonymous, 2022). In the peri urban areas of Maharashtra nowadays, there is an increasing demand of fine quality rice, with the quality parameter intermediate amylose content (%), soft gel consistency (mm), medium alkali spreading value, high head rice recovery (%) and grain elongation after cooking with this view cross was made between Pusa Basmati 1 and BPT 5204 which are leading varieties known for quality grain.

Methodology

The experimental material for the present study consisted of thirty segregating F_4 lines, along with their parents Pusa Basmati 1, BPT 5204 and three check*viz* Karjat-4, Karjat-8 and Trombay Karjat Kolam. All the recommended package of practices was followed along with necessary prophylactic plant protection measure raise a good crop. Observations were recorded and the data was subjected to statistical analysis.

Results

Pusa Basmati 1 x BPT 5204 showed variation in the segregating population, it was partitioned into phenotypic, genotypic and environmental variance. The phenotypic, genotypic, and environmental variances for various quality characters ranged from 0.09 to 27.75, 0.09 to 22.06 and 0.006 to 10.01, respectively. In general, the magnitudes of phenotypic variances were greater than genotypic variances. The phenotypic variance was maximum for gel consistency (27.75) followed by head rice recovery (12.65) and amylose content (8.44). The genotypic variance was maximum for gel consistency (22.06) followed by amylose content (7.21), head rice recovery (2.61%), Alkali spreading value (0.19) grain elongation after cooking (0.17) and Grain elongation before cooking (0.09). The environmental variances were lower than the genotypic variances for all the characters. The phenotypic coefficients of variation were greater in magnitude than the respective genotypic coefficients of variation. The magnitude of phenotypic and genotypic coefficient of variation was highest for amylose content (12.87), (11.89) followed by alkali spreading value (12.07), (11.31) gel consistency (7.47), (6.66) and grain elongation after cooking (6.56) (5.50) respectively. These estimates revealed that the heritability in broad sense ranged from 20 per cent for head rice recovery to 93 per cent for grain elongation before cooking, indicating high heritability for different yield attributing characters. High estimate of genetic advance was recorded for gel consistency (8.62) followed by Amylose content (5.11), Head rice recovery (1.51). High estimate of genetic advance as per cent mean was observed for amylose content (22.84%) followed by alkali spreading value (21.83), gel consistency (12.24%), grain elongation before cooking (10.49%), quality characters are controlled by both GCV and PCV also to use appropriate selection procedure for improvement of these characters in general and since high heritability coupled with high genetic advance reveals the presence of lesser environmental influence and prevalence of additive gene action in their expression. High heritability with low genetic advance indicated the influence of nonadditive gene action. The heritability provides the information on the magnitude of inheritance for quantitative characters, but it does not indicate the magnitude of genetic gain obtained by selection of best individual from the best population. So, heritability along with genetic advance is more useful for selection than the heritability alone.

Conclusion

Promising line 2015- 14- 8- 9- 3 was identified which has at par for the character grain elongation i.e. 5.96 mm and 8.36 mm before and after cooking as compared to Pusa Basmati 1 i.e. 6.86 mm and 8.40 mm before and after cooking, moreover promising line fetches 26% more grain yield, 12.7% high head rice recovery than Pusa Basmati 1, with intermediate alkali spreading value, gel consistency and amylose content (%). On the basis of mean performance high genetic variability for all characters for genotypic and phenotypic coefficient of variation with high heritability and high genetic advance exhibits that it was predominated by additive gene action and the environmental influence was low. Therefore, the promising line 2015- 14- 8- 9- 3which can be one of the best options for the consumers of peri urban region in the coming days.

References

Unpublished M.Sc (Ag), GPB, Thesis of Umate, A.T (2020), College of Agriculture, Dr. Balasaheb Sawant Konkan Agriculture University, Dapoli, Maharashtra, India.

Agronomic interventions for improvement of yield attributes and yield of little millet

Himasree B[1], Hemalatha S[2], Sumathi V[3], Sudhakar P[4] and Nagamadhuri K. V[5]

[1]Ph.D. Scholar, [2]Professor, Department of Agronomy, S.V. Agricultural College, Tirupati, Andhra Pradesh, India
[3]Programme Coordinator, Department of Agronomy, Krishi Vigyan Kendra, Nellore, Andhra Pradesh,
[4]Controller of Examinations, Department of Crop Physiology, LAM, Guntur, Andhra Pradesh, India
[5] Principal Scientist, Department of Soil Science & Agriculture. Chemistry, Institute of Frontier Technology, RARS, Tirupati, Andhra Pradesh, India
E-mail:himasreereddyb@gmail.com

Introduction

Small millets are highly nutritious, non glutinous and non-acid forming foods and considered to be the least allergenic and most digestible grains available. Small millets contain about 8 per cent protein and 4 per cent fat. (DHAN Foundation, 2014). Considering health consciousness and importance of nature's nutraceutical value, demand for this group of crops is ever increasing. To harness the ethical value of the people and to meet the demand, scientific advancements and technologies are essential and need of the hour. Crop geometry plays a key role in better utilization of the sunlight by the crop. Transplanting seedlings from nurseries has been adopted in several areas as a means of improving millet production by extending the growing season in areas with patchy and unreliable rainfall. The technical interventions which improve the yield of little millet have been lacking. However, sufficient research work has not been carried out for production improvement of little millet for different agro-climatic regions. In this context, an experiment is planned for developing the agronomic tools that enhance the production potential of little millet in Southern agroclimatic zone of Andhra Pradesh.

Methodology

A field experiment was conducted during *kharif*, 2020 on sandy loam soils of S.V. Agricultural College Farm, Tirupati. The experimental design was spilt-split plot and replicated thrice. Three different times of sowing of little millet (II FN of June (T_1), I FN of July (T_2) and II FN of July (T_3), three methods of establishment (Broadcasting (M1), Sowing at 30 cm × 10 cm (M_2) and transplanting 20 days old seedlings (M3)) and three nitrogen levels (20 kg N ha^{-1} (N_1), 30 kg N ha^{-1} (N_2) and 40 kg N ha^{-1} (N_3) were allotted to main plots, sub plots and sub-sub plots respectively. The variety used in the present experiment OLM-203 (Tarini) was developed from Odisha University of Agriculture and Technology (OUAT), Berhampur, Odisha. Five plants were selected at random from net plot area and labelled with tags for recording growth and yield attributes during the crop growing period.

Results

Yield attributes of little millet viz., number of panicles m^{-2}, panicle length, panicle weight, grain weight panicle^{-1} and grain yield of little millet were significantly higher with June II FN sown little millet (Table 1 & Table 2). While lower values of these yield attributes were recorded with the crop sown during II FN of July. Among the methods of establishment, transplanting at 30 cm × 10 cm resulted in superior values of the yield attributes. Broadcasted crop recorded significantly lower number of panicles m^{-2}, panicle length, panicle weight, grain weight panicle^{-1} and grain yield. Little millet outperformed in terms of all the yield attributes including test weight and grain yield when applied with 40 kg ha^{-1} compared to the other two nitrogen doses tried. Whereas significantly lower values of yield attributes and yield were obtained with the application of 20 kg N ha^{-1}. Interaction effect between methods of establishment and nitrogen levels was significant for number of panicles m^{-2} and grain yield. Combined effect of transplanting at 30 cm × 10 cm along with the application of 40 kg N ha^{-1} resulted in higher number of panicles m^{-2} and grain yield of little millet.

Table 1: Yield attributes of little millet as influenced by times of sowing, methods of establishment and nitrogen levels

TREATMENTS	No. of panicles m^{-2}	Panicle length (cm)	Panicle weight (g)	Grain weight panicle^{-1} (g)	Test Weight (g)
Times of sowing					
T$_1$: II Fortnight of June	130	29.7	2.25	1.66	2.29
T$_2$: I Fortnight of July	120	28.0	2.09	1.58	2.21
T$_3$: II Fortnight of July	101	23.1	1.96	1.42	2.13
SEm ±	2.1	0.34	0.028	0.026	0.075
CD (P = 0.05)	8	2.0	0.17	0.16	NS
Methods of establishment					
M$_1$: Broadcasting	91	24.7	2.04	1.46	2.19
M$_2$: Sowing at 30 cm x 10 cm	126	27.2	2.09	1.56	2.20
M$_3$: Transplanting 20 day old seedlings (30 cm × 10 cm)	135	28.9	2.18	1.65	2.23
SEm ±	2.2	0.38	0.029	0.036	0.036
CD (P = 0.05)	7	1.2	0.09	0.10	NS
Nitrogen levels					
N$_1$: 20 kg N ha^{-1}	100	24.5	1.97	1.45	2.12
N$_2$: 30 kg N ha^{-1}	118	26.8	2.10	1.55	2.22
N$_3$: 40 kg N ha^{-1}	134	29.5	2.23	1.67	2.28
SEm ±	3.0	0.80	0.041	0.036	0.042
CD (P = 0.05)	9	2.3	0.12	0.10	0.12
Interaction					
TxM					
SEm ±	3.8	0.63	0.050	0.050	0.091
CD (P = 0.05)	NS	NS	NS	NS	NS
TxN					
SEm ±	4.7	1.18	0.064	0.057	0.096
CD (P = 0.05)	NS	NS	NS	NS	NS
MxN					
SEm ±	4.8	1.19	0.065	0.059	0.070
CD (P = 0.05)	14	NS	NS	NS	NS
TxMxN					
SEm ±	1.1	0.25	0.015	0.014	0.021
CD (P = 0.05)	NS	NS	NS	NS	NS

Interaction between methods of establishment and nitrogen levels

	M1	**M2**	**M3**	**Mean of N**
N1	**85**	**105**	**111**	**100**
N2	**88**	**126**	**138**	**118**
N3	**99**	**146**	**157**	**134**
Mean of M	**91**	**126**	**135**	

Table 2. Grain yield (kg ha^{-1}) of little millet as influenced by varied times of sowing, methods of establishment, and nitrogen levels

		T_1	T_2	T_3	Mean of M	Mean of N
M_1	N_1	965	882	669	923	1018
	N_2	1067	967	746		
	N_3	1163	1038	813		
M_2	N_1	1163	1095	935	1249	1213
	N_2	1398	1312	1130		
	N_3	1537	1443	1228		
M_3	N_1	1260	1226	964	1422	1363
	N_2	1657	1461	1179		
	N_3	1954	1659	1432		
Mean of T		1352	1232	1011		

Interaction between methods of establishment and nitrogen levels				
2020				
	M1	M2	M3	Meanof N
N1	839	1064	1150	1018
N2	927	1280	1432	1213
N3	1005	1403	1682	1363
Meanof M	923	1249	1422	

	SEm ±	CD (P = 0.05)
T	20.3	123
M	31.4	97
N	30.6	88
T×M	48.8	NS
T×N	47.8	NS
M×N	53.5	157
T×M×N	12.6	NS

Conclusion

Growing little millet during II FN of June through transplanting method of establishment and the application of 40 kg N ha-1 recorded higher yield attributes and yield in the southern agroclimatic zone of Andhra Pradesh.

ICSCI 2022/T2/25

Evaluation of fungicides and bioagent against *Bipolaris setariae* causing Leaf blight disease in Browntop millet

Rohini, V. B. Sanath kumar, H. R. Raveendra, N. Kiran Kumar, G. Sugeetha, and Chandrappa

Department of Plant Pathology, University of Agricultural Sciences, Bangalore, College of Agriculture, Mandya. Karnataka, pin code: 571405 India.

Email: rmankari931@gmail.com

Introduction

Browntop millet *(Brachiaria ramosa*) is an introduced annual grass that originated in South-East Asia. Crop is grown in a variety of soils and climates. Like other millets, it is a hardy crop and well suited for dry land, it grows and matures over around 90 days and it is used for food and fodder purpose. Among the biotic stresses blight or brown spot caused by *Bipolaris setariae* is the most devastating disease-causing damage in all stages of plant growth, from seed-to-seed formation (Kumar *et al*., 2011). The study was undertaken with the objective to identify the best fungicide (systemic and contact) and biocontrol agent for the management blight disease. field experiment was carried out at Zonal Agricultural Research Station (UAS, Bengaluru), V. C. Farm, Mandya during *Kharif* - 2021.

Methodology

The experiment was laid out in a randomized block design with nine treatments replicated thrice, with a plot size of 2.5 × 3m with spacing of 30 ×10 cm apart with a susceptible variety GPUBT-4, and all the recommended agronomical practices were followed. The fungicides and bioagent were sprayed for each treatment, plot without fungicidal spray severed as a control. The data on the number of spots, length of the spots, and disease severity was recorded on 3 randomly selected plants in each plot. At a 5-day interval, after harvest the fodder and grain yield were recorded. All of the data was statistically analyzed using a standard procedure.

Results

Among nine different treatments, Azoxystrobin 23SC at 1ml/L followed by *Pseudomonas fluorescens* at 10g/L spray was significantly reduced the blight severity of 6.8 *per cent* with the no of spots 10.8 per leaf and length of spot 0.23mm followed by Azoxystrobin 23SC at 1ml/L reduced the blight severity of 11.2 *per cent*, no of spots 14.80 and length of spot 0.26mm, compared to other treatments as well as the untreated check. Whereas, other treatments recorded blight severity ranged from 14.19 *per cent* to 34.73 *per cent*, no of spots 15.73 to 31.80 and length of spot 0.32mm to 0.50mm when compared with untreated control recorded severity of 46.13 *per cent*, with no of spots 41.53 and length of the spots 0.68mm, with respect to yield parameters, the same trend was observed, maximum grain yield (1755.55kg/ha.), fodder yield (2400kg/ha) and highest B:C ratio of 3.81:1 was recorded in T6 as compared to other treatments and untreated check. It clearly indicated that Azoxystrobin 23 SC at 1ml/L followed by *Pseudomonas fluorescens* spray at 10g/L effectively reduced the blight inoculum and also boosting the yield potential of Browntop millet. Chouhan and Kumar (2022) found a similar pattern in management of brown spot disease in rice among eight fungicides propiconazole 25EC @ 0.1% was found most effective in controlling the disease up to 63.24 *per cent*.

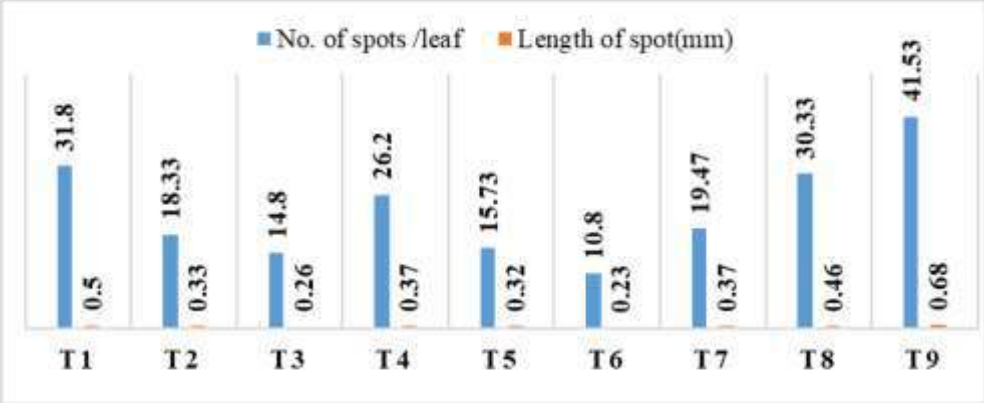


Fig. 1: Effect of treatments on no. of spot and length of spot

Table 1: Effect of fungicides (systemic and contact) and bioagent against Leaf blight of Browntop millet

	Treatments details	**% Disease severity**	**% Reduction over control**	**Grain yield kg ha^{-1}**	**% Increase over control**	**B:C ratio**
T_1	*Pseudomonas fluorescens* (talc formulation) @10g/L 25DAS	34.73	24.71	733	9.99	1.83:1
T_2	Propiconazole 25 % EC@1ml/L 25DAS	15.40	66.61	1222	83.33	2.99:1
T_3	Azoxystrobin 23% SC@1ml/L after 25DAS	11.2	75.72	1466	119.99	3.27:1
T_4	Mancozeb 63%+Carbendazim 12% WP @1g/L 25DAS	19.66	57.36	1182	77.33	2.96:1
T_5	T_2 followed by *Pseudomonas fluorescens talc* formulation spray @ 10g/L30DAS	14.19	69.22	1288	93.33	3.15:1
T_6	T_3 followed by *Pseudomonas fluorescens talc* formulation spray @ 10g/L DAS	6.8	85.26	1755	163.33	3.81:1
T_7	T_4 followed by *Pseudomonas fluorescens* talc formulation spray @ 10g/L 30DAS	17.33	62.43	1173	75.99	2.87:1
T_8	Mancozeb 75% WP@2.5g/L 25DAS	22.4	51.44	1155	73.33	2.84:1
T_9	Control	46.13	0	666	0	1.75:1
SE.m±		4.55		58.6		
CD @ 5 %				175.67		

Conclusion

Under *in vivo* conditions, Azoxystrobin 23SC @ 1ml/L followed by *Pseudomonas fluorescens* @ 10g/Lwasfound best with per centdisease reduction of 85.26 and per cent yield increase of 163.33 over check. It was determined to be the most effective in reducing disease and to get the best cost-benefit ratio when compared with other treatments.

References

Chouhan V and Kumar A. 2022.Evaluation of Fungicides for Management of Brown Leaf Spot Disease of Rice. Available at SSRN 4005520

Kumar P, Anshu V and Kumar S. 2011.Morpho-pathological and Molecular Characterization of *Bipolaris oryzae* in Rice (*Oryzae sativa*). Journal of Phytopathology, 159(1): 51- 56

ICSCI 2022/T2/26

Effect of germination on the bioactive properties and glycemic index of Jyothi rice based product

Deepa John, Muhammed Shabir P and Maya Raman*

Department of Food Science and Technology, Faculty of Ocean Science and Technology, Kerala University of Fisheries and Ocean Studies, Kochi-682506, Kerala, India

Email: mayaraman@kufos.ac.in

Introduction

Type-2 diabetes, a lifestyle disorder is the most prevalentdiabetic types affecting a large number of population possibly due to dietary habits and sedentary life-style (World Health Organization, 2020). The most effective way to prevent type-2 diabetes is by modifyingthe dietary habits especially in developing country. Consumption of pre-germinated brown rice reduces the risk of type- 2 diabetes (Imam et al., 2012). The main objective of the study was to germinate the most commonly consumed rice variety of Kerala Jyothi for different time intervals and analyze the changes in bioactive compounds. The optimum germination conditions resulting in increased antioxidant activity was selected for preparing a suitable rice-based product. Glycemix index of the product before and after germination were estimated.

Methodology

The paddy was soaked in distilled water in 1:10 ratio (grain: water, w/v) at 30±1℃ for 24 h and incubated at 35℃ for different intervals of time (0,12,24,36,48 h). Each sample was dried at 55℃ in hot air oven until moisture content reduced to 14% and stored at refrigerated condition until extraction and estimation. The extraction of un-soaked paddy and germinated seeds were performed according to Sutharut and Sudarat (2012), with slight modifications. The collected supernatant was used for further assay. Estimation of total phenolic and flavonoid contents were done by Folin- Ciocalteu's and aluminum chloride methods respectively (Kamtekar et al., 2014). The γ- aminobutyric acid (GABA) content was determined according to Jirapa et al. (2016), with slight modifications. The amylose content was determined by colorimetric method (Lauro et al., 1999). The antioxidant potential was analyzed by using 1,1-diphenyl-2-picrylhydrzyl (DPPH) scavenging assay (Chen et al., 2008). The rice sample, germinated for 36 h, was used to prepare Puttu (a traditional breakfast in South India). The Puttu, steam rice flour, was prepared by mixing flour and water lightly, tempering for 5-10 min and steaming the same for 15 min. The estimation of the glycemic index (GI) involved analysis of available starch and starch hydrolysis index 90 (HI 90) as per the formula given by (Goñi et al., 1997).

Results

The phenolic and flavonoid content of germinated seeds for 36 h were found to be higher than non-germinated rice kernels. The amylose content gradually increased with germination period and at 48 h highest amylose content was recorded. The antioxidant activity also showed an increment with germination and was highest at 48 h. However, GABA content did not increase with germination, which may be attributed to the conventional method of germination where water was not replaced after every 3-4 h of soaking. The natural fermentation during conventional germination affected GABA production (Sitanggang et al., 2021). Glycemic index assay: A decrease in the glycemic index values of germinated rice samples, (47.916) compared to the moderate glycemic index of non – germinate rice (56.89) was observed possibly due to the bioactivity of some other bio-functional components, such as ferulic acid, γ-oryzanol.

Conclusion

The soaking and germination increased the total phenols, total flavonoids, and amylose content, that reflected with improved antioxidant property. The glycemic index in Puttu developed using germinated rice (36 h) had low GI (47.91), which will assist in the management of type-2 diabetes. The germination aided in reducing the GI from moderate to low.

References

Imam, MU, NH Azmi, MIBhanger, N Ismail andM Ismail.2012. Antidiabetic properties of germinated brown rice: a systematic review. Evidence-based complementary and alternative medicine: 816501.

SutharutJ and JSudarat. 2012.Total anthocyanin content and antioxidant activity of germinated colored rice. International Food Research Journal 19.1.

Kamtekar S, V Keer and V Patil. 2014. Estimation of phenolic content, flavonoid content, antioxidant and alpha-amylase inhibitory activity of marketed polyherbal formulation. Journal of applied pharmaceutical Science, 4(9):061–065.

Lauro M, PForsell, M Suortti, S Hullemanand KPoutanen. 1999. α-Amylolysis of large barley starch granules. Cereal Chemistry,76(6): 925–930.

Goñi I, AGarcia-Alonso and F Saura-Calixto.1997. A starch hydrolysis procedure to estimate glycemic index. Nutrition Research, 17(3):427–437.

Jirapa K, Y Jarae, R Phanee, andK Phanee, K. 2016. Changes of bioactive components in germinated paddy rice (Oryza sativa L.). International Food Research Journal, 23(1): 229.

SitanggangAB., M Joshua, H Munarko, F Kusnandarand SBudijanto. 2021. Increased γ-Aminobutyric Acid Content of Germinated Brown Rice Produced in Membrane Reactor. Food Technology and Biotechnology, 59(3) :295-305.

ChenHMZhang, Z Qu and B Xie.2008. Antioxidant activities of different fractions of polysaccharide conjugates from green tea (Camellia Sinensis)..Food Chemistry, 106(2): 559–563.

ICSCI 2022/T2/29

Low phosphorus tolerance in advanced introgression lines from wild accessions of *Oryza spp*

Divya B*, Sunanda T, Kavitha B, Arun Kumar, Sai Theja D, Magudeeswari P, Pranay G, Anantha MS, Subba Rao LV, Sundaram RM, Sarla N
ICAR-Indian Institute of Rice Research, Hyderabad-500030, Telangana
*Email: *dbiirr23@gmail.com*

Introduction

Phosphorus (P) is an essential macronutrient required for plant growth. One third of the agricultural land in the world is devoid of adequate amount of P in the soil for optimum plant growth and development (MacDonald et al., 2011). Availability of P from soil to plant is limited due to its low mobility in nature and is often a limiting factor for crop yield. As P fertilizers are expensive and thus lower the profit to farmers in low input rainfed agricultural systems. Suggested approach to tackle this problem of low P in farming is the identification and development of genotypes with high phosphorous use efficiency (PUE) in low P soils without compromising yield (Aluwihare et al., 2016). Therefore, there is a necessity to identify and develop new genetic resources to explore diverse molecular mechanisms for P deficiency tolerance.

Methodology

The research work was conducted in ICAR-IIRR, Hyderabad during Rabi 2018 at IIRR farm using wild introgression lines from the *Oryza nivara* derived crosses, viz. C1(RP6458), C2(RP6459), C3(RP6460), and Swarna Sahbhagidhan and DRR DHAN-44, and Vandana, are taken as the control and were screened at low P and normal irrigated conditions(Fig.1). Genotypes were screened for grain yield and related parameters in two environments following Standard Evaluation System (SES, IRRI, 2013). Data was analysed using Statistical Tool for Agricultural Research (STAR). Correlation coefficient and path coefficient also carried out.

Results

Twenty-four advanced interspecific lines were characterized for agro-morphological traits under normal irrigated and low Phosphorous conditions along with checks Swarna, Vandana, Sahbhagidhan and DRR Dhan 44. The data were recorded on six agro-morphological traits to study genetic variability and phenotypic correlation. Analysis of variance among 24 promising rice genotypes showed highly significant differences for all the characters under study indicating the presence of a substantial amount of genetic variability. On the basis of mean performance of highest grain yield per plant exhibited under normal irrigated conditions, C3-179, C3-78 and C3-139 were found to be superior in grain yield. However, the mean performance of single plant yield was highest in C2-143(19.79) followed by C2-116 (19.73) compared to checks under low phosphorus conditions. Correlation study revealed that grain yield per plant showed the high significant positive correlation with plant height, and biomass, in both the normal irrigated and low phosphorus conditions. Thousand grain weight showed positive significant correlation with grain yield at low phosphorus condition and showed highly significant positive correlation with plant height and thousand grain weight at normal irrigated condition.

Fig.1 Screening of wild introgression lines at Rabi 2018 at IIRR farm both at Low P and normal irrigated conditions

Conclusion

Wild species are important donors in rice breeding programs as they have many beneficial alleles for rice improvement which were eliminated during domestication. The identified introgression lines are having potential to develop into high yielding varieties based on their stability and adaptation on multi environment testing in both Low phosphorus and normal conditions.

References

MacDonald GK, Bennett EM, Potter PA, Ramankutty N.2011. Agronomic phosphorus imbalances across the world's croplands. Proc Natl Acad Sci USA. 108(7): 3086-3090.

Aluwihare YC, Ishan1 M, Chamikara MDM .2016. Characterization and selection of phosphorus deficiency tolerant rice genotypes in Sri Lanka. Rice Sci. 23(4): 184-195.

ICSCI 2022/T2/30

Genotypic variability of recombinant inbred lines from interspecific crosses for widening the genetic base of *Oryza* spp.

De Silva N.P. S[1,3], Divya Balakrishnan[1], V.G. Shankar[2], Jyothi B[1], Senguttuvel P[1], Ladhalakshmi D[1], Gireesh C[1], Kalyani MB[1], Sruthi K[1], Suvarna C[1], G Padmavathi[1], LV Subbarao[1], N Sarla[1]

ICAR-Indian Institute of Rice Research, Hyderabad-500030, Telangana

[1]ICAR Indian Institute of Rice Research, Hyderabad, 500030, India

[2]Professor Jayashankar Telangana State Agricultural University, Hyderabad, 500030, India

[3]Regional Rice Research & Development Centre, Bombuwela, Kalutara, 12000, Sri Lanka

*Email: *dbiirr23@gmail.com*

Introduction

Rice is one of the world's major staple food crops and a model cereal species. Rice feeds more than half the human population worldwide. Ninety per cent of the world's production and consumption of rice is in Asia (FAO, 2016). Rapid population growth may pose a threat of severe food shortage world over due to factors like low yield, low productivity and yield plateaue, emerging new pest and diseases, various abiotic factors, shrinking natural resource base and narrow genetic base of working germplasm. This indicates that the challenge of increasing rice production by utilizing the limited natural resources. Therefore, enhancing rice productivity through novel genetic approaches is mandatory. As a primary gene pool, wild rice is a valuable genetic source with tremendous new genes (Roy and Shil, 2020), which are not much exploited by rice breeders yet, can be used to enhance the yields of cultivating rice through broadening the genetic variation in modern rice breeding.

Methodology

Use of introgression lines (ILs) having genomic fragments from wild rice in a back ground of mega varieties is a successfully proven technology and an encouraging trend to improve rice varieties with desirable traits with high yields. The present investigation was undertaken to identify high yielding lines with wild introgressions using an interspecific cross developed from *Oryza sativa*/ *O. nivara*. Including parental lines Swarna and 166s as checks, here we evaluated 153 rice lines developed by a cross between Swarna with 166s in three seasons, *viz*., *Rabi* 2017-18, *Rabi* 2018-19 and *Kharif* 2019 of Telangana region, at research field in Indian Institute of Rice Research, Rajendranagar, Hyderabad. The main objective of the study was to identify high yielding genotypes suitable for both *Kharif* and *Rabi* seasons. The RILs belong to F_5, F_6 and F_7 generations were phenotyped for yield and yield traits. The experiment was laid out in a Randomized Complete Block Design with two replications. Data was analysed using Statistical Tool for Agricultural Research (STAR). Correlation coefficient and path coefficient also carried out.

Results

Analysis of variance revealed significant differences for all the traits studied indicating the presence of inherent genetic variability among the genotypes studied and there is a high potential for yield improvement by selection in these traits. In three seasons broad phenotypic variation was observed and the trait average ranged for PH (72.14 to 104.24); TN (10.45 to 20.10); PTN (9.9 to 19.17); SPY (13.6 to 31.44); TGW (17.08 to 24.57); BM (10.7833.73) among the genotypes under study. Pooled analysis over three seasons data revealed that among all the genotypes tested; the shortest genotype was G5 (C1-5) and the highest tallest genotype was G12 (C1-13). The lowest number of tillers per plant was seen in G89 (C1-133) and the highest number was exhibited by G2 (C1-2). Lowest productive tillers per plant were observed in G89 (C1-133) while the highest number was recorded by G2 (C1-2). The genotype G5 (C1-5) recorded the lowest single plant grain yield and G14 (C1-15) scored the highest grain yield. Among the genotypes investigated genotype G41 (C1-55) showed the lowest TGW followed by G153 (Swarna). The highest TGW was shown by G76 (C1-116). The character association studies revealed that single plant grain yield had significant positive association with number of total tillers per plant, number of productive tillers per plant, thousand grain weight, biomass weight per plant and plant height at both genotypic and phenotypic levels in different seasons(Fig.1), indicating that these characters are very important for yield improvement and simultaneous selection of these characters will ultimately result in high yield.

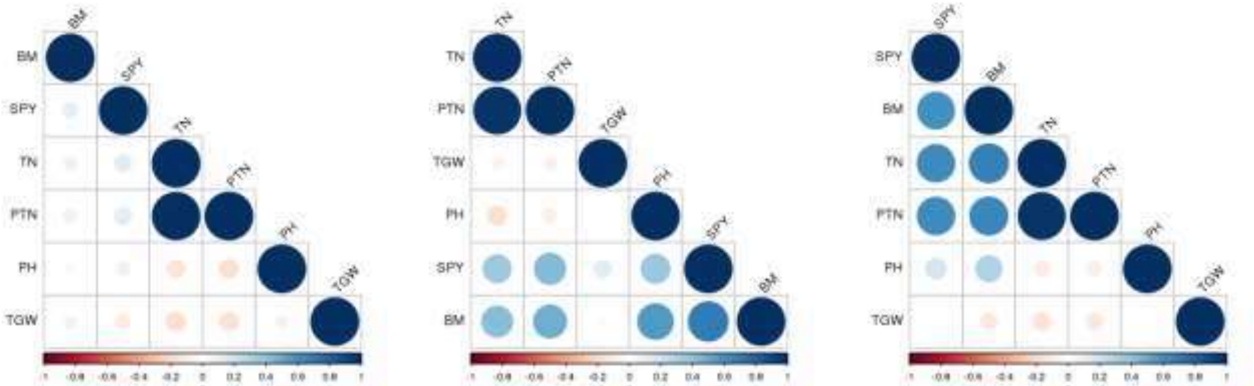


Fig.1 Correlogram showing trait association on yield related traits *Rabi* 2017-18, *Rabi* 2018-19 and *Kharif* 2019 at normal irrigated conditions

Conclusion

The pooled ANOVA explained that the variance among the RILs of Swrna x 166s, mainly because of the genotypic effect rather than the environment or Gx E effect. G65, G30, G50, G145, G148, G114, G14, G136, G12, G22, G20, G2, G29, G84, G76, G3, Swarna and 166s lines with both stabilities for yield and adaptability across environments and selected for further use in breeding programmes for yield improvement.

References

FAO, 2016.The state of food and agriculture. Food and Agriculture Organization of the United Nations, Rome.

Shakiba, E and Eizenga, G. C. 2014.Unraveling the secrets of rice wild species. In W. Yan and J, Bao (eds.) - Rice germplasm, genetics and improvement.1–58.

Validation of fertilizer prescription equation developed based on STCR-IPNS for rice

Bagavathi Ammal* U., Sankar.R*., Coumaravel.K* and Pradip Dey**
*Department of Soil Science and Agrl. Chemistry
PAJANCOA&RI, Karaikal-609 603, U.T. of Pondicherry, India.
** Project Co-ordinator (STCR), Indian Institute of Soil science, Bhopal- 462 038.MP, India
Email: pancham112@gmail.com.

Introduction

The slogan "Rice is life" is most appropriate for India as this crop plays a vital role in our national food security and is a means of livelihood for millions of rural households. The lower production of rice is due to imbalanced fertilization of N, P and K nutrients (Reddy and Ahmed, 2000). The most comprehensive approach of fertilizer application by incorporating soil test values, nutrient requirement of the crop, contribution of nutrients from soil, manures, fertilizers and fixing yield targets is possible only through STCR approach. Soil testing helps the farmers to use fertilizers according to needs of crop. Fertilizer use for targeted yield (Ramamoorthy *et al*.,1967) is an approach which takes in to account the crop needs and nutrients present in the soil.

Methodology

To validate the fertilizer prescription equation, a field experiment was conducted at farmer's field at Arachikuppam village, Puducherry with rice (ADT. 43). The soil of the experiment is classified under Sanyasikuppam soil series of *Fine-loamy mixed isohyperthermic Typic Ustropept* with the texture of sandy loam and low in available N (242 kg ha^{-1}) (Subbiah and Asija,1956), high in available P (26.0 kg ha^{-1}) (Bray *et al*.,1945) and medium in available K (242 kg ha^{-1}) (Stanford and English,1949). The experiment consisted of nine treatments *viz*., blanket recommendation, STCR-NPK alone for 5, 6 and 7 t ha^{-1} yield targets, STCR-IPNS for 5, 6 and 7 t ha^{-1} yield targets, farmer's practice and absolute control in RBD with three replications.

Fertiliser Prescription Equation

FN : 3.38 T - 0.25 SN - 0.48 ON

FP_2O_5 : 1.27 T - 0.79 SP - 0.76 OP

FK_2O : 1.65 T - 0.34 SK - 0.60 OK

Results

The grain yield of the test verification trial on rice revealed that, the yield ranged from 2.75 t ha^{-1} in control to 6.91 t ha^{-1} in STCR-IPNS 7 t ha^{-1}. With regard to STCR-NPK alone treatments for the targets of 5, 6 and 7 t ha^{-1}, the yield recorded were 4.61 ,5.68 and 6.72 t ha^{-1} respectively. Under STCR-IPNS, the yield obtained were 4.81, 5.82 and 6.91 t ha^{-1} respectively. The farmer's practice recorded the yield of 4.08 t ha^{-1} but it was higher than blanket recommendation (3.61 t ha^{-1}). The results have clearly brought out the fact that STCR treatments recorded significantly higher grain yield over both blanket recommendation and farmer's practice. (Table 1). Application of fertilizer based on STCR at critical physiological phases would have supported for better assimilation of photosynthates towards grain and also be attributed to the favorable effect of accelerating the growth and yield parameters by the IPNS +STCR. (Ray *et al*., 2000, Meena *et al* ., 2001 and Bagavathi Ammal *et al*., 2016)

The highest achievement of the yield targets was recorded with STCR-IPNS 7 t ha^{-1} (98.7 %) followed by STCR - IPNS -6 t ha^{-1} (97.0 %), STCR -IPNS –5 t ha^{-1} (96.2 %), STCR - NPK alone- 7 t ha^{-1} (95.9 %), STCR - NPK alone -6 t ha^{-1} (94.7 %) and STCR - NPK alone -5 t ha^{-1} (92.2. %). The results revealed that, the percent achievement of the targeted yields was within +/- 10 percent variation, which has proved the validity of the fertilizer prescribing integrated fertilizer doses for rice. The RR recorded for various treatments ranged from 7.36 kg kg^{-1} in farmers practice to 20.1 kg kg^{-1} in STCR -IPNS -7 t ha^{-1}. Among the STCR treatments, IPNS recorded relatively higher RR than NPK alone treatments. Blanket recommendation recorded 4.3 kg $kg^{-1,}$ which is lower than all the STCR treatments (Table 1)

The available nutrient status results revealed that the lowest available N, P and K was recorded in control (226.0, 23.3 and 90 kg ha^{-1}) and the highest value was recorded in STCR - IPNS treatments (Table 1). The increased available nutrients in STCR-IPNS treatments might be due to improved soil physical properties, which encourage prolific root growth resulting in better absorption of water and nutrients leading to higher yields of rice (Raniperumal, 1988 and Anil Kumar, 2000).

Table 1. Yield, Percent Achievement and Response Ratio in rice

S. No	Treatments	Fertlizer Dose (kg/ha)			Grain yield kg ha^{-1}	Available nutrients			Percent Achievement	Response Ratio
		N	P_2O_5	K_2O		N	P_2O_5	K_2O		
1	Control	0	0	0	2750	226.0	53.12	108	-	-
2	Blanket Recommendation	120	40	40	3610	245.6	95.03	154	-	4.30
3	Farmer's practice	100	30	50	4075	240.0	91.06	131	-	7.36
4	STCR - NPK alone –5 t ha^{-1}	110	23	46	4610	237.2	70.22	119	92.2	10.6
5	STCR - NPK alone- 6 t ha^{-1}	142	28	55	5680	240.0	70.63	134	94.7	13.0
6	STCR - NPK alone -7 t ha^{-1}	175	64	71	6715	242.8	98.45	157	95.9	12.8
7	STCR- NPK +IPNS –5 t ha^{-1}	70	20	16	4810	251.2	60.60	140	96.2	19.4
8	STCR- NPK +IPNS -6 t ha^{-1}	103	23	20	5820	259.6	51.16	166	97.0	21.0
9	STCR- NPK +IPNS –7 t ha^{-1}	136	36	34	6910	256.8	73.60	170	98.7	20.1

References

Anil Kumar, B.H.2000.Integrated use of organic and inorganic manures on growth and yield of finger millet under rainfed conditions. M.Sc. (Agri) Thesis, Univ.Agric.Sci., Bangalore.

Bagavathi Ammal, U., R. Sankar, K. Coumaravel, A. Baskar and Pradip Dey. 2016.Fertilizer phosphorus prescription for rice under STCR-IPNS in inceptisol of Puducherry. Poster presented in 81 st convention of ISSS held at RSKV, Gwalior.

Bray, R.H.1954.A nutrient mobility concept of soil plant relationship. Soil Sci.,78:9-22.

Meena M.S. Ahmed, M. Riazuddin and KR. Chandrasekhara. 2001.Soil test crop response calibration studies on Onion in Alfisol.Journal of Indian society of soil science.49:709-713.

Ramamoorthy, B., R.K. Narasimham and R.S. Dinesh. 1967.Fertilizer application for specific yield targets on Sonora (Wheat). Indian fmg.,17:43-45.

Raniperumal, S., Baskaraduraiswamy and Chellamuthu. 1988.Soil test crop response studies with organics and inorganic nutrients on finger millet. Madras Agric.J.,75(5-6):180-184.

Ray, P., K. Jana, A.K. Maitra, D.N. Saha, M.N. Chaudhury, J.S. Saha and A.R. Saha. 2000.Fertilizer prescription on soil test basis for jute, rice and wheat in a Typic Ustropept.J. Indian Soc.Soil Sci.,48:79-84.

Reddy, K.C and S.R. Ahmed. 2000.STCR based fertilizer recommendations for maize grown in inceptisol. J. Indian Soc.Soil Sci.,48(1):84-89.

Stanford, S and L. English. 1949.Use of flame photometer in rapid soil tests of K and Ca.Agron.J.,41:446-447.

Subbiah, B. V and C.L. Asija. 1956. A rapid procedure for the estimation of available N in soil.Curr.Sci.,25:259-260.

ICSCI 2022/T2/32

Rainfed rice-legume based cropping systems for sustainable productivity and improvement of soil fertility

A.K. Gore and P.O. Bhutada

Upland Paddy Research Scheme, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani - 431 402 Dist. Parbhani (M.S), India

Email: akgoremkv@gmail.com

Introduction

Globally rice is one of the most important food crops in Asia. India is an agricultural country which has arid and semi-arid tropical climate, favorable temperatures ranges and an extensive non-irrigation system in Marathwada region which can translates into a large potential for raising two or more agricultural crops simultaneously. Decreasing farm size which suggests that the farming system involving intercropping is their only hope to ensure efficient utilization of their resources for increased production and family income (Abdul jabbar *et al*., 2010). It has given way to reduce modern agriculture's overdependence on commercial fertilizer and single crop.

Methodology

In a field experiment variety PBNR-03-02 was sown on July 07th, 2018, July 21st, 2019 &July 1st, 2020 by keeping 30 cm distance in between two rows using 35 kg seed rate ha^{-1}. Recommended package of practices was adapted. Experiment was laid out in split plot design, replicated thrice. Among intercrops viz. for Soybean MAUS 71 and for Black gram BDU 1 were used in a gross plot size of 5.4 m X 5.4 m and net plot size of 4.8 m x 4.8 m. The main plots of five nutrient management practices viz., N_1-75 % RDF, N_2-100 % RDF, N_3- 75% RDF + Sulphur 20kg/ha, N_4-100% RDF + Sulphur 20 kg /ha and N_5 – RDF + FYM @ 5t/ha and five intercropping systems viz. S_{1-} Rice (sole), S_2- Rice + Soybean (3:2 in replacement series), S_3 – Rice + Black gram (3:2 in replacement series), S_4– Rice + sign (4:2 in replacement series) and S_5 - Rice + Back gram (4:2 in replacement series) as sub plots were tested.

Result

The grain yield and stability is the main and ultimate objective of growing rice crop with an intercrop. Among various nutrient management practices, the highest rice grain yield, intercrop (soybean) equivalent yield and rice equivalent yield was observed with 75 % RDF + FYM 5 t /ha and it was found to be significantly superior over rest of the treatments. Among various intercropping systems, the highest rice grain yield was observed with sole crop, however, highest intercrop seed equivalent yield and rice equivalent yield was recorded with rice + soybean (3:2) intercropping system followed by rice + black gram (3:2 in replacement series) intercropping system in Marathwada region and it is proved during three years of experimentation on the basis of pooled data table 1. Similar observations have also been made by Chen *et al.,* 2004.

Table 01: Rice grain yield (kg/ha) and SYE of Intercrop (kg/ha), rice equivalent yield (kg/ha) as influenced by various treatments

Treatments	Rice grain yield kg/ha				SYE of Intercrop(kg/ha)				REY of Rice (kg/ha)			
	2018	2019	2018	Pooled mean	2018	2019	2020	Pooled mean	2018	2019	2020	Pooled mean
Main plots : Nutrient management practices (N)												
N_1: 75 % RDF of rice	2240	1930	2060	2077	1153	843	899	965	2330	2020	2156	2169
N_2: 100 % RDF of rice	2435	2125	2275	2278	1254	944	1010	1069	2768	2458	2632	2619
N_3: 75 % RDF of rice + 20 kg Sulphur/ha	2325	2015	2135	2158	1197	887	940	1008	2544	2234	2367	2382
N_4: 100 % RDF of rice + 20 kgSulphur/ha	2565	2255	2435	2418	1321	1011	1091	1141	3127	2817	3042	2995
N_5: 75 % RDF + 5 t FYM/ha	2705	2395	2605	2568	1393	1083	1177	1218	3380	3070	3339	3263
SE ±	80.6	76.09	53.64	70.11	23.47	29.10	21.19	24.59	64.21	71.48	60.49	65.4
CD at 5%	241.1	228.2	160.4	209.9	70.2	87.31	63.30	73.60	192	214.4	180.8	195.7
Sub plots: Intercropping systems (S)												
S_1: Rice (30cm row spacing)	2700	2390	2566	2552	--	--	--	--	2700	2360	2566	2542
S_2: Rice + Soybean (3:2 in replacement series)	2348	2038	2086	2157	1209	899	1161	1090	3147	2807	3369	3108
S_3: Rice + Black gram (3:2 inreplacement series)	2410	2100	2347	2286	753	443	545	580	3136	2796	3279	3070
S_4: Rice + Soybean (4:2 in replacement series)	2215	1905	2216	2112	1140	830	893	954	2816	2476	3203	2832
S_5: Rice + Black gram (4:2 in replacement series)	2595	2285	2296	2392	811	501	500	604	2656	2316	3151	2708
SE ±	30.23	28.91	24.19	27.78	12.28	16.09	12.48	13.62	43.4	48.01	39.50	43.64
CD at 5%	90.4	86.74	72.30	83.1	36.71	48.26	37.24	40.74	130	144.0	118.5	130.4
Interaction (NxS)												
SE ±	55.6	51.73	62.11	56.48	36.5	41.31	44.75	40.85	103	109.2	70.18	94.13
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mean	2454	2143	2302	2300	1264	827	913	1001	2860	2520	2910	2763

Conclusion

The application of RDF + FYM @ 5 t/ha gave significantly high rice grain yield, intercrop equivalent yield (soybean) and rice equivalent yield. Whereas, rice + soybean (3:2 in replacement series) gave significantly higher rice yield, intercrop (soybean) equivalent yield and rice equivalent yield than rest of the intercropping system and sole crop yield.

References

Chen CM. Westcot, K. Nell and D. Wichman M. Knox.2004. Row configuration and nitrogen application barleypea intercropping in Montana. Agron. J. 96: 1738

Abdul J. Riaz A., Iftkhar H. B., Atique-UR-R., Zaheer A. V., and Shah N.,2010 Effect of different intercroppining systems on rice grain yield and residual soil fertility Pak. J.Bot., 42(4) 2339-2348rice-based

ICSCI 2022/T2/33

Gene expression studies for understanding the cross-talk molecular mechanism between nutrient use efficiencies

Nakul D. Magar[1,2], Kalyani M. Barbadikar[1], Padmashree R[1], Amol S Phule[1], Maganti Sheshu Madhav[1], Shailendra Sharma[2], Satendra Kumar Mangrauthia[1], C N Neeraja[1], R M Sundaram[1]

[1]ICAR-Indian Institute of Rice Research, Hyderabad

[2]Chaudhary Charan Singh University, Meerut

E-mail: kalyaniaau@gmail.com, Kalyani.mb@icar.gov.in

Introduction

Understanding the mechanism of nutrient uptake and the development of input-efficient rice lines are extremely essential for changing climatic conditions. The present agricultural scenario drives focus especially on the macronutrients nitrogen (N) and phosphorous (P) for their effective application. In this direction, rice lines/ genotypes having the genetic potential for these nutrient use efficiencies along with other desirable attributes need to be identified and developed along with an understanding of their molecular mechanisms. The present experiment has been conducted to study the gene expression patterns of selected specific transporters and transcription in promising rice lines (ethyl methane sulphonate mutants of Samba Mahsuri *viz.* TI-128, TI-112, TI-3, TI-17) having early seedling vigor, high yield under aerobic (water-limiting need based irrigation) field conditions, and robust root system architecture identified in our previous studies along with checks viz. Vandana and Swarna for phosphorous use efficiency and promising BAAP (Bengal Assam and Aus Panel) line for nitrogen use efficiency. With an aim to identify the selected genes operating under low nitrogen and low phosphorous gradients, and their expression levels in the roots, the present investigation was carried out.

Methodology

The gene expression patterns of specific transporters and transcription factors involved in nutrient uptake (having higher expression aerobic adapted line) were validated in rice lines showing better traits for aerobic adaptation i.e. water use efficiency, N use efficiency, P use efficiency along with check lines (Vandana for PUE, BAAP line for NUE, CR Dhan 202 -aerobic adapted cultivar for water limiting condition) grown in nitrogen gradient soil i.e. N100, N50, N0, and phosphorous gradients, P60 and P20 in a glass container under controlled conditions in six replications of light and humidity till the seedling stage.Root and shoot length, and fresh weight (six biological replication) were recorded using a metric scale and weighing balance respectively. The expression patterns of genes viz., *OsMT2c* (Mettalothionin), *OsNAC71* (NAC gene family), *OsNAS1* (N-amino synthase), *OsPHO1;2* (Phosphate transporter), *OsPHT1;6* (Inorganic Phosphate Transporter), *OsIAA* (IAA gene family), *OsCRL1* (Crown Rootless 1), and *OsLRR* (Leucine rich repeat) (TPH and Memp were used as internal controls) *viz*. phosphate transporters *OsPHO1;2*, *OsPHT1;6*,metal-nicotinamide transporter *OsYSL2*, aquaporin *OsPIP1;3* Mettalothionin *OsMT2C*,and transcription factors *viz*., *OsNAC7-1* (NAC domain contain like protein 7-1), dehydrin and expressed protein 1 (*Exp1)*, tumor protein homolog (*TPH)* and membrane protein (*Memp)* were used as endogenous genes.

Results

Molecular cross-talk mechanisms have been shown to be involved in nutrient interactions and signaling under limiting nutrients condition in rice. Moreover, there has been a correlation between the root parameters and the uptake use efficiencies of nutrients especially water, nitrogen, and phosphorous. The *LRR* gene in TI 3, TI 17 and PHT1;6 gene showed higher expression while under recommended phosphorous condition, TI-128 showed higher expression for PHO and PHT1;6 genes compared to checks such as Swarna and Vandana. The root-related data showed that, TI-3 and TI-112 respond to the P20 condition by increasing the root length significantly as compared to the positive checks as well as with the rest of the mutant lines. While, under recommended dose of nitrogen gradients, the *LRR* gene in TI-3, TI-17 and PHT1;6 genes showed higher expression while under recommended phosphorous condition, TI-128 showed higher expression for *LRR, MNT3, PHO NAC9,* and *PHT1;6* genes compared to checks such as positive check promising BAAP line. Line, T-112 showed higher expression of the NAC 9 gene as compared to positive checks viz. Vandana and BAAP line. Similarly, under a low nitrogen gradient, TI-128 showed higher expression for genes such as *IAA*, *MNT3*, *NAC9*, and *PHT1;6* compared to checks BAAP and BPT 5204. Moreover, root-related data showed that TI-112 and TI-128 respond to the low N condition by increasing the root length and root fresh weight significantly as compared to the checks as well as with rest of the lines.

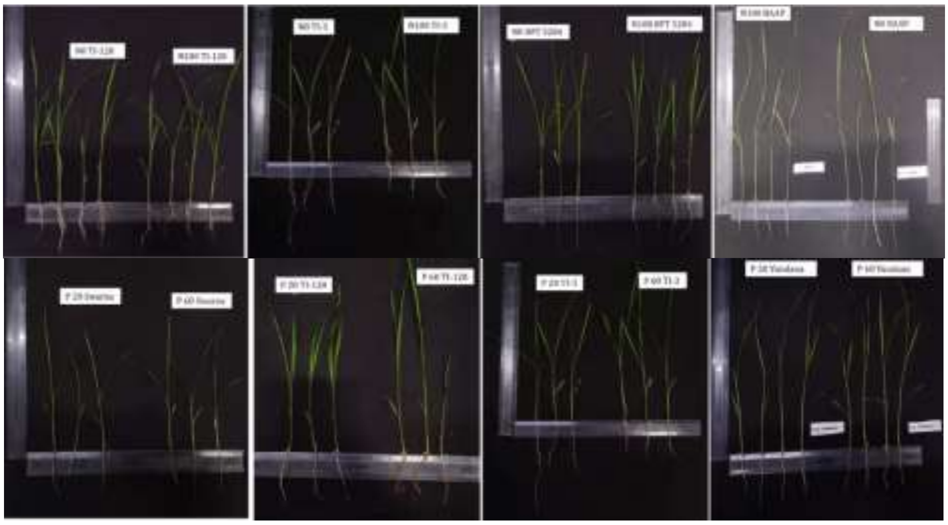
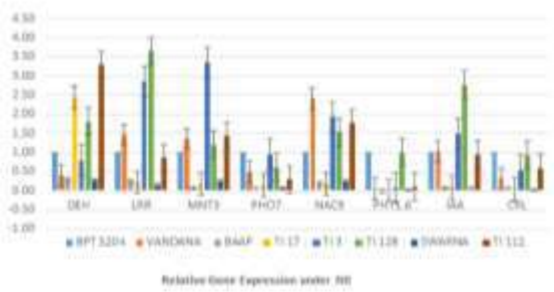
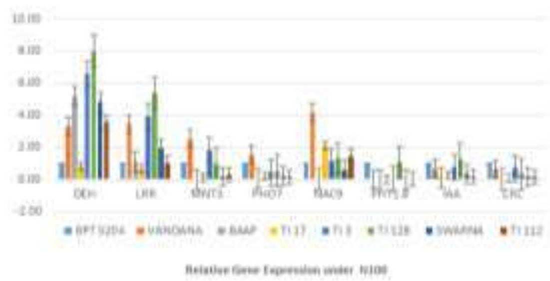


Fig. 1: Morphology of rice lines (showing better aerobic adaptation) under two nitrogen gradients (N0 and N100) and two phosphorous gradients (P20 and P60) at the seedling stage





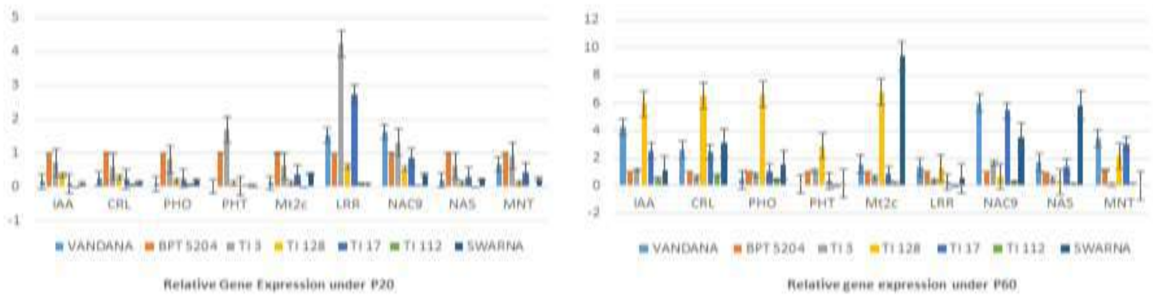


Fig. 2. Relative gene expression study under rice lines (showing better aerobic adaptation) under two nitrogen gradients (N0 and N100) and two phosphorous gradients (P20 and P60) at the seedling stage.

Conclusion

The expression patterns for the genes *viz. NAS, PHO, MT2C, PHT1.6* under lower nutrient gradients give an indication of the existence of a cross-talk mechanism in rice operating for optimizing the nutrient use efficiency. These genes can be further studied on a large set of rice genotypes/ lines for understanding the cross-talk nutrient signaling operating in rice for nutrient use efficiencies.

References

Cai, H., Xie, W., & Lian, X. (2013). Comparative analysis of differentially expressed genes in rice under nitrogen and phosphorus starvation stress conditions.Plant molecular biology reporter, 31(1), 160-173.

Fan, X., Zhou, X., Chen, H., Tang, M., & Xie, X. (2021). Cross-talks between macro-and micronutrient uptake and signaling in plants. *Frontiers in Plant Science*, *12*.

Phule, A. S., Barbadikar, K. M., Maganti, S. M., Seguttuvel, P., Subrahmanyam, D., Babu, M. B. B., & Kumar, P. A. (2019). RNA-seq reveals the involvement of key genes for aerobic adaptation in rice. Scientific reports, 9(1), 1-10.

Subudhi, P. K., Garcia, R. S., Coronejo, S., & Tapia, R. (2020). Comparative transcriptomics of rice genotypes with contrasting responses to nitrogen stress reveals genes influencing nitrogen uptake through the regulation of root architecture. International journal of molecular sciences, 21(16), 5759

Varietal improvement and weed management for aerobic rice cultivation in the drought-prone region of Jharkhand

Ekhlaque Ahmad[1], Ashok Kumar Singh[2], Krishna Prasad[1], Manoj Kumar Barnawal[3], Binay Kumar[4] Varsha Rani[5] and O. N. Singh[6]

[1]Junior Scientist-cum-Assistant Professor; [6]Vice –Chancellor

[1]Department of Genetics & Plant Breeding; [2]Department of Agronomy, [3]Department of Plant Pathology, [4]Department of Entomology, Birsa Agricultural University, Ranchi, Jharkhand-834006, India

Email: ekhlaque.bau@gmail.com

Introduction

Jharkhand is a drought-prone state in eastern India. Rice area, productivity are strongly influenced by rainfall pattern and amount of rain during the wet season**.** Around 90%of therice area is under rainfed. The state has undulating terrain. Where rain water around it very high. Less rain in June-July reduces the rice area, whereas mid-season drought spell in August and September affects production and productivity. Research on aerobic rice cultivation by directseeding of fertilizer responsive high-yielding verities with supplementary irrigation are possible option. Aerobic rice varietal trials, weed management under direct seeding and demonstration of available technology were carried out at Birsa Agricultural University (BAU), Kanke, Ranchi and at the drought- prone Zonal Research Station (ZRS)Chianki, Palamau, Jharkhand.

Methodology

Efforts were made to select better high yielding varieties and improved production technology for aerobic rice cultivation. A product on technology package was demonstrated in the drought years of 2017 and 2018 in BAU Rice Research farms, Kanke, Ranchi and in ZRS, Chinaki. The varieties IR64 (drt-1) of medium duration and Rajshree of late duration were demonstrated for different toposequences (Upper, middle, and lower). Dhaincha (*Sesbania aculeata*), sunnhemp (*Crotalaria juncea*), Cowpea (*Vigna unguiculata*) or urdbean (*Vigna mungo*) was grown along with direct seeded rice, uprooted and used as green mulch, 25 days after seedling.

Results

Chemical fertilizer 100:60:40 NPK ha^{-1} was used for variety IR64 (drt-1) and 80:60:40 NPK ha^{-1} for variety Rajshree. From several varietal trials during the 2017 and 2018 in Kanke, RP Bio 4918-B-B 1425 (6.10 t ha^{-1}, US 380(hybrid) (5.28 t ha^{-1}), RP 5943-421-16-1-1-B (5.68 t ha^{-1}), MEPH (4.35 t ha^{-1}), NVSR 2107 (4.73 t ha^{-1}) with early maturity were found promising, Leaf and panicle blast and brown spot were the major diseases. In varietal trials intermediate plant height (100 to 110 cm), non-lodging, and high yield (>4.0 t ha^{-1}) were major criteria for selection. Two to three irrigations were applied depending rainfall pattern.

Conclusion

For weed management, growing dhaincha or cowpea or urd bean with pre-emergence spray of pendimethalin at 0.75 kg a.i. ha^{-1} at 25 DAS was found effective and 24D at 0.8 kg a.i. ha-1 at 25 DAS was found produced higher yield using IR64 (drt-1)

References

Prasad R. 2011. Aerobic rice system. *Adv. Agron*., 111:207-247

Yang X, Bouman BAM, Wang H, Wang Z, Zhao J, Chen B. 2005. Performance of temperate aerobic rice under different water regimes in North China. Agric. Water Manage, 74:107-122.

ICSCI 2022/T2/35

Intensification of organic rice production system in acidic soil of Meghalaya through varietal replacement

Amit A. Shahane[1*] and U. K. Behera[2]

Department of Agronomy, College of Agriculture (Central Agricultural University, Imphal), Kyrdemkulai, Ri-Bhoi District, Meghalaya, India, 793105

Email: amitiari89@gmail.com

Introduction

Rice is cultivated in Meghalaya on 1.11 lakh ha with a production of 3.04 lakh tonnes (Anonymous, 2019). It is cultivated in all the three seasons (winter, autumn and spring) with major area in winter season; while among different ecosystems, rainfed upland and rainfed lowland are the two ecosystems in which rice is grown in state. As the seasonal rainfall (South West Monsoon season) in all districts of Meghalaya (1424 mm to 4376 mm) is more than water requirement for rice cultivation (Anonymous, 2020), the most of rice fields turns in to paddies during most part of growing season. The rice cultivation in Meghalaya state is known for organic production mode, the least use of agrochemicals, soil with high organic carbon content, high rainfall and prominence of local varieties and traditional practices. The intensification of organic production system is essential for enhancing productivity and returns which can be done through changes in sources of inputs, cultivation practices and genotypes. The genotype (variety) has major influence on productivity (Singh et al., 2020) of production system that's why crops such as rice and maize has high seed replacement ratio even in hilly area (Pandey et al., 2017). Considering lowland rice as major rice growing system, predominance of traditional varieties and potential to increase returns with replacement of traditional varieties, the intensification of organic lowland rice production system was planned with new cultivation for their performance in a region. The objective of study was to know about the productive performance of lowland rice varieties under organic production system. The area selected was cleared off from forest vegetation and brought under cultivation since last three years. The rice-vegetable (potato and pea) cropping system was followed since last two years. The soil of selected field is acidic due to high rainfall and leaching of bases; besides that, shallow depth of soil is another production constraint.

Methodology

The field experiment was carried out at Research Farm of College of Agriculture (CAU-I), Kyrdemkulai, Meghalaya (25^0 74' N and 91^0 81' E) during*kharif*2021. The climate of selected area is subtropical with average seasonal (June to September) and annual rainfall of 1424.1 mm and 2119.3 mm, respectively. The seasonal rainfall (28 May to 30 September, 2021) during the year of experiment was1328.9 mm with 73 rainy days; while the highest and the lowest relative humidity was reported in 27^{th} meteorological week (92.5 %) and 35^{th} meteorological week (74.6 %), respectively. The experiment was planned in randomized block design (RBD) involving four rice varieties viz., MTU-7029, MTU-1010, Ranjit and XRA-37923 and replicated four times. The seedlings were raised in dry bed nursery and transplanted after 25-27 days' growth. The field preparation involved two ploughing followed by puddling twice using power tiller. The transplanting was done manually at 20 × 15 cm spacing with 2-3 seedlings per hill on 12^{th} and 13^{th} July, 2021. The manure application involves application of poultry manure @ 2.5 t/ha and FYM @ 4 t/ha at sowing and 4 t/ha at 35 days after transplanting. The field was weeded twice (25 and 45 days after transplanting (DAT)). The crop was sprayed with cow dung slurry once as a precautionary measure against blast incidence. The water requirement of rice was met by rainfall and no extra arrangement and cost incurred on irrigation. The crop was harvested in third week of November and threshed after drying for two weeks. The biometric observations (plant height and tillers/m^2) were recorded three times (30 DAT, 60

DAT and at harvest) following standard procedure; while shoot dry matter accumulation was recorded at 60 DAT. For measurement of yield attributes, 5 panicles were selected randomly at harvest from each plot. The net plot was harvested and sun dried followed by weighing the biological yield. Threshing was done by manually operated paddle thresher and weighing of grain was done at 14 % moisture content. Straw yield was measured by subtracting grain yield from biological yield. The statistical significance among applied treatments was studied using the F-test and least significant difference (LSD) values (P = 0.05).

Results

Plant height and tiller/m^2 was not differing significantly across the rice varieties at all observations with highest values for both in Ranjit (Table 1). The dry matter accumulation at 60 DAS varied from 122 to 158 g/m^2 with significantly higher value in Ranjit and XRA-37923. The number of panicles/m^2 varied between 248 to 269 (No./m^2); while number of non-productive tillers varying from 12 to 24 per m^2. The yield attributes (filled, unfilled and total spikelets, weight and length of panicles) were highest in Ranjit which was closely followed by XRA-37923 and both these varieties were statistically superior over MTU-1010 and MTU-7029. All the studied four rice varieties had significantly different in grain and straw yield; while harvest index of Ranjit and XRA-37923 remain on par and found significantly superior over other varieties (Table 1). The highest grain yield was recorded in Ranjit (2.08 t/ha) and was 190 and 510 kg/ha higher than XRA-37923 and MTU-7029, respectively. The yield of 2.50 to 3.25 t/ha was reported in organic farming by Sihi *et al.* (2012). The yield in MTU-1010 was the lowest owing to inferior growth attributes (especially lower tillers/m^2) and higher weed population due to shy crop growth (Deka and Barua, 2015). The low soil fertility, shallow soil depth, acidic soil reaction and incidence of blast are the possible reasons for sub-optimal yield than expected. Besides that, weed menace, draining of ponded water due to highly permeable soil and slopy land are the other reasons for the sub-optimal yield.

Table 1: Performance of lowland rice varieties in acidic soil under organic production system

Growth/ yield attributes / economic parameters	Treatments (Rice varieties)				LSD (P= 0.05)
	MTU7029	MTU1010	Ranjit	XRA-37923	
Plant height (cm) at 30 DAT	24.4	23.7	27.0	26.9	1.90
Plant height (cm) at 60 DAT	73.7	73.0	77.4	78.3	6.20
Plant height (cm) at harvest	96.5	94.1	98.3	99.0	11.1
Tillers/m^2(no.)at 30 DAT	128.7	124.3	153.3	147.3	29.0
Tillers/m^2(no.) at 60 DAT	212.3	209.3	231.0	228.3	13.17
Tillers/m^2(no.) at harvest	273.0	270.7	281.7	278.7	9.77
Dry matter accumulation (g/m^2) at 60 DAT	130.5	122.2	158.3	156.3	9.64
Panicles/m^2(no.)	249.0	248.7	269.7	263.0	22.2
Length of Panicle (cm)	21.9	20.7	23.5	23.0	1.11
Weight of panicle (g)	1.41	1.33	1.68	1.57	0.22
Filled spikelets (no.)	114.3	108.3	140.3	138.5	15.6
Unfilled spikelets (No.)	23.0	19.7	30.0	27.7	6.1
Total spikelets (no.)	137.3	128	170.3	166.2	14.6
Grain yield (t/ha)	1.57	1.29	2.08	1.89	0.14
Straw yield (t/ha)	3.38	2.78	4.45	4.15	0.32
Biological yield (t/ha)	4.95	4.07	6.53	6.04	0.46
Harvest index (%)	31.7	31.6	32.6	32.5	0.76
Gross returns (× 10^{3}`/ha)	72.76	59.93	96.47	88.15	6.47
Cost of cultivation (× 10^{3}`/ha)	45.38	45.38	45.38	45.38	-
Net returns (× 10^{3}`/ha)	27.38	14.54	51.09	42.76	6.47
B:C ratio	1.60	1.32	2.13	1.94	0.14

(DAT: Days after transplanting)

The cost of organic rice production in our study was `45.38 × $10^3$ with gross and net returns varying from `59.93 × 10^3 to `96.47 × $10^3$ and `14.54 × 10^3 to `51.09 × $10^3$, respectively. Rangar *et al.* (2021) reported 33.22 `× 10^3 as cost of cultivation in organic production system; while Sihi *et al.* (2012) and Kondaguri *et al.* (2014) reported 21.82 ` × $10^3$ and 28.59 ` × 10^3 as cost of cultivation of organic rice, respectively. The highest net returns were recorded in Ranjit which was higher by ` 8.33× $10^3$, ` 23.72 × 10^3 and ` 36.55× 10^3, respectively over XRA-37923, MTU-7029 and MTU-1010. The higher rate of nutrient application leading to increase cost on nutrient management and no cost involvement in irrigation are distinct points of investment in rice cultivation in our study; while significant variation in yield arises out of genetic potential and varietal adoption to organic production mode in acidic soil is major reason for variation in gross and net returns.

Conclusion

Our study showed that, Ranjit and XRA-37923 performed well over other rice varieties and yield levels of 1.9 to 2.0 t/ha (XRA-37923 and Ranjit) with net returns of ` 42.76 × $10^3$ to ` 51.09× 10^3 can be achieved in acidic soil under organic production system in Meghalaya.

References

Anonymous. 2019. Handbook on area, production and yield of principal crops in Meghalaya, 2019 (including land use statistics and irrigation statistics), directorate of economics & statistics government of Meghalaya; available online on: megplanning.gov.in.; Accessed on 8th January 2022

Anonymous. 2020. Observed rainfall variability and changes over Meghalaya state; Met Monograph No.: ESSO/IMD/HS/Rainfall Variability/17(2020)/41; available online on: imdpune.gov.in. Accessed on 20th December, 2021

Deka J and IC Barua. 2015. Problem weeds and their management in the North-East Himalayas. *Indian Journal of Weed Science*, 47(3): 296–305.

Kondaguri RH, LB Kunnal, BL Patil, JA Handigol and MT Doddamani. 2014. Comparative economics of organic and inorganic rice farming in Tungabhadra command area of Karnataka. *Karnataka Journal of Agricultural Science*, 27(4): 476–480

Pandey A, ML Sharma and VK Sharma. 2017. Study on seed replacement ratio among the tribal farmers of northern hills agro-climatic zone of Chhattisgarh. *Indian Research Journal of Extension education*, 17(1): 88–93.

Rangar S, A Bhat, J Kachroo, N Panotra, M Sharma and SP Singh. 2021. Economic analysis of basmati under organic and non-organic conditions. *International Journal of Agriculture, Environment and Biotechnology*, 14(3): 223–239.

Sihi D, DK Sharma, H Pathak, YV Singh, OP Sharma, Lata, A Chaudhary and B Dari. 2012. Effect of organic farming on productivity and quality of basmati rice. *Oryza*, 49(1): 24–29.

Singh RP, AD Chintagunta, DK Agarwal, RS Kureel and SJ Kumar. 2020. Varietal replacement rate: prospects and challenges for global food security. *Global Food Security*, 25: p.100324; https://doi.org/10.1016/j.gfs.2019.100324.

ICSCI 2022/T2/36

Using phosphorus uptake 1 (*Pup1*) QTL linked markers for screening of advanced rice lines for phosphorus deficiency tolerance

Kiruba G[1], J Ramalingam[2*], N Aananthi[3], S Vellaikumar[2], S Thiyageshwari[4]

[1]*Department of Genetics and Plant Breeding, CPBG, TNAU, Coimbatore 641 003, Tamil Nadu, India.*
[2]*Dept. of Plant Biotechnology, CPMB, TNAU, Coimbatore 641 003*
[3]*Dept. of Genetics and Plant Breeding, AC&RI, Madurai 625 104*
[4]*Dept. of Soils Science and Agricultural Chemistry, TNAU, Coimbatore 641 003*
Email: kirubaganesan111@gmail.com

Introduction

Rice, the foremost cereal crop serves a vital part of human nutrition and caloric intake, providing more than one-fifth of the calories. The growth of human population as well as extent of biotic and abiotic stresses owns a great threatens for getting higher yields of crop production. Approximately in Asia, around sixty percent of the rain fed rice grown soils were affected by multiple stresses and phosphorus deficiency is one among them (Haefele and Hijmans, 2007). P is crucially used by the plant because of fixation processes. Among various screening methods such as hydroponics culture is used convenient method for controlling P concentration (Guo *et al*., 2006). With this background information the objective of our study was to evaluate advanced rice lines for their ability to tolerate phosphorus deficit.

Methodology

The experimental material consists of Thirty-three advanced backcross lines developed with phosphorus starvation tolerant gene (*OsPSTOL1)* genes and growing under Hydroponics condition along with the parents (ASD16, ADT43 and IR64 *Pup1*) (with (100%) and without (0%) phosphorus). Solution culture is prepared based on the modified Yoshida solution (Cock*et al.*, 1976)**.** The experiment was laid out in a completely randomized design (CRD) with two replications. Totally 10 parameters were observed which are represented in Table 2 which includes Acid phosphatase activity assay expressed as molar p-nitro-phenol released per min per mg of fresh weight (Sadasivam, 1996) and The P content (mg/g dry weight) in root and shoot were estimated colorimetrically by Vanadomolybdate yellow colour method (Piper, 1966).

Results

The combined ANOVA reveals that significant differences between +P and –P were observed in all the traits. Comparison of phenotypic performance of improved lines under two P conditions (+P and -P) mentioned in Table 1. In P sufficient condition the mean value of root length is about 15.31 cm with coefficient of variation CV (%) 10.02%, whereas in P deficient condition the mean value of root length is 16.07 cm and CV is 14.36 %. Among all the traits, root length and enzyme activity had increased under the - P condition when compared to + P condition (Nirubana *et al*. 2020) (Chithrameenal *et al*. 2018). The mean value of shoot length was found almost similar such as 40.60 cm in +P and 40.39 in – P condition. While the CV is found higher (10.81 %) in -P than +P sufficient condition (6.68%). Under - P condition, a drastic reduction in shoot growth was noticed, this may be due to the reason that rate of tissue expansion is directly related to P status of the tissue growth zone (Kavanova *et al*. 2006). Correlation among the different traits has been carried out in both + P and - P conditions to understand the relationship of phosphorus deficiency tolerance to other morphological traits in the study (Table 2)**.**

Table 1. Comparison of phenotypic performance of improved lines under two P levels (+P and -P) under hydroponic condition

S.NO	Traits	P sufficient conditions (+P)				P deficient conditions (-P)			
		Mean	Range	CD	CV (%)	Mean	Range	CD	CV (%)
1	Root length (cm)	15.31	10.20-24.70	3.11	10.02	16.07	11.50 - 22.80	4.68	14.36
2	Shoot length (cm)	40.60	27.50 - 60.50	5.50	6.68	40.39	29.90 - 75.5	8.86	10.81
3	Fresh root weight (g)	0.10	0.03 -0.37	0.06	29.53	0.15	0.04 -0.50	0.13	41.26
4	Fresh shoot weight(g)	0.44	0.12 -1.32	0.28	31.46	0.55	0.14 - 1.41	0.21	18.47
5	Dry root weight(g)	0.04	0.02 - 0.09	0.03	33.47	0.07	0.03 - 0.18	0.07	46.21
6	Dry shoot weight(g)	0.16	0.05 -0.50	0.14	44.12	0.22	0.07 - 0.62	0.13	28.70
7	Root P content (mg/g root weight)	0.26	0.06-0.92	0.09	16.13	0.08	0.01-0.31	0.06	33.10
8	Shoot P content (mg/g shoot weight)	0.36	0.05-1.11	0.09	11.64	0.08	0.01-0.12	0.06	35.73
9	Total P content (mg/g plant dry weight)	0.63	0.11-1.50	0.11	9.03	0.16	0.08-0.41	0.03	8.72

Table 2. Pearson correlation coefficients of the traits in (+P) and (-P) regimes grown under hydroponics condition

Conditions	Traits	RL	SL	RFW	SFW	RDW	SDW	Enzyme	RP	SP	TP
	RL	1.000	0.127	0.234	-0.028	0.021	0.013	-0.096	0.333^{*}	0.068	0.254
	SL		1.000	0.254	0.329^{*}	0.480^{**}	0.431^{**}	0.111	-0.017	0.324	0.244
	RFW			1.000	0.803^{**}	0.752^{**}	0.615^{**}	0.309	-0.009	0.008	0.003
	SFW				1.000	0.758^{**}	0.886^{**}	0.306	-0.087	-0.032	-0.075
+ P	**RDW**					1.000	0.611^{**}	0.328	0.107	0.1	0.143
	SDW						1.000	0.26	-0.234	-0.099	-0.213
	Enzyme							1.000	-0.233	0.075	-0.079
	RP								1.000	0.042	0.629^{**}
	SP									1.000	0.803^{**}
	TP										1.000
	RL	1.000	0.002	-0.106	-0.396	-0.15	-0.238	-0.092	-0.192	0.001	-0.161
	SL		1.000	0.441^{**}	0.430^{**}	0.594^{**}	0.652^{**}	0.308	0.007	0.066	0.06
	RFW			1.000	0.719^{**}	0.881^{**}	0.604^{**}	0.435^{**}	0.16	0.126	0.207
	SFW				1.000	0.727^{**}	0.837^{**}	0.561^{**}	0.231	0.097	0.254
- P	**RDW**					1.000	0.753^{**}	0.428^{**}	0.092	0.037	0.108
	SDW						1.000	0.512^{**}	0.054	0.099	0.105
	Enzyme							1.000	0.056	0.187	0.137
	RP								1.000	0.099	0.901^{**}
	SP									1.000	0.513^{**}
	TP										1.000

*Significant at 5% level; **Significant at 1% level; RL = Root length; SH = Shoot length; RFW = Root fresh weight; SRW = Shoot fresh weight; RDW = Root dry weight; SDW= Shoot dry weight; RP=Root phosphorous; SP= shoot phosphorous; TP= Total phosphorous

Under - P condition, increase in association between root P and total P content of the plant was observed and this cannot be observed in + P condition due to availability of phosphorus in the rhizosphere of plant. In this, root phosphorus and shoot phosphorus content is directly correlated with the total phosphorus in both the treatments and in +P condition, root length is positively intercorrelated with the root phosphorus content, shoot length is positively intercorrelated with shoot fresh weight and dry weights of root and shoot. While in –P treatment the traits viz., root fresh weight, shoot fresh weight, root dry weight and shoot dry weight were found to have positive intercorrelation with the enzymatic activity also, root length is positively intercorrelated with shoot fresh weight and shoot length is intercorrelated with fresh and dry weights of root and shoot. Fresh and dry weights of root and shoot were positively intercorrelated with the enzymatic activity (Rejmánková and Macek, 2008). The root P content, fresh and dry shoot weight and shoot length were strongly correlated for P deficiency tolerance under - P condition and these traits may be used as an indicator for screening tolerance to P deficiency (Nirubana *et al*. 2020).

Conclusion

To conclude, phosphorus uptake is a very complex character depending on many factors, whose importance vary accordingly to the environmental characteristics. Identification and introgression of phosphorus tolerance alleles is a significant and future breeding strategy to develop the cultivars tolerant to low phosphorus for attaining food and nutritional security. The attempted study lines IL2, IL7, IL11, IL16, IL28, IL52, IL62-2, IL62-4, IL63, IL69 showed a prominent feature that was exaggerated by the P levels., these lines can be further proceeded on multilocation trail and used in breeding programme.

References

Chithrameenal, K., Alagarasan, G., Raveendran, M., Robin, S., Meena, S., Ramanathan, A., & Ramalingam, J. 2018. Genetic enhancement of phosphorus starvation tolerance through marker assisted introgression of OsPSTOL1 gene in rice genotypes harbouring bacterial blight and blast resistance. *PLoS One*, *13*(9), e0204144.

Cock, J., S. Yoshida, and D.A. Forno. 1976. *Laboratory manual for physiological studies of rice*

Guo ZH, He LY, Huang W, Xu CG .2006 “Screening of rice for tolerance to low phosphorus stress”. J Plant Nutr Fertil 12:642–648

Haefele, S., and R. Hijmans. 2007. "Soil quality in rice-based rainfed lowlands of Asia: characterization and distribution."

Kavanova M, Grimoldi AA, Lattanzi FA, Schnyder H .2006 “Phosphorus nutrition and mycorrhiza effects on grass leaf growth. P status- and size mediated effects on growth zone kinematics”. Plant Cell Environ 29(4):511–520.

Nirubana, V., Vanniarajan, C., Aananthi, N., & Ramalingam, J. 2020. “Screening tolerance to phosphorus starvation and haplotype analysis using phosphorus uptake 1 (Pup1) QTL linked markers in rice genotypes”. *Physiology and Molecular Biology of Plants*, *26*(12), 2355-2369.

Piper, C.S. 1966. *Soil and plant analysis*: Hans Publishers; Bombay

Rejmánková, E., and P. Macek. 2008. "Response of root and sediment phosphatase activity to increased nutrients and salinity." *Biogeochemistry* 90 (2):159-169.

Sadasivam, S. 1996. *Biochemical methods*: New age international

ICSCI 2022/T2/37

Characterization of cytoplasmic diversified advanced backcross lines and restorer lines of pearl millet *[Pennisetum glaucum. (L.) R. Br.]* for various morphological and yield-associated traits

R. Rasitha[1], K. Iyanar[1], R. Ravikesavan[1]and N. Senthil[2]
[1]*Department of Millets, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore – 641 003*
[2]*Department of Plant Molecular Biology and Bioinformatics, Centre for Plant Molecular Biology and Bioinformatics, TamilNadu Agricultural University, Coimbatore – 641 003*
Email: rasitharahamath@gmail.com

Introduction

Pearl millet is one of the major millets cultivated by farmers due to its higher value for feed and fodder. The development of superior hybrids/varieties is needed for increasing productivity of plant which is suitable for different agroclimatic conditions. Characterization of genotypes based on a set of morphological, physiological and biochemical traits were found to be promising for developing new plants based on ideotype concept (Singh *et al.*, 2021).Characterization of plants play major role for enhance the yield potential by genetically altering specific plant features, each of which is chosen so as to contribute to higher economic yield and the morphological characters are universally undisturbed markers applied for testing distinctness, uniformity, and stability for varietal characterization (Kumar *et al.*, 2005). Characterization of genotypes enhances its utilization and improve productivity.

Methodology

The experimental material consists of 59 lines viz., 42 advanced backcross progenies with diverse cytoplasmic sources (A_1, A_4& A_5) developed at Department of Millets, CPBG, TNAU, Coimbatore during 2012 to 2019 and seventeen best performing restorer lines. The experimental material was characterized as per the National Test Guidelines for DUS of pearl millet. A total of 22 DUS based traits including 12 qualitative and 10 quantitative characters were recorded in different stages of crop growth and development.

Results

In the present investigation, among the 59 lines, 61% of lines showed erect nature of growth habit which was preferred when plants are grown under adverse climatic condition and the remaining 39% of lines had intermediate growth habit. Node pubescence and leaf sheath pubescence play a major role in hybrid development which gives protection against pest. Only 5 lines expressed presence of node and sheath pubescence while others were glabrous. Node & internode pigmentation act as important morphological markers for identification showed a wide range of variation in the experimental material. Among the 59 lines, 58, 22 and 15 per cent of the lines recorded green, purple and red pigmentation, while remaining lines showed brown colour node pigmentation. Similarly, 96% of the lines showed green internode pigmentation, whereas 4% of lines showed purple and red colour pigmentation. Anther colour is one of the important phenotypic markers for easy identification of genotypes. Among the 59 lines, 54 and 37 per cent lines showed purple and yellow colour pigmentation, whereas, 7 lines showed red colour anther (Fig 1). Kaviya (2016) & Prasad (2017) also reported such wide variation in the pearl millet for utilizing to synthesize new plant type for required conditions. Spike exertion is desirable characters for resistance against disease and seed setting. Out of 59 lines, 96% showed complete spike exertion, while others were partially exerted. Compact ear head and spike tip sterility are desirable for good seed set thereby increasing the yield. Among the 59 lines, 2% showed compact nature and 75% of lines displayed semi-compact to compact spike density. This result was supported by Gupta *et al.* (2011). Also, out of 59 lines, 66% of lines showed spike tip sterility. Similarly, spike shape, seed colour and seed shape exhibited wide range of variation which can be used as important yield contributing trait for development of new plants for hybrid development and this was supported by Gupta *et al.* (2011), Kumar *et al.* (2005) and Nehru *et al.* (2009).

Fig.1: Variability observed in morphological characters in 59 lines of pearl millets

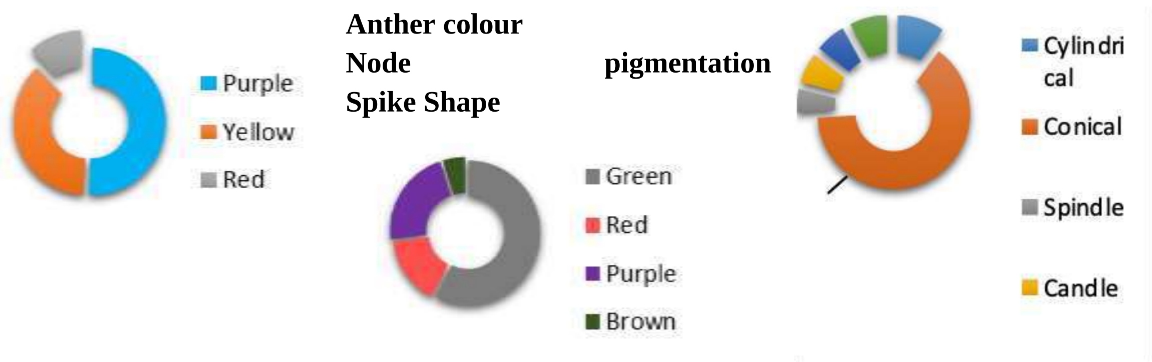


Fig. 2. Variation observed in Anther colour, and Spike shape of 59 lines of pearl millet

If the number of tillers/plant will increase, the grain yield and fodder yield will also get increased. Among the 59 lines, 34 were recorded the higher number of tillers/plant.Spike with maximum length and girth contributed more towards increasing the grain yield. None of the lines showed long spike length and nineteen lines recorded medium spike length and three restorer lines were recorded maximum spike girth. Ten restorer lines recorded maximum 1000 grain weight. Line possessing maximum grain weight showed very bold seed, which is a desirable trait for marketing. The maximum single plant yield was observed in four lines and utilizing these lines will increase the yield. The characterization of advanced backcross male sterile lines gives a clear-cut idea about characters which are suitable for parental lines in hybrid breeding programs, such as dwarf nature, complete spike exertion, absence of tip sterility, and good synchronization with donor plants. Plants with good pollen load, medium plant height, appropriate spike length, and girth for better hybrid development in future breeding programme were identified through evaluation of restorer lines. Based on this experiment, the important traits *viz.*, spike exertion, absence of tip sterility, number of tillers/plant, spike girth, 1000 grain weight, and single plant yield were identified and act as a selection indexes and it could be used as a key trait to increase yield for the ideotype breeding. The characterization of pearl millet genotypes for their morphological traits holds immense potential for their effective utilizationin a breeding programme. It helps us to select required traits for particular environments based on ideotype theoretical models and also to classify the genotypes and to measure genetic distance between different genotypes, which is essential for hybrid development.

References

Gupta, S., R. Bhattacharjee, K. Rai, and M. Kumar. 2011. "Characterization of ICRISAT-bred restorer parents of pearl millet." *Journal of SAT AgriculturalResearch* 9:5pp.

Kaviya 2016 "Variability and diversity for nutritional traits inpearl millet (*Pennisetum glacum*. L)" M. Sc thesis. pages 165

Kumar, A., A. Varier, R. Sherry, K. Aruna Kumari, M. Dadlani, and S. Sharma. 2005. "Characterization of pearl millet [*Pennisetum glaucum* (L.) R. Br.] genotypes by seedling anthocyanin pigmentation and seed characters." *Seed Science andTechnology* 33 (1):215-226.

Nehru, M., M. Kumar, D. Vart, R. K. Sharma, and M. Choudhary. 2016. "Research Article DUS characterization and diversity assessment in pearl millet inbreds." *Electronic Journal of Plant Breeding* 7 (4):925-933.

Prasad, T. 2017. "Characterization and Variability studies of RIL population for downy mildew resistance in pearl millet." M.Sc dissertation, Genetics and Plant breeding, Tamil Nadu Agricultural University Page 160

Singh, S., Y. Yadav, H. Yadav, D. Vart, and N. Yadav. 2016. "Morphological characterization of pearl millet hybrids *[Pennisetum glaucum (L.) R. Br.]* and their parents." *Journal of African Journal of Agricultural Research* 11 (5): 371-378.

Singh, Asheeh K. Singh and Arti Singh. 2021. “Breeding for crop ideotypes” Plant Breeding and cultivar development. Book chapter 25, Pages 497-516.

ICSCI 2022/T2/38

Identification of stable biofortified rice genotypes through G×E analysis

B. Umakanth[1], G. Padmavathi[2]*, Divya Balakrishnan[3], K. Chattopadhyay[4], Girish Chandel[5], Santosh Rathod[6], G Shiva Prasad[7], B. Krishna veni[8], P.S. Virk[9], L.V. Subba Rao[10] and R.M. Sundaram[11]

[1]Research Associate, Plant Breeding dept, ICAR-Indian Institute of Rice Research, Hyderabad,
[2]Principal Scientist, Plant Breeding dept, ICAR-IIRR, Hyderabad, PIN: 500030, Telangana, India
[3]Senior Scientist, Plant Breeding dept, ICAR-IIRR, Hyderabad, PIN: 500030, Telangana, India
[4]Principal Scientist, Plant Breeding dept, ICAR- NRRI, Cuttack PIN: 53006, Odisha, India
[5]Vice Chancellor, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India-492012
[6]Scientist (Agricultural Statistics), ICAR-IIRR, Hyderabad, PIN: 500030, Telangana, India
[7]Senior Scientist, Agricultural Research Station, Kampasagar PIN: 508 207, PJTSAU, India
[8]Senior Scientist &Head, Agricultural Research Station, Bapatla, PIN: 522101, ANGRAU, India.
[9]Harvest Plus, International Food Policy Research Institute (IFPRI), United States and International Center for Tropical Agriculture (CIAT), Columbia
[10]Head & Principal Scientist, Plant breeding department, ICAR-IIRR, Hyderabad, PIN: 500030, Telangana
[11]Director, ICAR-IIRR, Hyderabad, PIN: 500030, Telangana, India
Email: padmaguntupalli6@gmail.com

Introduction

Breeding for high-yielding nutrient rich rice genotypes is a more promising approach in improving micronutrient nutrition worldwide. The quantitative characters of rice show differential expression when tested in different locations and/or seasons due to genotype-by-environment (G×E) interaction. This is attributed to their polygenic inheritance and environmental influence, a challenge for rice breeders. Since G×E hinders the attainment of gain in response to selection, it is necessary to conduct multi-environment trials to find stable genotypes with consistent performance for yield traits. With this background, the present experiment is conducted to evaluate G×E of Zinc (Zn)rich rice breeding lines for various agronomic traits across five different locations in India to identify promising stable Zn biofortified lines.

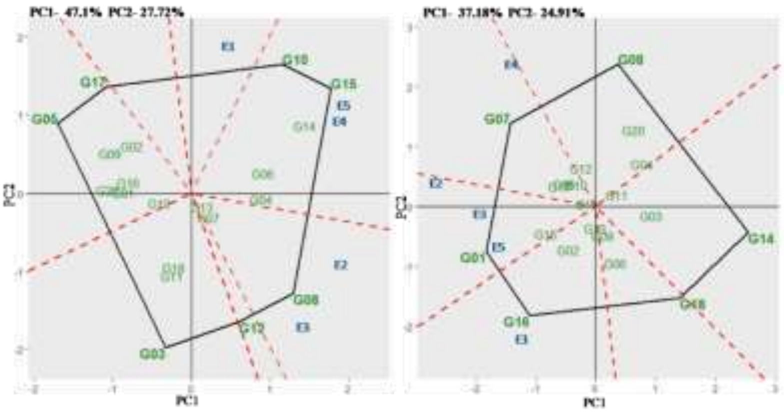
Methodology

A set of twenty genotypes viz., R-56 (G1), RRHP-MI30 (G2), R-RHZ-IB-80 (G3), CGZR-1 (G4), IET 24780 (G5), R-RHZ-SM-14 (G6), MI 156 (G7), Zinco rice MS (G8), DRR Dhan 45 (G9-Yield and micronutrient check), R-RHZLI 23 (G10), MI 127 (G11), DRR Dhan 63 or IET 26383 (G12), CGZR-2 (G13), R-RHZ-IH-82 (G14), DRR Dhan 49 (G15), Chandra Hasini (G16), CR Dhan 311 (G17), Kalanamak (G18-Micronutrient check), Samba Mahsuri (G19-Yield check), IR 64 (G20-Yield check), The experiment was laid out in RCBD with a 5m2 plot size. Data was recorded on eight agronomic traits, i.e., plant height, days to maturity, panicles per square meter, panicle length, number of grains per panicle, filled grains per panicle, 1000 grain weight, grain yield and Zn content in seed. The data of test genotypes at five different locations were subjected to location-wise ANOVA and combined ANOVA, using SAS V9.4's PROC GLM function. To evaluate phenotypic stability and adaptability, three models ie., Kang's yield-stability (YSi) statistic, GGE biplot and AMMI (Gauch HG. 2006), were used.

Results

Combined analysis of variance indicated that all the traits under study were significantly different ($P<0.001$) among genotypes, environments and G×E interaction, indicating the presence of significant variability among test genotypes, environments and interaction of genotypes with environments while expressing the traits. The overall genotypic mean showed wide variation for grain yield, which ranged from

3091 to 5173 Kg/ha, while 21.58 to 27.67 ppm for Zn content in seed. The environments contributed the highest proportion of total (G+E+GE) variation (57.08 %), followed by G×E (27.55%) and genotypes (15.37%) for yield. Similarly, for Zn content, the environments explained the largest proportion of total (G+E+G×E) variation (86.7%), followed by G×E (7.71%) and genotypes (5.59%). This indicates a major role of the environment and their interaction in the expression of grain yield and Zn content. Stability analysis using Kang's stability model exhibited the highest Ysi ranking for Zn content (21) in DRR Dhan 49 (G15) while for yield it was high (23) in R-56 (G1), indicating the consistent performance of these two genotypes across environments. Based on the grouping of environments, Maruteru and Raipur constitute the best representative locations for obtaining high grain yield and Zn content, respectively. Stability models of both GGE and AMMI biplots demonstrated that R-56 (G1) and Chandra Hasini (G16) were the most stable genotypes for yield with consistent superiority over check varieties. However, they showed low Zn content compared to checks. DRR Dhan 49 (G15) was identified as the most stable and adaptable genotype across 5 locations for Zinc content outperforming the checks. Based on the Which-Won-Where view of the GGE biplot, Chandra Hasini (G16) in Hyderabad, R-56 (G1) in Bapatla are the winner genotypes or best performing genotypes for yield. The other genotype, DRR Dhan 49 (G15), was the winning genotype in Raipur and Cuttack for Zn content (Fig 1).



a b

Figure 1: "Which-Won-Where" biplot for (a) Zinc and (b) for yield

Conclusion

Stability analyses of twenty Zinc biofortified rice genotypes revealed R 56 and Chandrahasini as more stable genotypes across 5 locations with higher grain yield while DRR Dhan 49 for both grain yield and Zn. DRR Dhan 49, a Znbiofortified variety released and notified in 2018 originally for the states of Gujarat, Maharashtra and Kerala, could also be utilized as a stable source of high Zinc in other states of Odisha and Chhattisgarh for improving health among consumers.

References

Gauch HG. 2006. Statistical analysis of yield trials by AMMI and GGE. Crop Science, 46:1488 -1500.

ICSCI 2022/T2/39

Effect of plant growth promoting beneficial micro-organisms in growth promotion of drought tolerant rice genotypes

Ram B. Khadka[1*], Subidha Thapa[1], Barsha Sharma[1], Amisha Rimal[1], Bikash Poudel[1], Supral Adhikari[1], Santosh Bhandari[1], Anupa Gaire[1], Sushmita Sapkota[1], Rita Bhandari[1] and Ujjawal Kumar Singh Kushwaha[2]

[1]*Scientist, Nepal Agricultural Research Council – National Plant Pathology Research Center, Khumaltar, Lalitpur, Nepal*

[2]*Nepal Agricultural Research Council – National Plant Breeding and Genetics Research Center, Khumaltar, Lalitpur, Nepal*

*Email:*ramkhadka.narc@gmail.com*

Introduction

Plant growth promoting microorganisms (PGPMO) can colonize as an endophyte in plant cells which influences phytohormone production, phosphate solubilization and thereby increasing the agronomic efficiency and reducing the cost of production and environmental pollution by curtailing the agrochemicals use (de Souza et al., 2015). However, the extent of growth stimulation by PGPMO is largely influenced by crop genotypes, suggesting that the response to PGPMO is under genetic control (Tucci et al., 2011). The balanced response of plants due to inoculation of PGPMO depends on the in-depth regulations of hormones and hormone-like compounds which are largely affected by crop genotypes, physiological status of the crop, cultivation conditions and particular strains. The current studies involve the use of a locally developed seed germination pouch in determining the impact of PGPMO in the growth performance of six different rice genotypes having different levels of water deficit tolerance under soilless culture.

Methodology

A seed germination pouch was developed using polypropylene plastic bags (26.5×17.5 cm) and blotting paper. Experiments were conducted in a factorial completely randomized design where the first factor was rice genotypes, and the second factor was PGPMO with 2 replications. Rice genotypes include (NR11374-B-B-23 (V1), IR 889665-39-1-6-4 (V2), NR-11271-13-B-6 (V3), NR11115-13-B-B-31-3 (V4), NR 11105B-B.27 (V5), and Khumal-10 (V6) having a different level of water deficit tolerance and PGPMO includes two *Bacillus* spp. isolate (29C and D22), two *Trichoderma asperellum* isolates (T25, and T31) native to Nepal. Rice seeds were surface sterilized followed by soaking overnight in either bacterial suspension (10^6 CFU ml^{-1}) or *Trichoderma* spore suspension (10^6 spore ml^{-1}) or sterile water (non-biocontrol, B_0). Then seeds were placed in germination pouches using a sterile tweezer. Rice was grown for 20 days, and seedling and root length were monitored every three days' interval. The area under the shoot growth curve (AUSPC) and area under the root growth curve (AURPC) were calculated for final analysis as mentioned by Wilcoxson et al., (1975). Statistical differences were assessed using function "lm in the lme4 package of R Studio (R-3.2.5) (RStudio Team 2019) and Fisher's test of least significant difference (LSD) by utilizing the Agricolae package in R studio (Mendiburu, 2015).

Results

Rice shoot and root growth as indicated by AUSPC and AURPC were significantly ($p<0.001$) affected by the genotypes. The AUSPC was highest inNR 11105B-B.27 (V5) followed by NR11115-13-B-B-31-3 (V4), and IR 889665-39-1-6-4 (V2). AUSPC was lowest in NR11374-B-B-23 V1 (43.6). The AURGC was significantly highest in NR 11105B-B.27 (V5) (65.3) and lowest in NR11374-B-B-23 (V1) (43.6).

Inoculation of PGPMO significantly (P<0.001) increased the root and shoot growth. The AURPC and AUSPC were significantly highest in *Bacillus* spp. D22 (68.1, 77.8) inoculated seeds compared to non-inoculated control. Similarly, root and shoot growth were also higher in *Bacillus* spp. 29C inoculated seeds compared to non-inoculated control. Inoculation *Trichoderma asperellum* T25 did not change both root and shoot growth compared to non-inoculated control. The shoot growth was increased by 19%, 33%, 20.3% and 27.2% by 29C, D22 and T25 and T31 respectively. *Bacillus* spp. 29C increased root growth by 13.5% and D22 by 21.6% compared to non-inoculated control. The interaction between genotype and PGPMO was also significant (P<0.001). In genotypes V1, V5 and V6 the root and shoot growth was not significantly affected by inoculation of PGPMO in seed. However, in V2 both root and shoot growth was higher in D22 and T31 inoculated seeds compared to non-inoculated control. Root growth was also higher in other PGPMO inoculated seeds compared to non-treated control. In the case of V3 shoot, growth was not significantly affected by inoculation of PGPMO but root growth was higher in PGPMO inoculated seeds. No significant effect of PGPMO was found in v5 and v6 but in case v4 shoot growth was higher in D22 and 29C inoculated plants compared to non-inoculated control but root growth was not significantly affected but PGPMO inoculation.

Table 1. Effect of plant growth promoting microorganisms and genotypes in root and shoot growth of rice

Genotype	PGPMO[1]	AUSPC [2]		AURPC [3]	
NR11374-B-B-23 (V1)		43.6	d	64.2	Bc
IR 889665-39-1-6-4 (V2)		64.2	ab	81.2	A
NR-11271-13-B-6 (V3)		51.5	c	56.6	C
NR11115-13-B-B-31-3 (V4)		60.9	ab	61.2	C
NR 11105B-B.27 (V5)		65.4	a	69.9	B
Khumal-10 (V6)		58.5	b	63.0	Bc
P-value		2.22E-12	***	4.23E-07	***
	29C	56.1	c	70.6	Ab
	D22	68.1	a	77.8	A
	T25	56.9	bc	56.0	D
	T31	62.4	b	64.3	Bc
	B0	45.4	d	61.1	Cd
P-value		7.93E-13	***	7.42E-10	***

Conclusion

The results indicate the locally developed seed germination pouch could be utilized for screening the effect of PGPMO in plant growth stimulation in rice. The PGPMO strains have differential interaction with rice genotypes indicating the root and shoot growth stimulation by PGPMO is PGPMO and rice genotypes dependent.

References

de Souza, R, A Ambrosini, LMP Passaglia.2015. Plant growth-promoting bacteria as inoculants in agricultural soils. Genet Mol Biol 38: 401–419. https://doi.org/10.1590/S1415-475738420150053

Mendiburu, FD, 2015. Package ‘agricolae’. R Package.

Tucci, M, M Ruocco, LD Masi, MD Palma, M Lorito. 2011. The beneficial effect of Trichoderma spp. on tomato is modulated by the plant genotype. Molecular Plant Pathology 12: 341–354.

Wilcoxson, R D, B Skovmand, AH Atif. 1975. Evaluation of wheat cultivars for ability to retard development of stem rust. Annals of Applied Biology 80: 275–281.

ICSCI 2022/T2/40

Marker trait association for grain quality, yield, and yield attributes in rice

Harendra Verma[1], Sakuonuo Theunuo[1], Lamalakshmi Devi[2], Kaberi Mahanta[3], Dipjyoti Rajkhowa[1]
ICAR Research Complex for NEH Region, Nagaland Centre, Medziphema-797106, Nagaland, India
ICAR Research Complex for NEH Region, Sikkim Centre, Tadon, Gangtok-737102, Sikkim, India
Horticultural Research Station, Assam Agricultural University, Kahikuchi-781017, Guwahati, India
Email: harendraicar@gmail.com

Introduction

A rise in living standards and awareness about the importance of nutritional value increased the demand for better-quality rice. That necessitates the plant breeders to develop rice varieties with high yields as well as improved grain quality rice to overcome this bottleneck. The grain quality preference varies across countries and within the country from one region to another region. Thus, there is a need to study grain quality parameters to meet the various location-specific preferred quality rice demands in the market. North East India region is gifted with a rich diversity of rice landraces that needs to be explored. However, studies on grain quality and yield attributes are highly limited in rice of the North East Hill region. Therefore, these landraces need to be conserved and exploited for selecting appropriate landraces among the local cultivars based on genetic structure and diversity for the development of improved rice varieties (Tarang *et al*., 2020). Association mapping helps in dissecting important agronomic traits for identifying alleles or QTLs controlling key traits. It searches for functional variation in a much broader germplasm context. Therefore, the present study was carried out with the three following objectives viz. 1. To explore marker-mediated genetic diversity and genetic structure in rice of the NEH Region and 2. Identification of markers for grain quality, yield and yield attributes using association analysis.

Methodology

To identify the genetic structure of the given population and assign individuals to populations, the software STRUCTURE version 2.3.4 was used (Pritchard *et al.*, 2000). To derive the optimal number of groups (K), STRUCTURE was run with K varying from 1 to 10, with five runs for each K value. To determine the true value of K, ad hoc statistic ΔK was followed. Parameters were set to 3,00,000 burn-in periods and 5,00,000 Markov Chain Monte Carlo (MCMC) replications after burn-in with an admixture and allele frequencies correlated model. The method described by Evano *et al.* (2005) was used to estimate the most probable K value for the analyzed data, using the web tool Structure Harvester ver. 0.6 application (Earl and Vonholdt, 2012). Association analysis between marker loci and phenotypic traits was performed in all trials using TASSEL (Trait Analysis by association, Evolution and Linkage) software version 4.0 (Bradbury *et al*., 2007) after accounting for the gross level population structure (Q) in GLM analysis. The Q+K (kinship) model was used in the MLM analysis with the P3D algorithm (Zhang *et al.,* 2010). Hence, the results of MLM which uses the Q+K model are reported in the study. The marker P value (0.001) was used to determine the significance of each marker-trait association.

Results

The population structure of the 130 germplasm lines was analysed by Bayesian clustering model based approach. The model based simulation estimated the maximum ΔK value at K=2 which is an indication that the whole population can be grouped into two subpopulations (Fig 1). These subpopulations were assigned P1 and P2 (Fig 1). The genotypes having probability of ≥ 80 % were considered as pure and assigned to corresponding subgroups while the others as admixtures. P1 subpopulation have Deihou, Mapok Chi, Chachak Hou and Epyo Tsuk Longsa landraces with long panicles, whereas P2 consisting of

Yunghah Hakla and Aongsho are short duration varieties. Population structure may lead to a spurious association between marker and traits. Therefore, structure analysis was carried out to avoid spurious associations.

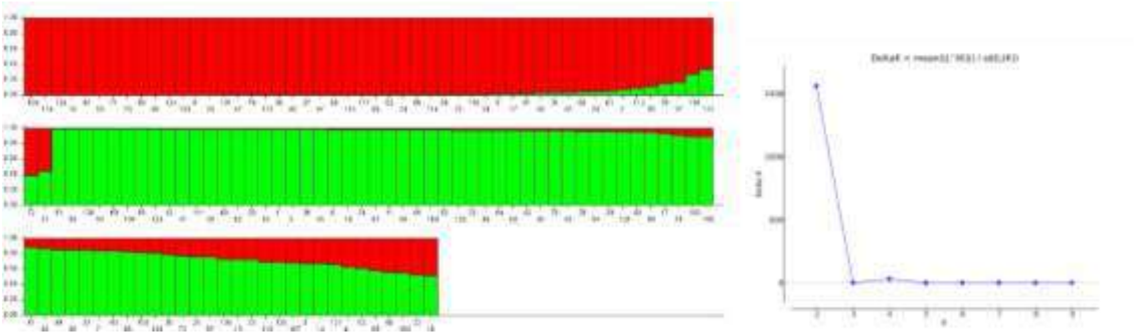


Figure: Marker trait association analysis using MLM model (mixed linear model) based on Q matrix generated in STRUCTURE and kinship matrix of TASSEL revealed a total of six associations at P < 0.0001 for grain quality and yield attributing traits with R^2 ranging from 3.55 to 11.91% under upalnd situation without type 1 error (Table 1). The marker RM240 located on chromosome 2 was associated with gel consistency explaining 11.91 % of variation, whereas marker RM112 located on same chromosome is associated with 3.17% of variation.

Table 1. Marker-trait association

Trait	Trait	Marker Name	Chromo some	F value	P value	R2	markerR2 (%)
Days to flowering	DF	RM101	12	17.4665	5.48E-05	0.0472	4.720106
Decorticated grain width	DGW	RM515	8	5.2489	6.22E-04	0.0355	3.552735
Days to maturity	DM	RM105	9	13.0216	4.45E-04	0.0398	3.980196
Gel consistency	GC	RM240	2	7.6777	1.51E-05	0.1192	11.91805
Gelatinization temperature	GT	RM112	2	13.0405	4.41E-04	0.0372	3.715737
Plant height	PH	RM1256	3	4.7851	2.09E-04	0.0958	9.576851

Conclusion

In the present study, six significant marker-trait associations were detected for grain quality and yield attributing traits. These markers can be used in marker assisted selection for improvement of grain quality and yield attributing traits in rice.

References

Bradbury, P. J., Zhang, Z., Kroon, D. E., Casstevens, T. M., Ramdoss, Y. & Buckler, E. S. (2007). TASSEL: Software for association mapping of complex traits in diverse samples. Bioinformatics, 23, 2633–2635.

Earl, D. A. & VonHoldt, B. M. (2012). Structure Harvester: A website and program for visualizing STRUCTURE output and implementing the Evanno method. Conserv Genet Resour. 4, 359–361.

Evanno, G., Regnaut, S. & Goudet, J. (2005). Detecting the number of clusters of individuals using the software STRUCTURE: a simulation study. Mol. Ecol. 14(8), 2611–2620.

Pritchard, J., Stephens, M. & Donnelly, P. (2000). Inference of population structure using multilocus genotype data. Genetics 155, 945–959.

Tarang, Alireza, Kordrostami, M., Kumleh, S., Chaleshtori, M. H., Saravani, M, G. & Sattari, M. (2020). Study of genetic diversity in rice (*Oryza sativa* L.) cultivars of Central and Western Asia using microsatellite markers tightly linked to important quality and yield-related traits. *Genetic Resources and Crop Evolution*, 67, 1537-1550.

Zhang, Z., Ersoz, E., Lai, C. Q., Todhunter, R. J., Tiwari, H. K., Gore, M. A., Bradbury, J., Yu, J., Arnett, D. K., Ordovas, J. M., & Buckler, E. (2010). Mixed linear model approach adapted for genome-wide association studies. Nature Genetics, 42, 355–360.

ICSCI 2022/T2/41

Phenotypic diversity in rice landraces for submergence tolerance

Rajeswari A, A Rajam, J Karthick, A Premkumar, V Krishnan, S Nadaradjan, Rajan Isha Pearl, R Murugan, K Tharanivel, MS Thamizhkumaran, G Raghularajan and S Thirumeni
Department of Plant Breeding and Genetics, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal – 609 603, Puducherry (UT), India
Email: rajeswariifire@gmail.com

Introduction

Submergence is a serious constraint especially in low lying areas of India and causes huge economic loss to growers. In Tamil Nadu and Puducherry, especially in the Cauvery delta zone, rice is frequently affected by flash flooding during the North East Monsoon (November-December) causing drastic yield loss. In earlier days, submergence tolerant genotypes such as FR13A, FR43B, Goda Heenati, Kurkaruppan and Thavalu were identified (Barik *et al*. 2020) and utilized in hybridization programme. Submergence tolerant QTL (*Sub1*) was identified and fine mapped on chromosome 9 in FR13A, a traditional landrace from Odisha, India (Sarkar *et al*. 2006) and the QTL was successfully introgressed into many high yielding popular rice varieties through Marker Assisted Backcrossing Strategies (MABC). Previously, number of studies were carried out to find out alternate donors for submergence tolerance in land races, germplasm (indigenous and exotic) and reported few minor QTLs for submergence tolerance (Toojinda *et al*. 2003). The present investigation was attempted to identify potential source for submergence tolerance and its components in different land races.

Materials and Methods

A total of 238 genotypes comprising of landraces along with two tolerant (FR13A and Swarna Sub1) and two susceptible checks (IR42 and Swarna) constitute the experimental material. They were sown in Augmented Randomized Complete Block Design (ARCBD) with a spacing of 15 cm x 10 cm in submergence pond to assess the performance of genotypes under submergence condition. The four checks were replicated 12 times and the genotypes were submerged on 51st day (from date of sowing) for a period of 14 days. During the period, the parameters *viz*. pH, EC and Dissolved oxygen of the stagnant water were recorded. After 10 days of de-submergence, data on survival (%) and submergence tolerance score were recorded using SES score (Standard Evaluation System of IRRI). Elongation ability (%) and other physiological parameters like chlorophyll content (mg/g of fresh weight) and chlorophyll fluorescence (Fv/Fm) were also recorded.

Results

The experimental materials were submerged in concrete submergence pond along with checks as shown in Figure 1. Based on the SES score and physiological parameters, 238 genotypes were classified into highly tolerant (4), tolerant (9), moderately tolerant (24), susceptible (53) and highly susceptible (148). The performance of four highly tolerant genotypes namely Nona Bokra, Sanna samba, NCS 840:IRGC 62530-1 and YEBAWYIN::IRGC 33885 -1 were on par with FR13A with respect to survival percentage and other physiological traits (Table 1). Similarly, the tolerant genotypes *viz.*, Kuriyakayama, Rajamannar, Rakthasudi, Karuthakar, Bangaragundu, Navale, KHAO' HAWM:IRGC 78257-1, Improved White Ponni introgression lines (having QTLs for *saltol+sub1+qDTY* 1.1) 65 PYR 27-2-1 and 27-2-2 shown on par performance with Swarna sub1 in terms of survival percentage and other physiological traits.

Table 1. Performance of highly tolerant genotypes based on their survival, elongation, chlorophyll content and chlorophyll fluorescence

S. No:	Name of the genotypes	Survival (%)	Elongation Ability (%)	Chlorophyll content (mg/g of fresh weight)		Chlorophyll Fluorescence (Fv/Fm)	
				BS	TDD	BS	TDD
1.	Nona Bokra	100	5.23	2.49	2.17	0.65	0.62
2.	Sanna samba	100	5.04	3.89	3.36	0.62	0.60
3.	NCS 840	100	9.83	2.92	2.48	0.59	0.56
4.	YEBAWYIN	100	7.27	3.33	2.86	0.61	0.58
5.	FR 13A	100	13.73	3.15	2.86	0.53	0.52
6.	Swarna Sub 1	90	19.68	2.16	1.89	0.59	0.58
7.	IR 42	-	-	3.62	-	0.55	-
8.	Swarna	-	-	3.99	-	0.56	-

BS – Before Submergence, TDD – Ten days after de-submergence

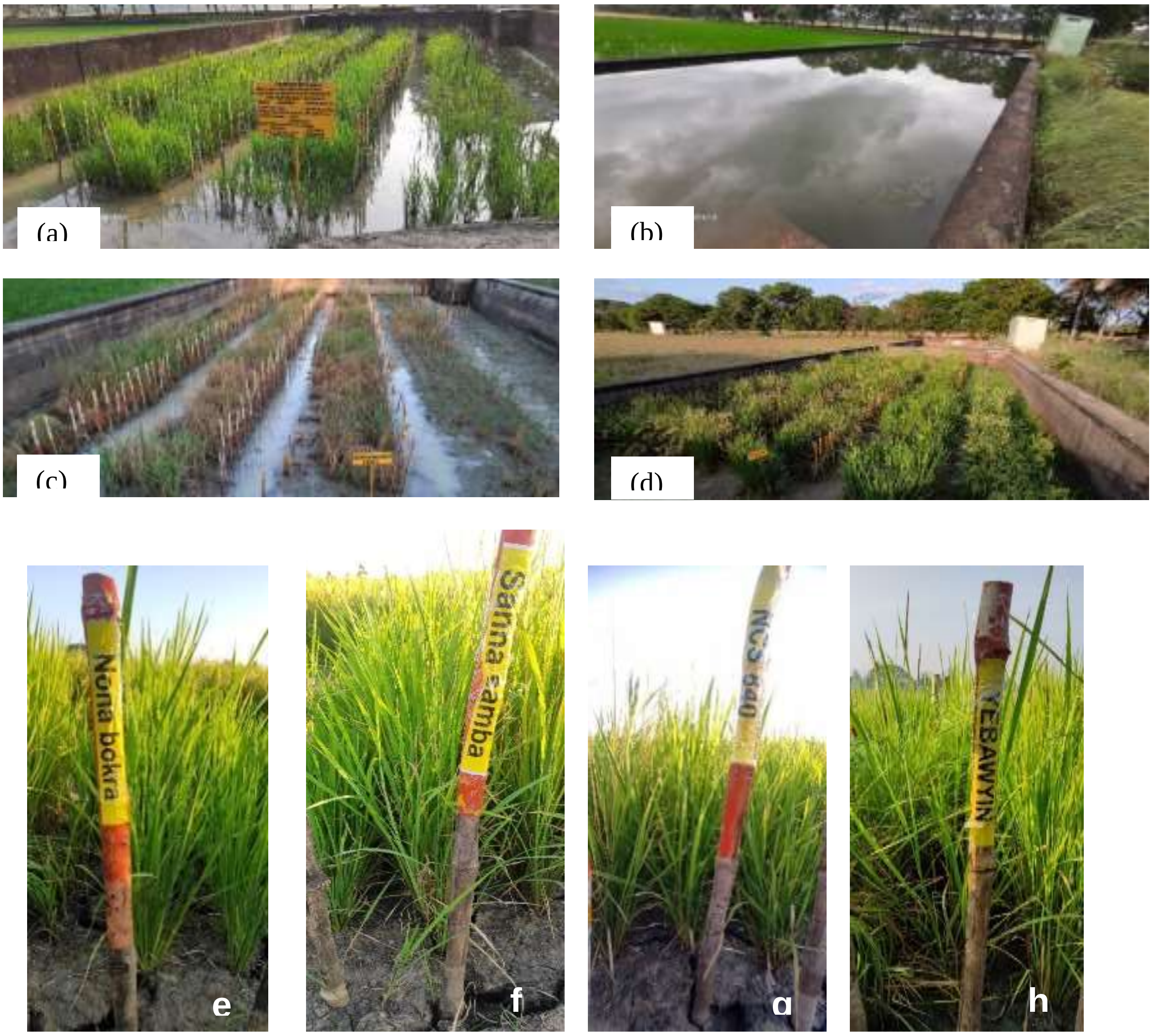


Fig. 1. Screening of 238 genotypes in submergence pond (a) Before submergence (b) During Submergence (c) After de-submergence (d) During flowering stage. Highly tolerant genotypes: (e) Nona Bokra, (f) Sanna samba, (g) NCS 840::IRGC 62530-1 and (h) YEBAWYIN::IRGC 33885-1 after de-submergence in vegetative stage

Molecular marker analysis using indel marker Sub1BC2 (6.38Mb) clearly distinguished the tolerant and susceptible genotypes. Screening of genotypes with other markers tightly linked to the target QTL is in progress and potential donors *Sub1* QTL will be identified for future breeding programs.

Conclusion

From this study, it has been identified that the four genotypes namely Nona Bokra, Sanna samba, NCS 840::IRGC 62530-1 and YEBAWYIN::IRGC 33885-1 are the potential donors for submergence tolerance other than FR13A. Of these four genotypes, Nona Bokra (highly tolerant) and KHAO' HAWM::IRGC 78257-1 (tolerant) have been already reported as saline tolerant genotypes. This present investigation may be considered as baseline research for characterization and utilization of valuable unexplored rice genetic resources and need to be confirmed in further days for identifying potential donors for submergence tolerance.

References

Barik, J, V Kumar, SK Lenkam and D Panda. 2020. Assessment of Variation in Morpho-Physiological Traits and Genetic Diversity in Relation to Submergence Tolerance of Five Indigenous Lowland Rice Landraces. Rice Science, 27(1): 32-43.

Sarkar RK, JN Reddy, S Sharma and AM Ismail. 2006. Physiological basis of submergence tolerance in rice and implication for crop improvement. Current Science, 91(10): 899-906.

Toojinda T, M Siangliw, S Tragoonrung, and A Vanavichit. 2003. Molecular genetics of submergence tolerance in rice: QTL analysis of key traits. Annals of Botany. 91, 243-253.

ICSCI 2022/T2/42

Study on Segregating generations in ADT45 x Nona Bokra rice cross using Honeycomb selection design under salt stress.

Rajam A[1], A Rajeswari[1], J Karthick[1], A PremKumar[1], V Vengadessan[1], C Jeyalakshmi[2], C Yoglakshmi[1], M Naveen[1], V A Fasoula[3] and S Thirumeni[1].

[1]*Department of Plant Breeding and Genetics, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal – 609 603, Puducherry (UT), India.*

[2]*Department of Plant Pathology and Agricultural Microbiology, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal – 609 603, Puducherry (UT), India.*

[3]*Institute of Plant Breeding, Genetics & Genomics and Department of Crop and Soil Sciences, University of Georgia, 111 Riverbend Road, Athens, GA 30602, USA.*

Email: rajamjai@gmail.com

Introduction

The ultimate task of a rice breeder is to breed varieties that can double crop production so as to feed ever increasing human population in limited cultivated area by the year 2050. Hence there is a need for proper utilization of less productive areas such as saline, drought and flood prone areas to sustain food security in India. The problem of soil salinity may be increasing in agricultural area either due to utilization of low-quality irrigation water or due to inflow of sea water (Kumar and Sharma, 2020). Conventional breeding method is more laborious and challenging in developing salt tolerant rice varieties due to genetic complexity of the trait and the performance of the genotypes varies from one environment to another environment. But this can be overcome by Honeycomb selection design (HSD) which accomplishes three distinct functions *viz*. effective sampling for environment diversity, effective selection among and within genetic entries and simultaneous selection in the absence of competition from early generation itself (Fasoula and Fasoula, 2000). The present study was carried out to test the applicability of Honeycomb selection design in F_5 generation of ADT 45 x Nona Bokra rice cross under salt stress with the objective of selecting the best performing lines having high yielding, early to medium maturing and semi dwarf nature.

Materials and Methods

The experimental material *i.e.* F_2, which is now advanced to F_5 generation was generated from a cross between ADT45 and Nona Bokra. ADT45, a popular short duration variety with a desirable feature of heavy tillering and short stature but susceptible to saline condition is used as a recipient parent. Nona Bokra, a land race of West Bengal, which is highly tolerant to saline condition is used as donor parent. In each generation, the seedlings of experimental material were transplanted with a spacing of 100cm x 90cm in Honeycomb selection design along with checks. For plants raised in Honeycomb selection design, JMP Add-In is a computer programme useful for construction of different Honeycomb designs and the analysis of data in order to select effectively the best entries and the best plants per entry (Fasoula *et al.*,2019). In F_2 generation, CSR10 was used as check. In F_3 generation, CSR10 and ADT45 were used as checks. In F_4 generation, CSR10 and TRY2 were used as checks. In F_5 generation, CSR10, TRY2 and TRY5 are used as checks. The trial plot was irrigated with saline bore well water to impose salt stress. To characterize salt stress, customized piezometers were placed in field. EC and pH were recorded periodically. In each generation, phenotypic observations like days to flowering, plant height, single plant yield, panicle length and panicle weight were recorded on single plant basis. The values of different phenotypic observations recorded in each generation were subjected to Honeycomb selection design analysis done by JMP Add-In computer program. Evaluation of each plant was done based on comparing yield of each plant positioned in the center of the ring with the yield of its neighbouring plants within the ring. The plant was selected only if it out yields other plants that is positioned within the ring (Fasoula and Fasoula, 2000). In each generation, top 100 plants were selected by plant yield index using JMP Add-In program and phenotypic observations like grain length, grain breadth, L/B ratio and grain colour of the seeds were recorded for those top 100 plants. Based on this, the best performing lines were selected in each generation.

Results

A total of 1500 plants consisting of 1285 F_2 and 215 CSR10 were raised in un-replicated Honeycomb selection design (UNR-1) at wider spacing/ nil competition as shown in Figure 1. The data recorded for days after flowering, plant height, single plant yield, panicle length and panicle weight on single plant basis were subjected to Honeycomb selection design analysis. Among 1500 F_2 individuals, 29 best performing plants were selected (given in Table 1) and forwarded to next generation *i.e.*F_3 generation.

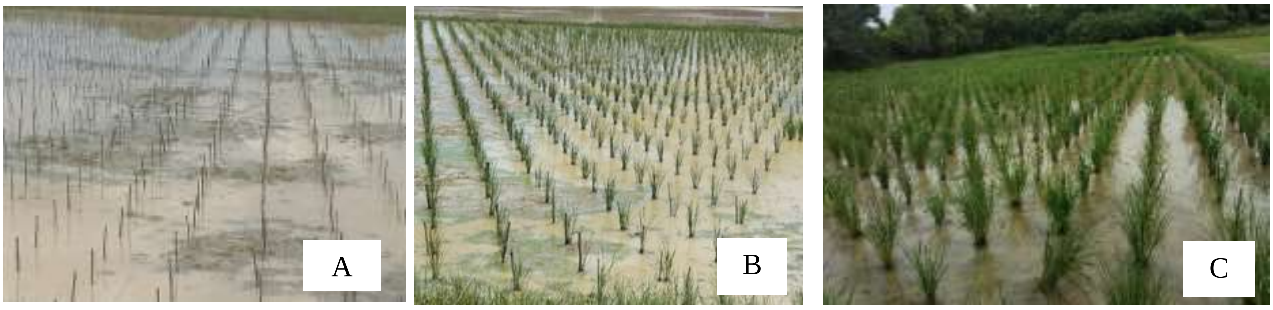
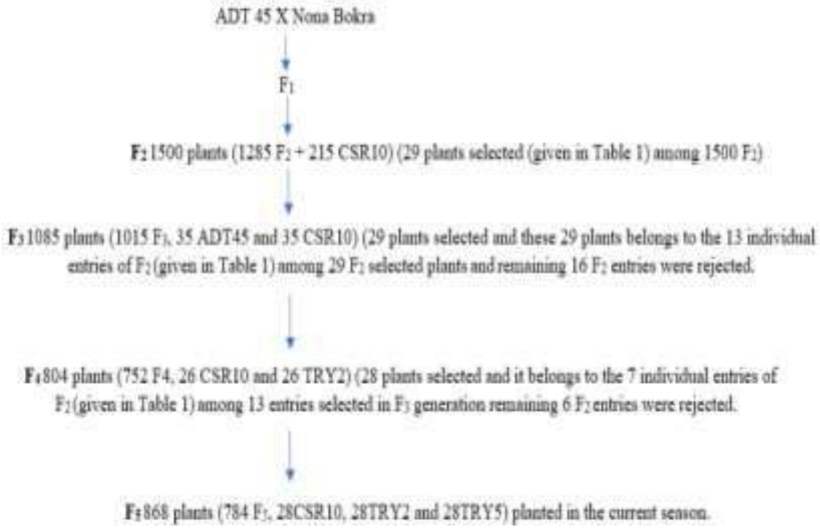


Figure 1. Layout of Honeycomb selection design A. Before transplanting, B. After transplanting and C. At vegetative stage



Flow chart describing selection of the best performing lines in each generation

Table 1. Entries selected and best lines per entry selected in F_2, F_3 and F_4 generation

29 Individual entries selected in F_2 generation	29 entries selected in F_3 generation from 13 individual entries selected in F_2 generation	28 entries selected in F_4 generation from 7 individual entries selected among 13 entries selected in F_3 generation
74th entry	X	X
8th entry	X	X
1053th entry	**2 plants selected**	**5 plants selected**
1189th entry	X	X
91th entry	X	X
559th entry	**2 plants selected**	**1 plant selected**
63th entry	X	X
1220th entry	**1 plant selected**	**1 plant selected**
473th entry	**4 plants selected**	X
1074th entry	**1 plant selected**	X
563th entry	**4 plants selected**	**13 plants selected**
1036th entry	**2 plants selected**	X
608th entry	**4 plants selected**	**5 plants selected**
636th entry	X	X
1192th entry	X	X
173th entry	X	X
700th entry	**5 plants selected**	**1 plant selected**
1114th entry	X	X
546th entry	X	X
293th entry	**1 plant selected**	X
1009th entry	X	X
742th entry	X	X
887th entry	X	X
983th entry	X	X
739th entry	**1 plant selected**	X
686th entry	**1 plant selected**	X
742th entry	X	X
263th entry	X	X
405th entry	**1 plant selected**	**2 plants selected**

The selected 29 plants were planted in replicated Honeycomb selection design (R-31) with a total of 1085 plants (1015 F_3, 35 ADT45 and 35 CSR10). Based on the performance, 29 plants were selected among 1085 F_3 plants. The selected 29 plants were planted in replicated Honeycomb selection design (R-31) with a total of 804 plants (752 F_4, 26 CSR10 and 26 TRY2). Based on the performance, 28 plants were selected and forwarded to F_5 generation. The selected 28 plants, planted in replicated Honeycomb selection design (R-31) layout with a total of 868 plants (784 F_5, 28 CSR10, 28 TRY2 and 28 TRY5) in the current season.

Conclusion

In Honeycomb selection design, selection is practiced from early generation itself. The selection efficiency is also increased in Honeycomb selection design due to the better phenotypic expression of each plant at wider spacing under absence of competition. Whereas in conventional selection methods, the selection is done in later generations and practiced under densely-grown plots to mimic the environment where cultivars are grown commercially which reduces the selection efficiency. Thus, it is concluded that Honeycomb selection design is superior to conventional selection methods. In the current season, F_5 generation is planted and best performing lines will be selected based on the selection criteria.

References

Kumar P and Sharma PK. 2020. Soil salinity and food security in India. Frontiers in Sustainable Food system. 4: 533781.

Fasoula, V.A., and D.A. Fasoula. 2000. Honeycomb breeding: principles and applications. Plant Breeding Review. 18:177–250.

Fasoula V, Thompson K & A. Mauromoustakos.2019. The prognostic breeding application JMP Add-In Program. Agronomy 9.

ICSCI 2022/T2/43

Development of new cytoplasmic male sterile lines JMS 23A and JMS 24A in rice (*Oryza Sativa* L.)

P. Madhukar, B. Srinivas, P. Gonya Nayak, B. Laxmi Prasanna

Rice Section, Regional Agricultural Research Station (RARS), Polasa, Jagtial-505529, Professor Jayashankar Telangana State Agricultural University, Hyderabad-500030, India.

Email: madhu0743@gmail.com

Introduction

Hybrid rice has an average yield advantage of 15% to 20% over inbred cultivars. Most commercial hybrid rice has been developed based on a three-line system, viz., A (CMS line), B (maintainer line), and R (restorer line). The most predominantly utilized CMS system is known to employ wild abortive-type CMS (WA-CMS), which has accounted for 90% of the three-line hybrids produced in China and 10% of the hybrids developed outside of China (Sattari *et al*. 2007; Huang *et al.* 2014). A major technical handicap in the development of hybrid rice using WA-CMS is a limited source of maintainer lines, as many Indica Group elite cultivars are known to carry restorer genes for WA-CMS lines; thus, they cannot be used as maintainer lines. Till now 133 hybrids were released by public and private institutions among which majority of the hybrids were long slender grain type. Hence, in hybrid rice breeding programme, there is a need to develop medium slender or short slender grain type with good head rice recovery, which greatly depends on the development of B-line with high out crossing percentage, dwarf nature, short duration and with high combining ability. The major objective of the present experiment was to transfer wild abortive-cytoplasmic male sterility system into the nuclear back ground of elite maintainer lines.

Methodology

In *Kharif -2014* and *Kharif- 2016* identified the two elite maintainers *i.e.* JGL 23655 and RTN 139 respectively, in test cross nursery evaluation. To transfer a WA-CMS system into the back ground of elite maintainers (JGL 23655 and RTN 139) successive backcross progenies need to be studied ranging from BC_1 to BC_6/BC_9 along with their corresponding maintainer lines. Each pair of backcross progeny planted in 3-5 rows with 10-12 plants each, using a single seedling/hill. In BC_1 to BC_3 generations, the number of rows planted is more than in BC_4 to BC_6/BC_9 generations. The backcross F_1s planted side by side with single plant progenies of corresponding maintainer lines. Such a layout facilitates the comparison of back cross (BC) progenies with corresponding maintainer lines to determine how closely they resemble each other in each BC generation. Three single plants from corresponding maintainer lines were back crossed with the sterile and stable back cross progenies at Regional Agricultural Research Station (RARS), Polasa, Jagtial, Telangana, India (JGL 23655 and RTN139 are recurrent parents). During the process of evaluation, the pairs which segregate for pollen sterility were discarded because these progenies cannot be converted into stable CMS lines.

Results

From *Kharif* 2014 the elite maintainer JGL 23655 repeatedly back crossed with JMS1A up to BC_9 generation, finally in *Kharif* 2019 (in BC_9) identified new cytoplasmic male sterility (CMS) line JMS 23A with nuclear back ground of JGL 23655. Confirmed that the new CMS line developed i.e. JMS 23A is isogenic to JGL 23655 after critical examination of 100 per cent pollen sterility and phenotypic acceptability (Table 1). In the same way another elite maintainer *i.e.* RTN 139 identified in test cross nursery (TCN) during *Kharif* 2015. The maintainer RTN139 repeatedly backcrossed with JMS 18A from *Kharif* 2016 (BC_1) to *Kharif* 2020 (BC_6). In each generation backcross progenies from BC1 to BC6 were evaluated for pollen sterility per centage with KI solution under microscope and the backcross progeny having 100 per cent pollen sterility, plant height, day to 50 per centage similar to recurrent parent were forwarded. Finally, in *Kharif* 2020 (in BC_6) identified another new cytoplasmic male sterility (CMS) line JMS 24A with nuclear back ground of RTN 139.

JMS 1A x JGL 23655	JMS 18A x RTN 139
F1 x JGL 23655	F1 x RTN 139
BC1F1 x JGL 23655	BC1F1 x RTN 139
BC9F1 x JGL 23655 JMS 23A (New CMS line with 100% Pollen sterility and isogenic to recurrent parent JGL 23655)	BC6F1 x RTN 139 JMS 24A (New CMS line with 100% Pollen sterility and isogenic to recurrent parent RTN 139)

Fig.1 JMS 23A Identification **Fig.2 JMS 24A Identification**

Table 1. Special characteristics of new CMS lines JMS 23A and JMS 24A

S.No.	Entry	Days to 50% flowering	Plant height (cm)	Grain type	Outcross %	Grain length (mm)	Grain breadth (mm)	Kernal length (mm)	Kernal breadth (mm)	L/B ratio
1	JMS 23A	83	105	MS	Less out cross per centage (12%)	7.68	1.83	5.08	1.49	3.4
2	JMS 24A	94	109	MS	High out cross per centage (18%)	7.05	1.57	4.79	1.27	3.77

Conclusion

Finally, the newly identified cytoplasmic male sterility (CMS) lines JMS 23A (JMS 1A x JGL 23655) and JMS 24A (JMS 18A x RTN 139) both are having short duration with dwarf nature having medium slender grain type. It was observed that the CMS line JMS 24A showed high outcross percentage, it could be used as one of the best parental line in hybrid rice breeding development programme.

References

Sattari, M., Kathiresan, A., Gregorio, G.B., Hernandez, J.E., Nas, T.M., Virmani, S.S. 2007. Development and use of a two-gene marker-aided selection system for fertility restorer genes in rice. Euphytica (2007) 153:35–42.

Huang, J.Z., Guo E, Z., Zhang, H.L. and Shu, Q.Y. 2014. Workable male sterility systems for hybrid rice: Genetics, biochemistry, molecular biology, and utilization. *Spinger*, http://www.thericejournal.com/content/7/1/13. 7:13

ICSCI 2022/T2/44

Introgression of *Sub1* QTL into cv. ADT 39 rice variety for submergence tolerance through marker-assisted backcross breeding (MABB)

Karthick. J, K. Paramasivam, S. Nadaradjan, A. Premkumar, T. Anandhan and S. Thirumeni
Department of Plant Breeding and Genetics, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal - 609603 Puducherry (U.T) India
Email: biokarthick915@gmail.com

Introduction

Submergence is considered as aserious abiotic stress especially in low lying areas and causes enormous loss to farmers. In low lying areas of South Asia, frequent flooding causes the crop to be completely submerged approximately for 10-15 days. In India, 30% of the rice cultivated areas comprising 12-14 million hectares is vulnerable to flooding and produces less than 2 tonnes/hectare (0.5-0.8 tons/hectare) in the low-lying areas. During North-East monsoon (October-December), due to heavy down pour, short term submergence regularly affects 2 to 3 lakh hectares in tail end areas of Cauvery delta zone of Tamil Nadu and Puducherry. Therefore, rice varieties planted during this period suffer heavy yield loss (Panda and Barik 2021, Koppa and Amarnath, 2021). A major QTL (*Sub1)* explaining about 70% of phenotypic variation for submergence tolerance has been identified and fine mapped on chromosome 9 in the submergence tolerant landrace FR 13A. This provided an opportunity to apply marker assisted backcrossing (MABC) to develop submergence tolerant versions of rice cultivars that are widely grown in the flood prone region and the MABC approach was successfully employed in the transfer of *Sub1* QTL into popular rice varieties namely Swarna and CR 1009.

Methodology

ADT39, a widely grown cultivar of Tamil Nadu and Puducherry (Samba-Aug/Sep sowing) matures in 120-125 days is prone to submergence. To impart submergence tolerance in ADT 39, Swarna sub1 was crossed to it to introgress *Sub1* QTL through MABC strategies. In the MABC technique, foreground selection was done using three markers tightly linked to *Sub1* QTL *viz*. Sub1Bc2 (6.38Mb), ART 5 (6.50 Mb), RM 8300 (6.60Mb). Markers RM 23818 (4.90Mb), RM 23805 (4.5Mb), and RM 23931(7.14Mb), RM 23976 (8.30Mb) were used for recombinant selection at proximal and distal ends respectively. Linkage drag was minimized through recombinant selection. True F_1's of ADT 39 x Swarna sub1 were identified with markers tightly linked to Sub1 loci and the positive plants were backcrossed to ADT 39 to generate BC_1F_1 generation. Single recombinants obtained in BC_1F_1 were backcrossed to ADT 39 double recombinants in $BC_2F_{1.}$ The double recombinants were selfed to fix homozygous double recombinants in $BC_2F_{2.}$ TheBC_2F_2 population along with parents and checks were subjected to phenotyping in a submergence (water level 10 cm above plants) pond by submerging 51 days old seedlings for a period of 14 days. Water was drained out after 14 days and data on survival percentage, submergence tolerance score was recorded on 7 and 14 days after desubmergence following IRRI's Standard Evaluation System. Simultaneously, recovery of recurrent parent genome in these introgression lines was assessed using 50 K SNP chip analysis done at ICAR-NIPB, New Delhi.

Results

The grue F_1s of ADT 39 x Swarna Sub1 (Figure.1) were identified using foreground marker *Sub1Bc2* and backcrossed to ADT 39 to develop backcross generations. In BC_1F_1 generation, the analysis of the markers executed in 312 plants, 186 were identified to possess target gene; four single recombinants three on proximal and one on the distal ends were obtained. These recombinants were backcrossed to ADT 39 to obtain double recombinants BC_2F_1generations (740 seeds). Out of 740 BC_2F_1 plants, 403 plants were found to possess *Sub1* gene and four double recombinants were identified from these positive plants using recombinant markers. The double recombinants (P#199-9, P#232-29, P#365-82, P#301) were selfed to obtain homozygous double recombinants in BC_2F_2.

A number of 20 promising Near Isogenic Lines (NILs) in BC_2F_3 were identified with more than 75% survival. The tolerant check FR13A recorded 100% survival, whereas the susceptible check IR 42 recorded 0.0%. Similarly, recurrent parent ADT 39 displayed 19.2% of survival, while Swarna sub1 recorded 57.6 % against submergence stress. The introgression lines showed quicker recovery from submergence stress than the recurrent parent ADT 39 and the donor parent Swarna sub1. Genome recovery analysis in theses promising lines using 50k SNP chips resulted in the background genome recovery of recurrent parent ranged from 92.0% to a maximum of 94.45%.

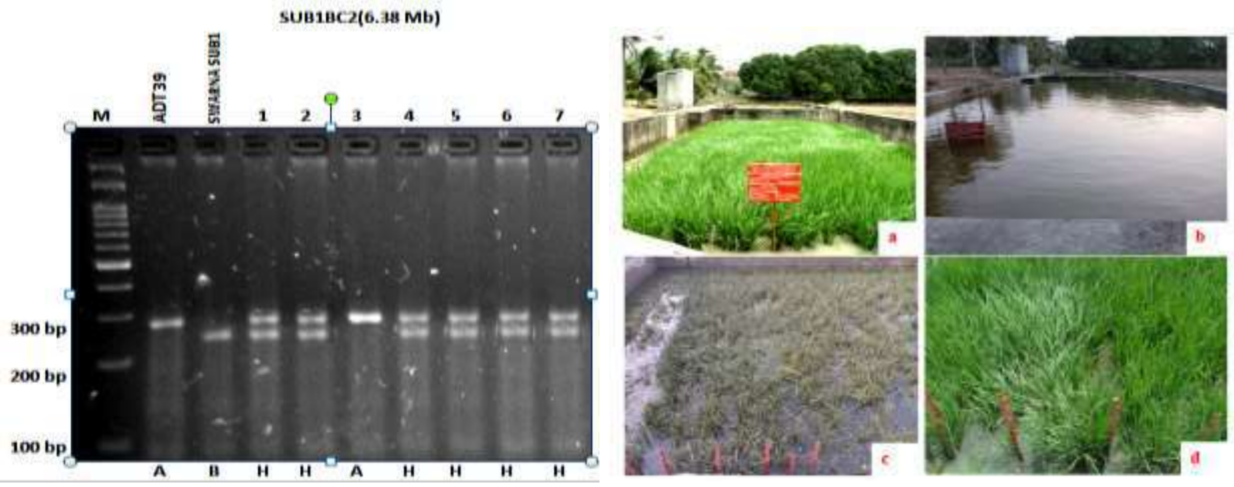


Figure. 1 Foreground selection of introgression lines using Sub1bc2 marker and Phenotyping of backcross population in submergence pond (a) Before submergence (b) During submergence (c) Immediately after desubmergence (d) 21 days after desubmergence

Based on phenotypic screening, marker analysis for target trait and recurrent parent genome recovery three lines *viz*., KR 19005, KR 19011 & KR 19015 (Table.1) were selected and nominated to multilocation trials through AICRIP (AVT-1NIL sub).

Table 1: Performance of introgression lines, parents, and checks after de-submergence

S.No	Genotypes	Survival % after de-submergence		Submergence tolerance score	%Genome recovery
		7 days	14 days		
1	KR 19005	80.8	84.8	2	94.45
2	KR 19011	79.5	80.3	2	93.05
3	KR 19015	78.9	79.8	2	92.87
4	ADT 39	22.0	19.2	9	-
5	Swarna sub1	59.7	57.6	4	-
6	IR42	0.31	00.0	9	-
7	FR13A	100.0	100.0	1	-
	CD@5%	18.26	18.26	-	-

Conclusion

The introgression lines were similar to recurrent parent ADT 39 in all aspects except tolerance to submergence stress. Marker assisted backcrossing approach can, therefore, be successfully adapted to introgress *SUB1* QTL into ADT 39 to convert into a submergence tolerant variety in few backcross generations.

References

Panda D and J Barik. 2021. Flooding tolerance in rice: Focus on mechanism and Approaches. *ScienceDirect*. 28(1): 43-57.

Koppa N and Amarnath G. 2021.Geospatial assessment of flood-tolerant rice varieties to guide climate adaptation strategies in India.

ICSCI 2022/T2/45

Evaluation of rice genotypes of NEH region for low phosphorus and high aluminium conditions in acidic soils of Meghalaya

Balakrishnan C[1], Riya Raj[1], Mayank Rai[1] and Amit kumar[2]

[1]*School of Crop Improvement, CPGS, CAU, Umiam, Meghalaya- 793103*

[2]*ICAR Research Complex for NEH Region, Umiam, Meghalaya*

Email: mrai.cau@gmail.com

Introduction

Rice is the pre-eminent food crop of north-eastern India. However, the productivity of rice in the region is low majorly due to acidic nature of soils and cultivation of indigenous rice cultivars. Acidic soils are characterized by low pH (below 6.5) with adverse effects like deficiencies of major (phosphorus) and minor (calcium and magnesium) nutrients and increase in the phytotoxic elements like aluminium (Al) and iron (Fe). The present research was conducted with the objective to characterize the rice genotypes based on agro-morphological traits in field and to screen the genotypes for high Al toxicity and low P tolerance in hydroponics to identify the superior lines that perform well in acidic soils of Meghalaya.

Methodology

A set of 88 rice genotypes were grown in upland acidic soils (pH 5.2) with low P (<9 kg/ha) and evaluated for agro-morphological traits. Further, the same set of rice genotypes were subjected for screening in hydroponic condition specific to aluminium toxicity and low phosphorus condition. Additionally, the gene specific markers for low phosphorus and aluminium toxicity tolerance in rice were used to find the marker trait association.

Results

As the result of screening through gene specific markers, marker K-46-2 (r^2> 13.33%), RM 258 (r^2> 17%) and ART-1 (r^2 = 35.3%) were found to be associated with the traits responsible for tolerance in high Al and low P conditions as per general linear model (GLM) and mixed linear model (MLM) study. The genotypes namely, Manipur Special, GR-12, Yemshea Ngha, Welhinyi Kezurd, Chini Dhan and Dalbao have shown superior performance in both field and hydroponic conditions. Under aluminium toxicity conditions, the traits like difference in root length (DRLT) and root to shoot length ratio (RSLT) in treatment were having high GCV. In case of low phosphorus condition, the traits like shoot length (SLTF), difference in shoot length (DRLT), root to shoot length ratio and root to shoot dry weight ratio (RSDT) in treatment were having high GCV.

Conclusion

The genotypes having ideal combination of genes for Al toxicity and P use efficiency with higher yield in acidic soils were identified. Gene based markers like K46-2, RM258 and ART-1 have been identified to be associated with high Al and low P tolerance were identified which would further ease the process of identification of desirable genotypes.

Table 1. Results of ANOVA, variability and heritability of traits studied in Magnavaca solution and Yoshida solution

	Magnavaca solution for Al toxicity									Yoshida solution for P use efficiency										
Trait	$M_{tr}SS$	Max	Min	Mean	CV	GCV	PCV	HBS	GAM	$M_{tr}SS$	Mean	Min	Max	CD (5%)	CV	SEm	GCV	PCV	H2	GAM
RLCI	3.2**	7.6	0.15	3.03	27.6	27.6	52.3	0.28	29.9	4.12**	2.87	0	9.35	3.1	61.65	0.19	29.15	61.65	0.22	28.39
RLCF	3.8	14.9	4.3	8.62	4.34	4.34	22.16	0.04	1.75	6.32 **	8.13	3.17	13.82	3.35	22.86	0.2	9.65	22.86	0.18	8.39
DRLC	5.13**	11.62	0.1	5.59	18.36	18.36	36.09	0.26	19.23	4.93 **	5.27	0.17	10.81	3.67	36.61	0.21	10.54	36.61	0.08	6.26
RLTI	3.25*	7.97	0.26	3.14	24.96	24.96	51.64	0.23	24.86	3.58 *	2.81	0	8.1	3.01	60.38	0.18	26.99	60.38	0.2	24.85
RLTF	3.94**	11.3	3.18	6.86	14.33	14.33	25.13	0.32	16.82	9.18	8.44	3.8	13.93	3.24	24.3	0.22	14.73	24.3	0.37	18.4
DRLT	3.70**	8.87	0.2	3.72	24.93	24.93	45.4	0.3	28.2	7.68 **	5.63	0.15	12.28	3.78	38.02	0.23	17.61	38.02	0.21	16.81
SLCI	2.61**	5.88	0.93	2.64	30.35	30.35	53.22	0.33	35.65	2.12 **	2.85	0.87	5.88	1.79	40.11	0.12	24.67	40.11	0.38	31.26
SLCF	28.08**	36.68	5.98	19.21	12.86	12.86	24.4	0.28	13.97	40.79 **	17.18	3.35	29.34	6.94	26.93	0.5	17.69	26.93	0.43	23.94
DSLC	28.27**	35.03	2.58	16.58	14.73	14.73	28.49	0.27	15.7	34.66 **	14.33	2.05	26.92	6.78	31.04	0.49	19.93	31.04	0.41	26.37
SLTI	1.20**	6.38	0.7	2.62	22.22	22.22	35.39	0.39	28.75	1.86 **	2.8	0.9	6.38	1.82	39.72	0.12	22.39	39.72	0.32	26
SLTF	27.98**	34.15	6.97	18.33	15.51	15.51	24.33	0.41	20.37	52.1	16.86	5.16	27.9	5.83	27.05	0.5	20.73	27.05	0.59	32.72
DSLT	27.77**	32.5	2.98	15.71	17.49	17.49	28.63	0.37	22.01	45.76	14.06	1.69	25.25	5.99	31.78	0.49	23.48	31.78	0.55	35.74
SCRC	4.77**	11	2	6.41	18.27	18.27	28.74	0.4	23.93	5.37 **	5.61	1	13	3.05	33.92	0.21	20.1	33.92	0.35	24.54
SCRT	2.42**	11	3	6.58	11.82	11.82	20.5	0.33	14.04	4.98 **	5.64	1	14	3.36	31.6	0.19	10.13	31.6	0.1	6.68
RSLC	0	1.5	0.25	0.49	15.4	15.39	36.7	0.18	13.29	0.07 **	0.52	0.24	2.36	0.44	45.21	0.03	16.43	45.21	0.13	12.29
RSLT	0.031**	1.1	0.16	0.41	22.42	22.42	36.7	0.37	28.23	0.05 **	0.54	0.18	1.21	0.26	32.34	0.02	21.7	32.35	0.45	29.99
RSDC	0.1	2.53	0.02	0.28	14.01	14.01	102.98	0.02	3.94	0.01	0.2	0.02	0.77	0.15	41.4	0.05	16.65	41.4	0.16	13.81
RSDT	0	2.52	0.02	0.24	13.07	13.07	90.33	0.02	3.88	0.04	0.22	0.03	0.52	0.37	88.14	0.13	29.4	88.14	0.11	20.23

Where, RLCI- Root length control initial; RLCF- Root length control final; DRLC- Difference in root length control; RLTI- Root length treatment initial; RLTF- Root length treatment final; DRLT- Difference in root length treatment; SLCI- Shoot length control initial; SLCF- Shoot length control final; DSLC- Difference in shoot length control; SLTI- Shoot length treatment initial; SLTF- Shoot length treatment final; DSLT- Difference in shoot length treatment; SCRC- Number of secondary roots in control; SCRT- Number of secondary root in treatment; RSLC- Root to shoot length ratio control; RSLT- Root to shoot length ratio treatment; RSDC- Root to shoot dry weight ratio control; RSDT- Root to shoot dry weight ratio treatment; $M_{tr}SS$- Treatment mean sum of square; Max- Maximum; Min- Minimum; SEM- standard error of mean deviation; CV- Coefficient of variation; CD 5%- Critical difference at 5%; GCV- Genotypic coefficient of variation; PCV- Phenotypic coefficient of variation; HBS- broad sense Heritability; GAM- genetic advance as percentage of mean.

Table 2 . Marker-Trait association as analyzed by general and mixed linear methods

SI.NO.	Marker	Trait	GLM P	R square (%)	MLM P	R square (%)
1	K46-2	Root length treatment final	0.01	13.33	<0.001	29.68
		Difference in root length treatment	0.28	-	<0.001	19.71
		Shoot dry weight in treatment	0.57	-	<0.001	23.95
2	RM258	Shoot length treatment final	0.02	19.15	0.332	-
		Difference in shoot length treatment	0.04	17.58	0.961	-
		Root to shoot length ratio treatment	0.01	21.76	0.02	14.5
3	ART-1	Difference in root length treatment	0.87	-	0	35.3

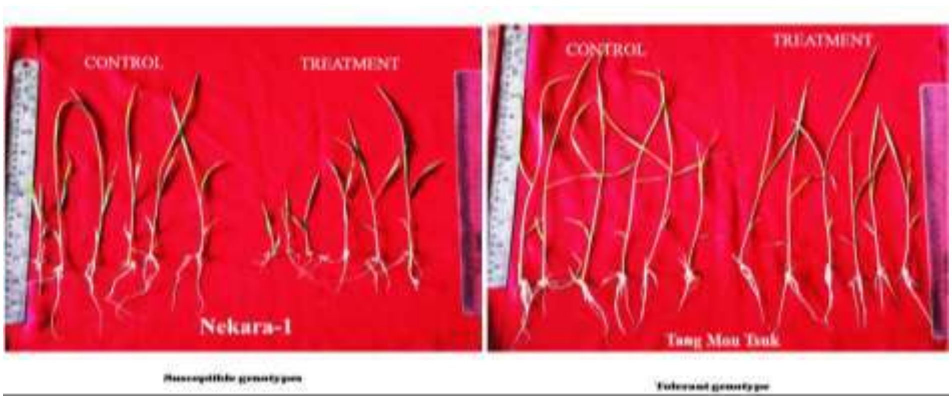


Fig. 1. Morphology of susceptible and tolerant genotype in Al toxicity conditions

References

Famoso AN, Clark RT, Shaff JE, Craft E, McCouch SR and Kochian LV. 2010. Development of a novel aluminum tolerance phenotyping platform used for comparisons of cereal aluminum tolerance and investigations into rice aluminum tolerance mechanisms. Plant Physiology 153(4): 1678-1691.

Chin JH, Gamuyao R, Dalid C, Bustamam M, Prasetiyono J, Moeljopawiro S and Heuer S. 2011. Developing rice with high yield under phosphorus deficiency: Pup1 sequence to application. Plant Physiology156(3):1202-1216

ICSCI 2022/T2/46

Selection criteria and genetic variability studies in dry direct seeded rice (*Oryza sativa* L.)

V. Sridhar[1], M. Goverdhan[2], G. Shiva Prasad[3], K. Sumalini[4] and N. Lingaiah[5]
[1, 3 & 5]Scientist, Agricultural Research Station, Kampasagar, Nalgonda, PJTSAU (Telangana), 508 207, India.
[2]Associate Director of Research, Regional Agricultural Research Station, Palem, PJTSAU, (Telangana), 509 215, India.
[3]Associate Professor, College of Agriculture, Rajendranagar, Hyderabad, PJTSAU (Telangana), 500 030, India.
Email: sridharphd@gmail.com

Introduction

Rice (*Oryza sativa* L.) is mostly grown under submerged soil conditions and requires more water as compared to other crops. Due to erratic rainfall patterns, increasing scarcity of resources especially water and labor, changing climate, emerging energy crisis and the rising cost of cultivation (Ladha *et al*., 2009), direct seeded rice has become regular practice under rainfed situations. To increase the area of cultivation and yield potential under water scarce area, it is essential to develop new plant types which are suitable for dry direct seeded rice conditions and requires more efforts to understand the genetic background of the material being handled on the part of the plant breeder. The present investigation has been carried out to evaluate and identify rice varieties/cultures suitable for dry direct seeded rice (DDSR) with specific traits like seed vigour index, grain filling percentage (%), test weight (g) and grain yield/plant (kg/ha).

Methodology

The experimental material for the present investigation comprised of 30 rice genotypes which include varieties/advanced cultures of PJTSA University Telangana, were evaluated in a complete randomized block design with three replications during *Kharif*, 2021 at Agricultural Research Station, Kampasagar, Telangana state, India. The data were recorded on five randomly selected plants from each replication for nine quantitative traits and except days to 50% flowering which was computed on plot basis. Estimates of phenotypic and genotypic coefficients of variation according to Burton & De Vane (1952), heritability estimates in broad sense according to Lush (1940) and genetic advance as suggested by Johanson *et al*. (1955) were calculated following standard statistical procedures.

Results

The analysis of variance revealed significant genotypic difference for all the traits studied indicating that a large amount of variability was present in the material. The range, mean, variability estimates, heritability and genetic advance as percent of mean are presented in Table 1. The phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the traits which may be due to interaction of genotypes with the environment.Phenotypic and genotypic coefficient of variations (Table 1) were higher for number of grains per panicle, test weight (g), seed vigour index indicating more opportunity of selection for these characters and it was low for the characters, panicle length (cm), grain filling percentage (%) and selection for these characters will not be efficient because, variation is mainly influenced by environment. High heritability was observed for no. of effective tillers/m^2 followed by days to 50% flowering, no. of grains per panicle, seed vigour index and test weight (g). High heritability coupled with high genetic advance as percent of mean was found for seed vigour index followed by no. of grains per panicle, test weight and no. of effective tillers/m^2 indicating the preponderance of additive gene action for the expression of these characters with minor influence of environment and selection may be effective for improving these characters. High heritability accompanied with moderate genetic advance as percent of mean was observed for the traits days to 50% flowering and plant height (cm). Moderate heritability with high genetic advance was found for grain yield (kg/ha), reflected the preponderance of non-additive gene action and selection for these traits may not be rewarding (Lingaiah *et al*., 2020).

Table 1: Estimates of variability and genetic parameters for nine traits in rice

S. No.	Character	Range		Mean	Coefficient of Variation (%)		H (bs) (%)	G.A. as % of mean
		Min.	Max.		GCV	PCV		
1	Days to 50% flowering	80	114	91.60	10.64	10.95	94.44	21.30
2	Plant height (cm)	79	130	100.40	11.56	14.12	67.00	19.51
3	No. of effective tillers/m^2	360	720	514.5	15.62	15.83	97.37	31.76
4	Panicle length (cm)	18.4	28.6	23.20	9.90	13.59	53.1	14.87
5	No. of grains/panicle	65	176	118.90	23.26	27.33	72.44	40.79
6	Grain filling percentage (%)	63	93.3	83.00	9.00	12.83	50.36	13.28
7	Test weight (g)	13.3	31.2	20.41	21.00	25.82	66.67	35.47
8	Grain yield (kg/ha)	3465	6757	5483.7	15.46	20.5	56.85	24.00
9	Seed vigour index	1350	3698	2331.4	23.33	26.73	76.14	41.94

Conclusion

The present study revealed that there was considerable amount of genetic variability in the traits, seed vigour index, no. of grains per panicle, test weight and no. of effective tillers/m^2 and selection for these traits would be more effective for developing high yielding rice genotypes suitable for dry direct seeding.

References

Burton GW and De Vane EH. 1952. Quantitative inheritance in grasses. Proc.6th *International Grassland Congress*, 11:277-283.

Johnson HE, Robinson H F and Comstock RE. 1955. Estimates of genetic and environmental variability in soybean. *Agronomy Journal*, 47: 314-318.

Ladha JK, Singh Y, Erenstein O and Hardy B. 2009.Integrated Crop and Resource Management in the Rice–Wheat System of South Asia. pp. 69–108.

Lingaiah N, Satish Chandra B, Venkanna V, Rukmini Devi K and Hari Y. 2020. Genetic Variability and Correlation Studies in Yield Traits of Elite Rice (*Oryza sativa* L.) Genotypes. *Indian Journal of Pure & Applied Bioscience*, 8 (6): 359-363.

Lush JL. 1940. Intra sire correlation and regression of off-spring on dams as a method of estimating heritability of characters. *Proc. Amer. Anim. Prod.* 33: 293-301.

ICSCI 2022/T2/47

Identification of a novel gene, *Wbph13(t)*, governing resistance to white-backed planthopper by QTL analysis using SNP markers in Sinnasivappu, a landrace of rice

G. Padmavathi[1]*, B. Umakanth[2], V. Jhansi lakshmi[3], M. Sheshu Madhav[4], L.V. Subba Rao[5] and R.M. Sundaram[6]

[1,3 & 4]Principal Scientists, [2]Research Associate, ICAR- Indian Institute of Rice Research, Hyderabad, Telangana-500030, India

Email: padmaguntupalli6@gmail.com

Introduction

Rice breeders are developing high yielding varieties to meet the food requirement of global population. But several pests and diseases affect rice crop causing drastic yield reduction in high yielding varieties (HYVs). The whitebacked planthopper (WBPH) is one of the phloem sucking insects of rice which is becoming predominant by causing severe damage to crop (Yamasaki et al. 2003) in recent years with changing climate. To have stable and durable resistance to WBPH, it is essential to identify new resistance genes and combine the diverse resistance genes using marker-assisted breeding for accelerate development of resistant varieties. Hence, the objective of this study is to identify novel resistance loci using a recombinant inbred line population involving Sinnasivappu, a potential landrace with high level of WBPH resistance using Genotype-by- sequencing (GBS) SNP markers.

Methodology

A mapping population of 140 recombinant inbred lines ($F_{10:11}$) derived from the cross Swarna, a mega variety susceptible to WBPH and Sinnasivappu (AC No.15444), a landrace resistant to WBPH was used in the present study. The parents and RILs were screened along with checks (MO1- Resistant and TN 1- Susceptible) in the greenhouse against WBPH during the seedling stage following the Standard Seedbox Screening Test (Heinrichs et al., 1985) GBS, the high-throughput next-generation sequencing technology, was performed using Illumina HiSeq 2500 platform for discovering SNPs. The QTL analysis was done by Inclusive Composite Interval Mapping (ICIM version 4.0) (Meng et al., 2015). For fine mapping studies, a set of 44 SSRs spanning the QTL region picked from the Rice Annotation Project Database (RAP-DB, http:// rapdb.dna.afrc.go.jp/) were used to survey parental polymorphism, out of which eight polymorphic SSRs were selected for genotyping RILs.

Results

Phenotypic data on damage scores displayed near normal distribution indicating polygenic control of resistance. GBS approach generated SNP data which is used in the construction of a high-density linkage map with 3620 SNP loci spanning a map distance of 22547.9cMQTL analysis using SNP marker and phenotypic data identified a major QTL, *qWbph DS$_2$*, for WBPH resistance. It occupied a 2.21 Mb region on Chr #2 flanked by SNP markers C2-24136056 to C2-26349262, explaining 13.5%phenotypic variation. *qWbph DS$_2$* appears to be a novel QTL since no reported QTLs/genes are identified in the *qWbph DS$_2$* region.

Further construction of linkage map and QTL analysis with polymorphic SSR markers narrowed down the QTL region from 2.21 Mb to 0.53 Mb between SNP marker C2_24136056 and SSR marker RM13606. *In silico* analysis revealed the presence of three annotated genes, namely BTB domain containing protein,

Protein kinase-like domain containing protein and Zinc finger, RING-type domain containing protein located in the fine-mapped *qWBPH DS*$_2$ locus, which has biological function playing a key role in regulating the plant's defence against biotic stresses (Fig 1).

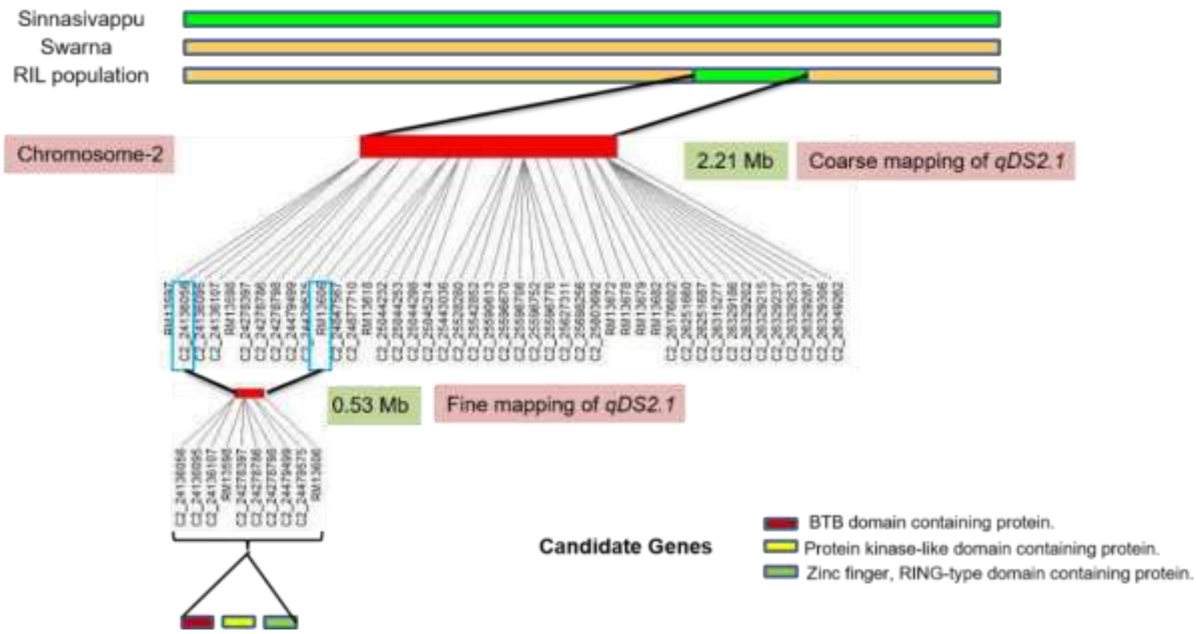


Fig. 1: Fine mapping and identification of candidate genes underlying WBPH resistance locus *qWbph DS*$_2$

Conclusion

In this study, we identified a major QTL, i.e., *qWbph DS*$_2$ exhibiting resistance to WBPH population on chromosome #2 with 13.5% phenotypic variance flanked by two SNP markers C2-24136056 to C2-26349262 in a landrace, Sinnasivappu. Further, the QTL region was fine mapped to 0.53 Mb segment using SNP and SSR markers within the QTL region flanked between the DNA markers C2-24136056 and RM 136065. This new locus is tentatively designated as *Wbph13(t).* The identified tightly linked flanking markers of SNP and SSR could be used for marker-assisted introgression of *Wbph 13(t)* in breeding programs.

References

Heinrichs E A, Medrano F G and Rapusas H R. 1985.Genetic Evaluation for Insect Resistance in Rice. IRRI, Los Banos, Philippines

ICSCI 2022/T2/48

Markers assisted selection for pyramiding of gall midge resistance genes in Siddhi, a popular rice variety

Y. Hari*, B. Satish Chandra, R. Shravan Kumar, Ayesha Siddiqua, S. Malathi, K. Rajendra Prasad, U. Nagabhushanam, K. Rukmini Devi, V. Venkanna, P. Raghu Rami Reddy, Ch. Damodara Raju, G. Neelima, and R. Uma Reddy

Regional Agricultural Research Station, PJTSAU, Warangal 506 007, India

e-mail: itsyhari@yahoo.co.in

Introduction

Siddhi (WGL-44), a high yielding, Medium Slender (MS) grain type rice variety with 140-145 days of duration, but is susceptible to gall midge biotype 4M prevalent in Warangal condition (Telangana State, India). Considering the susceptibility of Siddhi to gallmidge resistance especially for biotype GMB4M,we crossed Siddhi with a gallmidge resistant line BM 71,possessing the two gallmidge resistant genes i.e. *gm3*and *Gm4*. The true F_1s were selfed and the F_2 plants were subjected to marker-assisted selection (MAS) for *gm3*and *Gm4*genes by using functional markers. The 'double' positive F_2 plants were selfed and their progeny were subjected to MAS for *gm3*and *Gm4*genescoupled with phenotype based visual selection for agro-morphological characters. At F_6 generation, three improved linesof Siddhi (i.e., WGL-1940, WGL-1941 and WGL-1956) possessing gallmidge resistance (*gm3*and *Gm4*genes), higher yield than Siddhi and fine-grain type were identified. All the improved lines of Siddhi, after further evaluation for 2-3 seasons will be nominated for multi-location trials under All India Coordinated Rice Improvement Project (AICRIP) for their release to the farming community.

Methodology

BM 71 possessing *gm3* and *Gm4*genes in homozygous condition was used as the donor parent for gall midge resistance genes. Siddhi, high yielding medium slender (MS) grain type rice variety with 140-145 days' duration of released in the year 2013 and it is derived from the cross between. B.P. T5240/A.R.C5984 and Kavya /kavya/BPT5204 was used as a recurrent parent. In addition to these, Taichung Native 1 (TN1) was used as a susceptible check while screening the improved lines for gall midge resistance. BM 71 was used as the male parent and crossed with Siddhi. The true F_1s were selfed and the F_2 plants were subjected to marker-assisted selection (MAS) for *gm3*and *Gm4*genes by using functional/gene linked markers. The homozygous F_2 plants were then selfed to generate $F_{3,}$ $F_{4,}$ F_5 and F_6 generations and at each generation the improved lines were selected based on high gall midge resistance, fine-grain type (i.e. medium-slender grain type) and yield through phenotype based selection coupled with marker assisted selection for gall midge resistance. For Phenotypic screening of Gallmidge resistance, advanced lines along with parents and susceptible check (TN1) were raised under field conditions. All the recommended agronomic practices for rice cultivation were followed except application of any insecticide throughout the crop growth during *Kharif*, 2021. Symptoms on plants were scored on 30 and 50 days after transplanting based on percent of silver shoot damage. Test entries with nil damage and up to 5% silver shoot damage were considered as resistant while others were grouped as susceptible (Vijaya Lakshmiisolation and PCR was performed as per the procedure described by Hari et al. 2022. The PCR based markers gm3del3 and Gm4LRR (Hari et al. 2022) were used to confirm the presence of the resistant allele of gm*3* and *Gm4*genesin the F_1 and subsequent generations.

Results

The F_1s generated from the cross, Siddhi/BM71 were screened using the *gm3* and *Gm4*functional markers *viz*., gm3del3 and Gm4LRR respectively to identify 'true'F_1s showing heterozygous amplification pattern.

A total of 12 'positive' F_1s were identified and these positive F_1s were selfed to generate F_2 plants. Out of 596 F_2 plants, a total of 378 were identified to be positive for *gm3*, a total of 362 were identified to be positive for G*m4* and 36 were identified to be double positives for *gm3* and *Gm4*genes in homozygous condition by using the functionalmarkers. These were then advanced from F_2 to F_6 generations by following pedigree based method. At F_6 generation we identified three Siddhi improved lines i.e., WGL-1940, WGL-1941 and WGL-1956 displayed high level gall midge resistance (Table 1) on par with donor parent and high yield as compared to the original recurrent parent. In the present study, field level screening was employed for phenotypic evaluation of the advanced lines for GM resistance at RARS, Warangal. Towards the same, TN1 was used as susceptible check, three improved lines of Siddhi i.e. WGL-1940, WGL-1941 and WGL-1956along with recurrent parents Siddhi and donor parent BM 71were screened for GM reaction during *Kharif,* 2021. As expected the donor genotype (BM 71) showed resistance (score '1') (Table 1) where as recipient genotype (Siddhi) showed susceptibility (score '7') (Table 1) while the check (TN1) showed high susceptibility (score '9') (Table 1). The improved lines (namely WGL-1940, WGL-1941 and WGL-1956) displayed resistance with (score '1') (Table 1).

Table 1. Field screening of rice cultures against gall midge during *Kharif*, 2021 at RARS, Warangal

S.No.	Designation	Ist Observation (32 DAT)		IInd Observation (50 DAT)		Damage score based on %silver shoots	Reaction based on % silver shoots	Allelic status of Gm genes	
		% plant damage	% silver shoots	% plant damage	% silver shoots			*gm3*	*Gm4*
1	WGL-1940	5.00	0.15	10.00	0.61	1	R	rr	RR
2	WGL-1941	0.00	0.00	10.00	0.99	1	R	rr	RR
3	WGL-1956	0.00	0.00	15.00	0.98	1	R	rr	RR
4	Siddhi (Recipient Parent)	20.00	2.36	90.00	18.87	7	S	RR	rr
5	BM-71 (donor parent)	0.00	0.00	10.00	0.51	1	R	rr	RR
6	TN1 (Susceptible check)	30.00	3.04	95.00	27.34	9	HS	RR	rr
7	Aganni (Resistant check)	0.00	0.00	5.00	0.44	1	R	rr	RR

Note: HS-Highly susceptible, MR-Moderately resistant, R-Resistant, S-Susceptible, For gm3 gene : rr- indicates positives for gm3 gene & RR indicates negatives for gm3 gene.
For Gm4 gene: RR- indicates positives for Gm4 gene & rr indicates negatives for Gm4 gene

Conclusion

The three Siddhi improved rice lines like WGL-1940, WGL-1941 and WGL-1956 were promising and showed resistance to gall midge at both phenotypic and genotypic level. Hence, these selected cultures would be of immense value either for forwarding towards developing durable resistant varieties or for utilization in further resistance breeding programs for crop improvement.

References

Vijayalakshmi P, Amudhan S, Himabindu K, Cheralu C, Bentur JS. 2006. A new biotype of the Asian rice gall midge *Orseolia oryzae* (Diptera: Cecidomyiidae) characterized from the Warangal population in Andhra Pradesh, India. International Journal of Tropical Insect Science, 26: 207-211.

Hari Y, Malathi S, Shravan Kumar R, Lavanya B, Pranita B, Venkanna V, Rukmini Devi K, Satish Chandra B, Rajendra Prasad K, Nagabhushanam U, Raghu Rami Reddy P, Uma Reddy R, Shasthree T. 2022. Phenotypic and Genotypic Screening of Warangal Rice Varieties against Gall Midge (*Orseolia oryzae*) Environment and Ecology, 40 (3A): 1288-1294.

ICSCI 2022/T2/49

KNM 6965 –A high yielding early duration long slender PJTSAU rice (*Oryza sativa* L.) variety suitable for the states of Chhattisgarh and Maharashtra

Sreedhar Siddi[1*], D. Anil[2], R. Abdul Fiyaz[3], L.V Subbarao[4] and M. Sreenivas Prasad[5]
[1,2]Agricultural Research Station, Kunaram, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Dist. Peddapalli, Telangana State-505 174, India.*
[3,4,5]Indian Council of Agricultural Research-Indian Institute of Rice Research, Rajendranagar, Hyderabad, Telangana State-5000 030, India.
Email: siddu.35@gmail.com

Introduction

Rice is an essential staple diet of more than half of the world's population (Suman et al. 2021), and80% of the world's rice is produced and consumed by Asian countries. Among rice growing countries in the world, rice is cultivated about 44.1 million hectares with a production of 165.3 million tons in India (Kesh et al. 2021). It is also the most important staple food crop of Chhattisgarh and Maharashtra of India and is cultivated in varying climate and soil conditions in almost all the districts. Still, there is a pressing need for improving productivity to reduce the cost of cultivation, even though increased yield performance has been made in recent years with advanced agricultural technologies. An increase in yield has been facilitated by genetic improvement of rice varieties through breeding, and value of rice to producers and consumers can be markedly increased by grain quality. Earliness is one of the objectives of modern breeders, contributes to reducing harvest and post-harvest losses, and increases food security, and has an advantage of varieties to suit various cropping situations (Bueno and Lafarge, 2017). Hence, breeding for early duration varieties has been an important strategy with more yield and acceptable grain quality.

Methodology

The breeding at Agricultural Research Station, Kunaram focused on combining various traits desired by farmers, including high yield, blast resistance, earliness, and quality. In this connection, pedigree method of breeding was followed to develop a variety with the required objective by selecting two parents i.e. MTU 1010 and KNM 118. The female parent, MTU 1010 is noted for its high yielding potential with long slender grains, earliness and tolerance to pest and diseases developed at Regional Agricultural Research Station (RARS), Maruteru. KNM 118 is a long slender variety with good marketability and is selected for its earliness and resistance to leaf blast and, moderately resistant to neck blast developed at Agricultural Research Station, Kunaram used as a male parent. These two parents were crossed and raised the F_1 and crossed plants were confirmed, based on the characters at Agricultural Research Station, Kunaram during the year 2015. The seeds of $F_2$was evaluated with approximately 10,000 populations in the year, 2015-16. The farm is geographically situated at 18.6°N Latitude, 79°E Longitude, and at an elevation of 231m. The soil is silty loam with *p*H 7.43 and EC 0.26 dS m^{-1}. Pedigree method of breeding was followed in the F_3 and F_4 populations by selecting single plants for the characters, such as long slender grain, semi dwarf, long panicle, with a good number of grains. This process was continued up to F_5 till these lines attained uniformity in height, panicle length, grain type along with leaf blast resistance. The breeding line with Index No. KNM 6965 resulted from the bulk harvest of a F_5 family in 2017-18 and it was subsequently evaluated in the yield trials from the year 2017-18 to 2019-20 at Agricultural Research Station, Kunaram. It was nominated and tested in AICRIP (Irrigated Early-Transplanted) trials *i.e.*, IVT-E-TP, AVT-1-E-TP and AVT-2-E-TP during the *kharif* seasons of years 2019, 2020 and 2021, respectively.

Results

The entry, IET 28343 (KNM 6965) yielded +17.86%, +30.74 % and +12.95% a higher than national, zonal, and local checks respectively on overall mean and found suitable for irrigated wet lands in the states of irrigated areas of Chhattisgarh and Maharashtra. In the overall performance, KNM 6965 recorded a mean productivity of 4922 kg ha^{-1}in three years of all the trials over the 22 locations (Table 1) having moderate resistance to leaf blast, and grain discoloration with better adaptability. The promising high yielding rice genotype, IET 28343 (KNM 6965) was released through Central Varietal Release Committee on the name of Telangana Rice 7 for the states of Chhattisgarh and Maharashtra during the year 2022. It has semi dwarf plant type with moderate tillering, erect flag leaf, all plant parts green, semi compact well exerted semi erect attitude of branching panicle, straw colored awn less grains and its grain classified as translucent long slender grain with low shattering. It possessed long slender grains with intermediate amylose content (21.82%), which is very important in a consumer's point of view as it is very much required for good cooking quality. Further, it yields more head rice of 66.9% with translucent kernels which is highly essential from the millers' point of view for fetching a good price in the market.

Table 1. Summarized grain yield (kg/ha) data of coordinated varietal trials

	Year of testing	No of trials /Locations	Variety, KNM 6965 (IET28343)	National Check (CO 51)	Zonal Check	Local check
Mean grain yield(kg/ha)	2019	5	4757	3746	3621	4703
	2020	8	4684	4345	3346	4204
	2021	9	5226	4265	4217	4303
	Weighted Mean		**4922**	**4176**	**3765**	**4358**
% Increase overchecks and qualifying varieties	2019			26.99	31.37	1.15
	2020			7.81	39.98	11.42
	2021			22.52	23.93	21.45
	Weighted Mean			**17.86**	**30.74**	**12.95**
Frequency in the top three ranks (pooled for three years)			5/22	3/22	0/22	0/22

Note: The mean yield data given in the table is pertaining to the states proposed.
Adaptability Zone: For the states proposed to release- Chhattisgarh and Maharashtra
Weighted mean: [(4757x5) +(4684x8) +(5226x9)]/ [5+8+9] =4922

Conclusion

The variety IET 28343 (KNM 6965) is an early duration, long slender variety which is needed for cultivation in the states of Chhattisgarh and Maharashtra during Kharif season in the intensive irrigated ecosystem due to its high yield potential, earliness (120-125 days), leaf blast resistance, and non-shattering with good grain quality in comparison to the check varieties.

References

Bueno CS, T Lafarge. 2017. Maturity groups and growing seasons as key sources of variation to consider within breeding programmers for high yielding rice in the tropics. Euphytica, 213:74.

Kesh H, R Kharb, K Ram, R Munjal, P Kaushik, D Kumar. 2021. Adaptability and AMMI biplot analysis for yield and agronomical traits in scented rice genotypes under diverse production environments. Indian Journal of Traditional Knowledge, 20(2): 550-562.

Suman K, CN Neeraja, P Madhubabu, S Rathod, S Bej, KP Jadhav, JA Kumar, U Chaitanya, SC Pawar, SH Rani, LV Subbarao, SR Voleti. 2021. Identification of Promising RILs for High Grain Zinc Through Genotype × Environment Analysis and Stable Grain Zinc QTL Using SSRs and SNPs in Rice (*Oryza sativa* L.). Frontiers in Plant Science, 12, 587482.

ICSCI 2022/T2/50

SSR linked qDTYs markers for diversity studies to identify novel donor's tolerance to drought in upland rice (*Oryza sativa* L.)

Ranjith. P[1]*, S. Sahu[2], S. K. Dash[3]
[1,2]*Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha, India.*
[3] *ICAR- National Rice Research Institute (NRRI), Cuttack, 753006, Odisha, India.*
Email: ranjithpbgouat@gmail.com

Introduction

Rice (Oryza sativa L.) is an important source of calories and some protein for more than half of the world's population. Nearly 3.5 billion people feed on rice. By 2050, at least 50% more rice production is required to feed nine billion people. Thus, it is important to understand plants response against adverse conditions of paddy fields with the hope of improving better tolerance to environmental stress. Molecular breeding approaches had improved our basic understanding about abiotic stress tolerance in rice through identifying and introgressing major effect QTLs. However, drought adversely affects the growth of rice at all the stages, and the occurrence of drought during the early reproductive stage (anthesis) causes a significant loss of grain yield (Boojung and Fukai, 1996). With the aims of estimating the genetic relationship, estimating proline content and identify the upland rice genotype as donor for drought tolerance traits, the present work was carried out.

Methodology

A field experiment was conductedwith34ricegenotypes in two replications following randomized block design (RBD) including three tolerant and one susceptible check. The checks included IR 20 (susceptible), and Mahulata, Selumpikit, CR-143-2-2 (tolerant). Genomic DNA was isolated from leaf tissue of 15 days old seedlings using modified SDS method, DNA was amplified in PCR using a set of 33 SSR markers linked to six different *qDTYs* (both major and minor) to screen the upland genotypes for the polymorphic allelic diversity. Parameters such as number of alleles (Na), effective number of alleles per locus (Ne), allele frequency and expected heterozygosity (He) using POPGENE software were calculated. The gels were visualized under UV gel documentation system, Diversity studies were carried out in STRUCTURE v2.3.4, Analysis of Molecular Variance (AMOVA) and PCOA was analysed using GenALEx v6.5. Phylogenic tree was constructed using DARwin software. Proline content was estimated for 7 day old seedlings (Acid ninhydrin method by Chinard et al., 1952).

Results

The grouping pattern of the upland genotypes into 3 sub-populations (SP1, SP2 and SP3) is shown in Fig. 1. The sub-populations SP1 containing 9 genotypes and SP3 comprised 4 genotypes each whereas SP2 consisted of 6 genotypes. Both the drought tolerant checks (CR-143-2-2 and Mahulata) two reported donors were grouped together in SP1. Furthermore, SP2 consisted of the 2 drought susceptible checks (Salempikit and IR20). Satyabhama and Kalinga-III, two popular upland varieties, were grouped in SP3. The grouping of genotypes based on their inferred ancestry (Q values) into the three sub-populations. Analysis of Molecular Variance (AMOVA) was used to study genetic variation within and among the three sub- populations. It was observed that the diversity within the sub-populations (58%) explained most of the genetic diversity in comparison to among the population (28%), within the individuals (12%). For PCoA, the genotypes belonging to each of the three subpopulations were labeled distinctly. Analysis shows that the first three axes explain a cumulative variation of 45.84% (PCA1-27.47, PCA2-12.58, PCA3-8.79).

Conclusion

The molecular analysis confers that Sahabhagidhan, Khandagiri, Parijat and MTU 1001 have some resistance towards drought conferring both phenotypic and genotypic screening. Genotypes like Sahabhagidhan, Khandagiri and Parijat they are sharing the same clusters having major qDTY which can be used in future hybridization and backcross breeding programs. Varieties *viz*. Jyotirmayee, Heera, Kharavela, Hiranmayee and Gajapati had low proline content under moisture stress condition, indicating that these are drought tolerant varieties. were also found to be drought tolerant which may be recommended to the farmers for general cultivation in drought prone areas.

References

Boonjung H and Fukai F. 1996.Effects of soil water deficit at different growth stages on rice growth and yield under upland conditions, phenology, biomass production and yield, *Field Crops Research*, **48**: 47–5.

Chinard FP. Photometric estimation of proline and ornithine. J Biol Chem. 1952 Nov;199(1):91-5. PMID: 12999819.

ICSCI 2022/T2/51

Identification of tolerant genotype for rice false smut disease through artificial inoculation and parental polymorphism survey using SSR Markers

D. Ladhalakshmi[1*], M. Bhaskar[1], Preeti[2], P. Koteshwar[1], Divya Balakrishnan[1], G. S. Laha[1], M. S. Prasad[1] and R. M Sundaram[1]

[1]ICAR-Indian Institute of Rice Research, Hyderabad, Telangana, India – 500030

[2]University of Agriculture Sciences, Raichur, Karnataka, India - 584104

Email: dladha.lakshmi@icar.gov.in

Introduction

In recent decades, false smut caused by Ustilaginoidea virens (teleomorph: Villosiclava virens) has been categorized as a major grain disease of rice. The pathogen directly affects the economic yield of the crop and the quality of the grain by the production of toxins known as Ustiloxins and Ustilaginoidins that are harmful to animal and human beings. Favorable climatic factors viz., drizzling and prevalence of cooler climate during booting and flowering stage and cultivation of susceptible variety with high nitrogenous fertilizer increase the severity of disease. When the disease appears in epidemic proportion in the field, each panicle may get infected and under these conditions, the yield loss can be very high (>80%). The pathogen infects the spikelet and converts it into fungal structures known as smut ball which contains chlamydospores. In addition, the pathogen also causes sterility of spikelets, especially the spikelets around the smut balls. Though the disease can be managed through the application of prophylactic fungicide application at the booting stage of the rice crop, the identification of false smut disease-tolerant lines/ varieties will be very helpful to develop eco-friendly management practices. In the present study, we have developed and standardized an effective and highly reproducible artificial screening technique to evaluate diverse germplasm to identify promising donors for rice false smut disease. We studied the parental polymorphism between the selected promising donor and false smut susceptible genotype using simple sequence repeat (SSR) markers.

Methodology

Pure culture of U. virens was mass multiplied in Potato sucrose broth and 2 ml of conidial suspension (~ 2 x 105conidia/ml) was used to artificially inoculate selected tillers of a hill at the booting stage of the crop through injection method using a sterile hypodermic syringe. Around 50 germplasm lines were screened artificially under field conditions for three consecutive seasons (Kharif 2019, 2020, and 2021). Data on the number of infected panicles/hill and number of smut balls/panicle were recorded 15 days after inoculation. A total of 848 SSR markers distributed over different rice chromosomes were used to study the parental polymorphism between susceptible popular cultivar BPT 5204 and identified tolerant donors. DNA was extracted by the CTAB method and PCR was carried out with SSR markers with a profile of initial denaturation at 94oC for 5 min and 35 cycles of 1 min denaturation at 94oC, 1 min annealing at 58oC and 1 min extension at 72oC and final extension at 72oC for 7 mins.

Results

Among the lines screened, the percentage of panicle infection ranged from 60 -100% with the number of smut balls varying from 1-41. Of the germplasm screened, one line ,*viz*., IC 334233 showed a high level of tolerance to false smut with a disease score of 1 by repeated artificial screening. The identified donor genotype was crossed with the susceptible cultivar BPT 5204. A parental polymorphism study was carried out between the parents (tolerant IC 334233 and susceptible BPT 5204) using 848 SSR markers. Out of 848 markers screened, only 88 SSR markers were found polymorphic. These polymorphic SSRs will be used to characterize genetics of false smut resistance in IC 334233 using F2 mapping population. A similar study was reported by Andargie *et al*. (2018), in which the injection method of inoculation was adopted in the field and used 360 SSR markers to identify the false smut disease resistance QTLs.

Conclusion

False smut disease-tolerant line was identified through an artificial inoculation method developed at ICAR-IIRR. Eighty-nine SSR markers were identified for genotyping of the F_2 population of BPT 5204 X IC 334233.

References

Andargiea M, L Lia, A Feng, X Zhu and J Lia. 2018. Mapping of the quantitative trait locus (QTL) conferring resistance to rice false smut disease. *Current Plant Biology*, 15: 38-43.

Ladhalakshmi D, GS Laha, R Singh, A Karthikeyan, SK Mangrauthia, RM Sundaram, P Thukkaiyannan, and BC Viraktamath. 2012. Isolation and characterization of Ustilaginoidea virens and survey of false smut disease of rice in India. *Phytoparasitica*, 40: 171–176.

ICSCI 2022/T2/52

Investigations on occurrence different morpho species of rice brown planthopper *Nilaparvata lugens* Stal. in Tunga Bhadra Project area of Karnataka

Mallikarjun[1], Sujay Hurali [2], G. S. Guruprasad[3], A. Prabhuraj[1], Shobha Rani[1] and B. G. Masthanareddy[2]

[1]*Department of Agricultural Entomology, University of Agricultural Sciences, Raichur-584 102*
[2] *ICAR - AICRIP, Agriculture Research Station, Gangavathi-583 227*
[3]*Department of Agricultural Entomology, University of Agricultural Sciences, Dharwad- 580 005*
Email: morphosis77@gmail.com

Introduction

Rice (*Oryza sativa* L.) is the staple food for more than half of the world's population. India occupies the number one position in rice with respect to area, but when comes to productivity India occupies 15th position. Low productivity of rice has been attributed to various biotic and abiotic factors. Among biotic factors, losses caused by insect pests are considered as one of the prime factor. More than 100 species of insects have been documented feeding on rice. Of which, 20 are major. In Karnataka, brown planthopper (BPH) *Nilaparvata lugens* Stal. and white backed plant hopper, *Sogatella furcifera* Horvath are considered as major pests. Both the plant hoppers often co-occur on the same plant. Each species has the traits of congregating in large numbers and exhibit rapid population growth. There is a prediction that different morphs of BPH occurring in rice ecosystem. In this context, a study was undertaken to know existence of different morpho species of BPH in TBP area of Karnataka.

Methodology

Study was carried out at Agricultural Research Station (ARS), Gangavathi, Koppal district, Karnataka during *Kharif* and rabi 2018-19. Brown planthoppers were collected from two locations of Tunga-Bhadra Project (TBP) areas *viz.*, Gangavathi and Dhadhesugur. The selected paddy field was divided into two equal parts, with one part to record planthopper density and another part for morphological characters' study under NIKON SMZ 25 microscope. For the study of male genitalia, the procedure advocated by Oman (1949) and Knight (1965) for the leafhoppers was followed. Twenty each male and female specimens of each species *viz.*, brown morph, black morph of brown planthoppers were used for the measurement. The measurements of various body parts were made with the help of a standardized ocular micrometer placed in one of the eyepieces of stereoscopic microscope. All the measurements are expressed in millimeters. The measurements of different body parts *viz.*, Total body length, clavus, forewing, frons, proclypeus, protonum, scutellum, vertex was done.

Results

Among BPH, two forms were found which are phenotypically different in their colouration and they are brown morph and black forms (plate 2). The male genitalia of brown planthopper of both the colour forms were dissected to study the structural variation of paramere, anal tube and aedeagus (plate 2) of all the insects of two locations. All these structures were observed under NIKON SMZ 25 microscope. It was observed that there were no variations in the genital structures of brown and black forms and hence, these two forms are mere colour variants and are not different species or subspecies in both the locations. In morphometric studies like variation with respect to the length of clavus, clypeus, forewing, frons, pronotum, scutellum, vertex, total length and width of clypeus, forewing, frons, head, pronotum, vertex and distance between eyes (plate 1) of both the forms also revealed that there were no observed variations (Table 1). Hence, it was concluded that these belong to a single species as *N. lugens*. This colour variation is more pronounced in nymphs and less pronounced in adults. Within the nymphs also only later instars shows remarkable variations in colour. The present findings are in line with the earlier reports of Rao (2006), who reported that there are no variations in genital structures of both brown and black forms of brown planthopper, representing only one species *i.e.*, *N. lugens*.

Table 1: Morphometrics of different body regions of brown and black morph of *N. lugens*

Species body regions	***N. lugens* (Stål) (Brown morph)**		***N. lugens* (Stål) (Black morph)**	
	Male	**Female**	**Male**	**Female**
Length	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**
Clavus	1.40±0.15	1.49±0.11	1.35±0.06	1.53±0.11
Clypeus	0.21±0.03	0.21±0.01	0.21±0.05	0.24±0.05
Forewing	2.31±0.01	2.53±0.13	2.33±0.15	2.63±0.16
Frons	0.38±0.05	0.42±0.06	0.39±0.05	0.45±0.09
Pronotum	0.16±0.01	0.19±0.01	0.16±0.02	0.24±0.02
Scutellum	0.22±0.04	0.26±0.02	0.25±0.04	0.26±0.02
Vertex	0.17±0.02	0.19±0.01	0.18±0.02	0.21±0.03
Total length	2.41±0.11	3.04±0.17	2.65±0.13	3.24±0.21
Width	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**
Clypeus	0.18±0.01	0.20±0.02	0.18±0.03	0.18±0.01
Forewing	0.68±0.06	0.77±0.06	0.71±0.03	0.80±0.06
Frons	0.18±0.01	0.22±0.02	0.20±0.02	0.24±0.02
Head	0.46±0.10	0.56±0.03	0.58±0.09	0.59±0.04
Pronotum	0.59±0.10	0.79±0.03	0.76±0.09	0.78±0.08
Vertex	0.19±0.02	0.22±0.02	0.18±0.02	0.23±0.02
Distance between Eyes	0.18±0.03	0.20±0.02	0.19±0.02	0.24±0.12

Mean of 20 observations

Macropterous adult female and male (dorsal view) of brown planthopper *N. lugens* (brown morph)

Macropterous adult female and male (dorsal view) of brown planthopper *N. lugens* (black morph)

Fig.1: Female and male (dorsal view) of morphs of brown planthopper

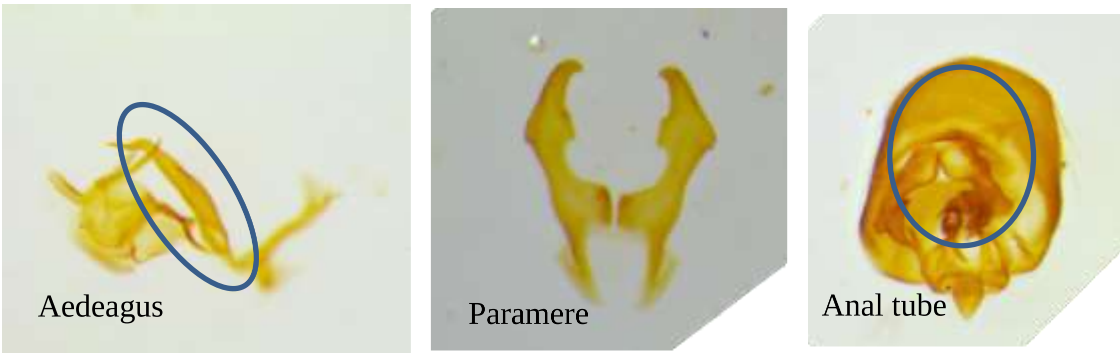


Fig.2: Genital structures of brown plant hopper, *N. lugens*

Conclusion

The brown planthopper, *N. lugens* collected from rice fields from four locations of two taluk *viz.*, Gangavathi and Siraguppa. During collection it was observed that the existence of two different morphs in brown planthopper *N. lugens*. The genital study revealed that both the morphs belong to same species *i.e.*, *N. lugens*. In morphometric studies of different parts of these two morphs also revealed that there are no such variations with respect to the body size of the morphs.

References

Knight, W. J., 1965, Techniques for use in the identification of leafhoppers (Homoptera: Cicadellidae). *Entomologist's Gazette*, 16(4): 129-136.

Oman, P., 1949, The Nearctic Leafhoppers (Homoptera: Cicadellidae) A generic classification and check list. *Mem.Entomol. Soc. Washington*, 3:1-253.

Rao, V. T., 2006, *Nilaparvata lugens* (Stal.) (Fulgoridae: Homoptera) as a pest of paddy cultivation in North Madras and its control.*Ind. J. Entomol*., **12**: 241-246.

ICSCI 2022/T2/53

Genetic variability studies for yield and yield attributes in fine grain rice (*Oryza sativa*L.) genotypes

A. Sheeba[1]andP. Yogameenakshi[2]

[1]*Associate Professor (Plant Breeding and Genetics), Agriculture Research Station, Kovilpatti-628 502, Tamil Nadu Agriculture University, Tamil Nadu, India.*[2]*Associate Professor (Plant Breeding and Genetics), Rice Research Station, Tirur, Tamil Nadu Agriculture University, Tamil Nadu, India.*
Email: sheebateddy@gmail.com

Introduction

Rice plays a fundamental role in Indian agriculture as it is the staple food for more than 70 per cent of the population. It accounts for 43 per cent of food grain production in the country. To meet the food requirement of growing population, the development high-yielding varieties is essential. The development of new high-yielding rice varieties superior to the existing varieties mostly depends upon the amount of genetic variability present in the population. Recognizing the importance of genetic variability in plant breeding experiments, the present study was undertaken to study the genetic variability in fine grain rice genotypes.

Methodology

The present investigation was carried out at Department of Plant Breeding and Genetics, Agricultural College and Research Institute, Madurai during Summer, 2021 to assess the genetic variability among twenty-two fine grain rice genotypes for eight biometrical traits. All the 22 genotypes were raised in a plot size of 3 x 3 m in a Randomized Block Design, replicated thrice adopting a spacing of 20cm between rows and 10cm between plants within a row. Biometrical measurements were recorded for the traits *viz*. days to fifty per cent flowering, plant height, productive tillers/plant, panicle length, filled grains/panicle, spikelet fertility, 100 grain weight and plot yield. The mean data of the above observations were utilized for studying the genotypic and phenotypic variances (Burton, 1952), Heritability (Lush, 1940), and genetic advance (Johnson *et al.,* 1955).

Results

The success of breeding program depends upon the quantum of genetic variability available for exploitation and the extent to which the desirable characters are heritable. Components of genetic parameters for yield and yield attributing traits are presented in Table 1. The PCV was higher than the corresponding GCV which could be attributed to the role of the environment. A higher magnitude of PCV and GCV was recorded by plot yield indicating the presence of high degree of variation for these traits among the genotypes. The moderate magnitude of PCV and GCV was recorded by productive tillers per plant, filled grains per panicle and hundred grain weight indicated the considerable level of variability in these traiThe genotypicypic coefficient of variation measures the extent of genetic variability percent for a trait but it is not sufficient for determination of the amount of heritable variability. In addition, estimation of heritability and Genetic Advance as % of mean is also needed to assess the heritable portion of total variation and extent of genetic gain expected for effective selection. In the present study, the high heritability was recorded by the characters days to 50 % flowering, plant height, filled grains per panicle, hundred seed weight and single plant yield indicating that these characters are least influenced by the environment. The genetic advance was high for single plant yield followed by filled grain per panicle and hundred seed weight whereas moderate genetic advance as percent of mean was registered by plant height and productive tillers per plant. Highheritability along with high genetic advance as percent of mean for single plant yield followed by filled grain per panicle and hundred seed weight (Table 1). Presence of high heritability and genetic advance for the traits single plant yield, filled grain per panicle and hundred seed weight indicating the presence of additive gene action.

Table 1. Components of genetic parameters for yield and yield attributing traits in rice

Characters	**PCV**	**GCV**	**Heritability in broad sense (%)**	**Genetic advance as percent of mean**
Days to 50 % flowering	5.06	4.74	87.67	9.15
Plant Height (cm)	10.02	9.66	92.95	19.18
Protective tillers per plant	18.03	10.16	31.77	11.80
Panicle Length (cm)	11.92	6.99	34.43	8.45
Filled grains per panicle	13.96	13.14	88.68	25.50
Spikelet Fertility (%)	6.29	3.66	33.99	4.40
Hundred Seed weight	15.10	13.39	78.65	24.47
Single Plant Yield (g)	27.72	26.15	89.00	50.82

Conclusion

Presence of high and moderate magnitude of PCV and GCV, high heritability and genetic advance for the traits single plant yield, productive tillers per plant, filled grains per panicle and hundred grain weight suggested the possibility of improving these characters through selection.

References

Johnson, H.W., Robinson, H.F. and Comstock, R.E. (1955). Estimates of genetic and environmental variability in soybean. *Agron. J.*, 47: 314-318.

Lush JL. Correlation and regression of offspring in rams as a method of estimating heritability of characters. Proceedings of American Society of Animal Production. 1940; 33:292-301.

ICSCI 2022/T2/54

Cluster analysis studies for grain yield and its components in early and medium duration rice (*Oryza sativa* L.) genotypes

B. Satish Chandra*, Y. Hari, G. Neelima, Ch. Damodar Raju and R. Uma Reddy
Regional Agricultural Research Station, Professor Jayashankar Telangana State Agricultural University, Warangal (506007), Telangana, India.
Email: chandragene@gmail.com

Introduction

Rice is one of the major food crops is consumed by more than half of the world population (Jiang *et al.*, 2020). In India, rice is cultivated under a wide range of ecosystems. Because of the wide range of adaptability, India has a rich diversity and variability which can be utilized for the enhancement of rice. Multivariate analysis like Mahalanobis D^2 statistic quantifies the degree of divergence in a population at the genotypic level and assess the relative contribution of different components to the total divergence both at the intra-cluster and inter-cluster levels. Keeping this in view, an attempt was made in this study to find out the genetic diversity among 30 rice genotypes for yield and its components which would help in the selection and further improvement of these genotypes.

Methodology

The experimental material for present study was comprised of 30 rice cultivars developed at Regional Agricultural Research Station (RARS), PJTSAU, Warangal, Telangana, India. The material was laid out in a randomized block design during *kharif*, 2021 at RARS, Warangal. Twenty-five days' age old seedlings of each entry was transplanted in 6.0 m^2 area with two replications by adopting spacing of 20×15 cm between the rows and within the row. All recommended package of practices and need based plant protection measures were followed to raise a good crop. Data were recorded at maturity on 10 random plants for each entry in each replication for number of productive tillers per m^2, plant height (cm), panicle length (cm) and number of grains $panicle^{-1}$. Days to 50% flowering and grain yield kg ha^{-1} were recorded on whole plot basis, whereas, random sample was used to estimate 1000 grain weight (g) for each entry in each replication. The analysis of genetic divergence was done using Mahalanobis (1936) D^2 statistics. Grouping of genotypes into clusters was carried out following Tocher's method (Rao, 1952). These parameters were estimated using Windostat software version 8.1.

Results

D^2 statistics revealed that, 30 genotypes were grouped into 7 clusters (Table 1). Cluster I was the largest comprised of 13 genotypes followed by cluster III with 9 genotypes and cluster II with 4 genotypes. However, cluster IV, V, VI and VII were consisted with single genotype each. The intra cluster distance ranged from zero to 133.9 (Table 2). Highest inter cluster distance (1272.49) was observed between cluster IV & VII followed by cluster IV & V (1097.39), cluster VI & VII (1013.83), cluster II & VII (944.20) which indicated the existence of high genetic diversity among genotypes studied. Higher genetic distance was noticed between mono-genotypic cluster IV (WGL 1793) and other mono-genotypic cluster VII (WGL 1782). The cluster mean values varied in all the clusters for all the 7 quantitative traits studied. Cluster II recorded the highest mean values for grain yield kg per ha (6297.4), whereas cluster III genotypes characterized highest for panicle length (29.36).

Table 1. Distribution of 30 rice genotypes into different clusters based on 7 traits.

Cluster	No. of genotypes	Genotypes grouped
Cluster I	13	WGL 1779, WGL 1780, WGL 1781, WGL 1783, WGL 1785, WGL 1787, WGL 1788, WGL 1792, WGL 1794, WGL 1795, WGL 1796, WGL 1797, WGL 1800
Cluster II	4	WGL 1789, WGL 1790, WGL 1791, SOMNATH
Cluster III	9	WGL 1775, WGL 1776, WGL 1777, WGL 1778, WGL 1784, WGL 1786, WGL 1798, WGL 1799, WGL 1801
Cluster IV	1	WGL 1793
Cluster V	1	KNM 118
Cluster VI	1	RNR 15048
ClusterVII	1	WGL 1782

Cluster VII genotype (WGL 1782) was characterized with early in flowering (88.0 days) and 1000 grain weight (30.5 g) including good grain yield (5793.0 kg/ha), hence this genotype could be used for obtaining high yielding, early duration, and long slender grain varieties. Percent contribution of the traits towards genetic divergence revealed that days to 50% flowering contributed the most (27.58%) followed by 1000-grain weight (27.36%) and Plant height (27.36%) for the total genetic divergence, thus, these traits could be given due importance by the breeders for development of superior rice genotypes under crop improvement programme.

Table 2. Average intra (diagonal) and inter cluster distances (Tocher's method) for 30 rice genotypes

Cluster	I	II	III	IV	V	VI	VII
I	90.62	394.68	271.83	614.29	179.29	415.67	234.28
II		107.40	476.97	344.62	708.10	335.14	944.20
III			133.90	294.41	603.96	294.31	519.45
IV				0.00	1097.39	130.26	1272.49
V					0.00	667.15	243.96
VI						0.00	1013.83
VII							0.00

Conclusion

The parents for hybridization programme should be selected based on the magnitude of genetic distance, contribution of different characters towards the total divergence and magnitude of cluster means for different characters' performance having maximum heterosis. WGL 1791, WGL 1789 and WGL 1793 were medium duration and WGL 1782, KNM 118 and RNR 15048 are early duration genotypes having maximum genetic divergence with high mean values for yield contributing characters could be utilized in the breeding programmes.

References

Jiang N, Yan J, Liang Y, Shi Y, He Z, Wu Y, Zeng Q, Liu X. and Peng J. 2020. Resistance genes and their interactions with bacterial blight/leaf streak pathogens (*Xanthomonas oryzae*) in rice (*Oryza sativa*L.)-an updated review. *Rice*, 13(1): 1-12.

Mahalanobis PC. 1936. On the generalized distance in statistics. In: Proceedings of the National Institute of Sciences of India (2), 49–55.

Rao CR. 1952. Advance Statistical Methods in Biometrical Research. John Wiley and Sons, New York.

ICSCI 2022/T2/55

Predatory potential of coleopterans on *Nilaparvata lugens* (Stal) in rice ecosystem

Gurjot Kaur[1]. PreetinderSingh Sarao[2]
[1]Research scholar, Department of Entomology,
[2]Principal Entomologist, Department of Plant Breeding and Genetics,
Punjab Agricultural University, Ludhiana-141004, Punjab, India.
Email: gurjotkaurkkp@gmail.com

Introduction

The primary staple meal for nearly 50% of the world's population is rice (*Oryza sativa*). Many tropical and subtropical nations throughout the world grow it. But there are several biotic and abiotic restrictions which have a negative impact on rice productivity (Horgan, 2018). Brown planthopper (BPH), *Nilaparvata lugens* (Stal), is a serious pest of rice that causes huge economic losses. In India, most of the rice is irrigated. The irrigated rice system is distinct from other agricultural productions because water plays a significant role. Irrigated rice consists of both terrestrial and aquatic habitat (Schoenly *et al.*, 1998). These two aspects of the rice crop account for the incredibly high complexity and biodiversity. Our rice fields are strong and steady even without the use of insecticides because of a very dense web of all-purpose natural enemies. In agricultural ecosystems coleopterans are most abundant species of predators (Snyder, 2009). The present study was carried out to investigate diversity and predatory efficiency of various species of coleopterans in rice ecosystem.

Methodology

The present investigations were carried out at Rice Research Area, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana during the *Kharif* of 2019, 2020 and 2021. Natural enemies were surveyed and collected from the crop raised by following all the agronomic practices as recommended by Punjab Agricultural University package and practices but without the application of insecticides (Anonymous, 2019). Aspirator and sweep net methods were used to collect beetles from the research field. After collection beetles were starved for 24 hours. Ten BPH nymphs in their fourth to fifth instars were added to a plastic vial with a diameter of l cm and a height of 20 cm, together with little bits of rice stems. In each vial, beetle species were introduced at the rate of one beetle per vial. After one day, the amount of nymphs each species of beetle ingested was counted. Throughout the whole crop season, ten replications of the consumption rate trials were conducted for each species of beetle. Test for significance of the treatments was carried out using one-ways ANOVA followed by post-hoc comparison with Tukey's honestly significant difference (HSD).

Results

Beetles collected from 3 different families showed significant predation against *N. lugens*. Among coccinellids, *Coccinella septempunctata, Coccinella transversalis, Brumoides suturalis, Micraspis discolor* and *Coccinella sexmaculata*, whereas *Peadrus fuscipes* belonging to family Staphylinidae and *Ophinea nigrofasciata* belonging to family Carabidae were collected. Based on the rates of intake of BPH nymphs, a ranking was created and it was found that maximum number of nymphs were consumed by *M. discolor*. Although nymphs consumed by *Peadrus fuscipes* were also at par with consumption rate of *M. discolor.* Similar results were given by Karindah (2015) in which he studied the predation of predators on *N. lugens* and observed the order of maximum prey consumption as *Micraspis* species, *P. fuscipes*, and *O. nigrofasciata,* respectively. In our studies, the order of prey consumption rate was as *M. discolor >P.*

fuscipes >*C. transversalis* >*O. nigrofasciata* >*M. sexmaculatus* > *C. septempunctata* >*B. suturalis* (Table 1).

Table 1. Prey consumption rates of rice field coleopterans predators of *N. lugens* in the laboratory at 10 prey density

Species	Family	Prey killed (%)	Mean number of nymphs consumed/killed per day ± S.E
Micraspis discolor	Coccinellidae	80	8.00±0.89^{ab}
Peadrus fuscipes	Staphylinidae	76	7.60±1.28^{ab}
Coccinella transversalis	Coccinellidae	69	6.90±1.22^{bc}
Ophinea nigrofasciata	Carabidae	63	6.30±1.61^{bc}
Menochilus sexmaculatus	Coccinellidae	52	5.30±2.45^{cd}
Coccinella septempunctata	Coccinellidae	46	4.60±1.42^{de}
Brumoides suturalis	Coccinellidae	37	3.70±1.41^{e}

Conclusion

The present study clearly reveals that the coleopterans have potential for biocontrol of BPH in rice ecosystem. There is need to conserve or augment these species as they form integral part of IPM. In order to protect the ecosystem and natural enemies, farmers should only use insecticides at the ETL of BPH populations to manage them.

References

Anonymous. 2020. Package of Practices for the Crops of Punjab (Kharif 2020). Directorate of Extension.

Horgan FG. 2018. Integrating gene deployment and crop management for improved rice resistance to Asian planthoppers. *Crop Protection*, 110: 21–33.

Karindah S. 2015. Predation of Five Generalist Predators on Brown Planthopper (*Nilaparvata lugens* Stål). *Jurnal Entomologi Indonesia*, 8: 55-62.

Rashid MM, Jahan M, Islam KS. 2017b. Effects of nitrogen, phosphorous and potassium on host choice behavior of brown planthopper, *Nilaparvata lugens* (Stål) on Rice Cultivar. *Journal of Insect Behaviour*, 30: 1-15

Snyder WE. 2009. Coccinellids in diverse communities: Which niche fits? Biol Control 51: 323–35. https://doi. org/10.1016/j.biocontrol.2009.05.010

ICSCI 2022/T2/56

Screening for sheath blight resistance in segregating generations of identified mutant crosses in rice

Poloju Vamshi, Pradeep Goud, Madhavi Latha, Prashanth Varma, Guha Pritam, Sumeeth Reddy, Mantri Sravan, Sandeep, Ganesh and Maganti Sheshu Madhav*
ICAR- Indian Institute of Rice Research, Hyderabad-500030, Telangana, India
Email: vamshipoloju10@gmail.com

Introduction

The exponential increase in the demand for rice is expected with the growing world population and increasing trend in rice consumption globally. The demand is aggravated to a greater extent by the shrinkage of agricultural land and the annual loss of crops as well. The soil-water borne basidiomycetous necrotroph *Rhizoctonia solani* (teleomorph: *Thanatephorus cucumeris*) causing rice sheath blight disease is a complex fungal pathogen that has become one of the major threats to rice cultivation worldwide, especially after the adoption of high-yielding varieties. Samba Mahsuri (BPT 5204) is a popular, high-yielding rice variety with medium slender grain and acceptable cooking quality along with excellent combining ability in transferring significant traits into other varietal backgrounds. But its high susceptibility to various biotic and abiotic stresses necessitates the enhancement of genetic variability in Samba Mahsuri background. Considering the merits, Samba Mahsuri was used to develop a comprehensive mutant population. In the present study from the huge EMS mutagenized population the novel genetic sources for major biotic stress sheath blight and yield are identified. The objectives of the present work are to increase the extent of variation in the gene pool of rice and to identify the novel variants which can be used as donors for sheath blight resistance in the rice improvement programme.

Methodology

A total of 10,500 Samba Mahsuri grains were mutagenized with chemical mutagen, EMS (Ethyl Methane Sulfonate) using 0.8% and 1.2% concentrations. The mutagenized seeds were grown to raise the M_1 generation. The M_1 plants were protected from out crossing and individual M_1 plants were harvested to obtain the M_1 seeds. Upon screening of subsequent generations of mutant population, two entries SB-6 and SB-8, stable mutants with high resistance to sheath blight were chosen to cross to a mutant SM-93 possessing all the desirable traits from BPT-5204. The cross population was evaluated with artificial inoculation for resistance to sheath blight disease under field conditions. The progeny with a score of 0 or 3 were advanced to the next generation and further tested under field conditions in the subsequent years (2021 and 2022) and both seasons *Kharif* and *Rabi* with artificial inoculation.

Isolation of pathogen: Samples of diseased plant tissue (0.5 cm of length) were cut from the lesions, washed in running tap water, blotted dry and transferred to an isolation medium *i.e.,* 2 % agar**.** The agar plates were then incubated for 24–48 h at 28–30 °C. Mycelial tips with morphological characters typical of *R. solani*, growing out from the infected plant tissue were cut and cultured on fresh PDA plates. Conical flasks were used in the multiplication of the pathogen on autoclaved stem pieces (2–3 in. in length) of water sedge (*Typha angustata*) soaked in 1% peptone solution. Then the sealed flasks were incubated at 25 °C in growth chamber for 8–10 days before being used for inoculation of rice plants (Bhaktavatsalam *et al*. 1978).

Pathogen inoculation and disease scoring: The rice plants wereinoculated with four to five typha stem bits colonized with fungal mycelia (and sclerotia) at maximum tillering stage (approximately 40 days after planting) in the central region of rice hills at 5–10 cm above the waterline and then tied with a rubber band under high humidity in the microclimate. Data on plant height and lesion height were recorded at 21 days after inoculation (DAI) to calculate relative lesion height (RLH). RLH was calculated by using the following formula and graded as per 0–9 Standard Evaluation System (SES) scale (IRRI 2002) (Table 1).

$$\text{RLH \%} = \frac{\text{Lesion height (cm)}}{\text{Plant height (cm)}} \times 100$$

Table 1 Standard Evaluation System (SES) (IRRI 2002) for sheath blight of rice

Disease score	Disease Reaction	Description (based on relative lesion height-RLH %)
0	Immune	No infection
1	Resistant	Vertical spread of lesion up to 20 % of plant height
3	Moderately Resistant	Vertical spread of lesion up to 21–30 % of plant height
5	Moderately Susceptible	Vertical spread of lesion up to 31–45 % of plant height
7	Susceptible	Vertical spread of lesion up to 46–65 % of plant height
9	Highly Susceptible	Vertical spread of lesion up to 66–100 % of plant height

Results

In the preliminary screening of 210 F_3 entries during *Kharif*-2021 against sheath blight, 14 and 34 entries recorded the resistance score of 1 and 3 respectively. These entries on screening in subsequent generation *i,e*., F_4 during rabi-2021-2022 it has been observed that five and 24 entries shown 0 and 3 score respectively. Among the 29 resistant entries in F_4 five entries each from both the crosses SM-93 x SB-8 (0 score) and SM-93 x SB-6 (3 score) were found to be outstanding in their yield performance (Table. 2) along with desirable BPT-5204 traits.

Table 2 Disease score of outstanding F_4 entries for sheath blight of rice

S.No.	Entry	Score	Yield		S.No.	Entry	Score	Yield
	SM-93 x SB-8					SM-93 x SB-6		
1	51-96-4-1	0	28		6	47-87-4-1	3	21
2	51-95-4-1	0	23		7	47-87-5-1	3	23
3	51-121-3-2	0	27		8	47-87-5-2	3	26
4	51-90-3-1	0	27		9	47-77-5-1	3	32
5	51-123-2-1	0	26		10	47-120-4-2	3	23

Conclusion

The identified entries can be further subjected to strong selection pressure for desirable traits under multi locations for evaluation and release. Molecular characterization of novel genes for sheath blight resistance can be focused on and the genes that are linked to the phenotype can be readily used in introgression programmes.

References

Bhaktavatsalam G, Satyanarayana K, Reddy AP, John VT. 1978. Evaluation for sheath blight resistance in rice. International Rice Research Newsletter, 3: 9-10.

IRRI. 2002. Standard evaluation system for rice. International Rice Research Institute, Los Banos, Manila.

ICSCI 2022/T2/57

Identification of effective SSR marker to study the Genetic variability in the rice false smut pathogen *Ustilaginoidea virens*

M. D. Aparna, D. Ladhalakshmi*, M. Bhaskar, G.S. Laha, V. Prakasam, M.S. Prasad and R.M. Sundaram
Indian Institute of Rice Research, Hyderabad
*Email:**dladha.lakshmi@icar.gov.in

Introduction

False smut disease of rice, caused by *Ustilaginoidea virens* (Cooke) has attained major importance because of its impact on the quality and quantity of the grain and grain yield. Factors *viz*., high humidity, temperature between 25^{0}C to 30^{0}C especially during grain filling stage, intense cultivation of hybrid rice, late sowing, and heavy application of nitrogen fertilizers favor disease occurrence and intensity. The pathogen infects the young spikelet and converts the grain into a ball-like fungal fruiting structure known as smut balls. Initially, the colour of the smut ball appears white, which later turns into yellow and then to dark black upon maturity (Ladhalakshmi *et al*., 2012). Understanding the plant pathogen's genetic diversity will help us develop suitable management strategies. Molecular markers are used to study the genetic variability among different isolates within the population. Simple sequence repeat (SSR) markers are one of the genetic markers widely used to study genetic variability, because of their high reproducibility, multi-allelic nature, co-dominant nature with genome-wide coverage (Yu *et al*., 2015). In India, very few reports are available about the existence of genetic diversity of *U. virens*. In this study, we tested forty-three *U. virens*, specific simple sequence repeat (SSR) markers to study the genetic variation in sixty isolates of *U. virens* collected from different rice-growing areas of India.

Methodology

A pure culture of *U. virens* was inoculated in Potato sucrose broth and incubated for 2 weeks at 28^{0}c at 125 rpm in Rotary incubator shaker. The mycelium was collected by filtration method and blot-dried for extraction of DNA. DNA of the pathogen was isolated through CTAB method (Ladhalakshmi *et al*., 2012). Out of forty-three SSR markers, thirty-four were selected based on their amplification efficiency. The polymerase chain reaction (PCR) mixture (10µl) consisted of 0.5µl of 2.5mM dNTPs, 1µl of (10 pmol)of each primer (Forward and reverse primer), 0.3µl of Taq polymerase (3 U), 1µl of Taq buffer, 5.2µl of Nuclease free water and DNA template (2µl). PCR reaction was performed with an initial denaturation step at 94^{0}C for 3 min, 35 cycles of amplification (30 seconds for final denaturation at 94^{0}C, 30 seconds for primer annealing temperature and 30 seconds for extension at 72^{0}C), and one cycle of final extension at 72ºC for 5min. Amplified PCR products were analyzed by Agarose (2%) gel electrophoresis.

Results

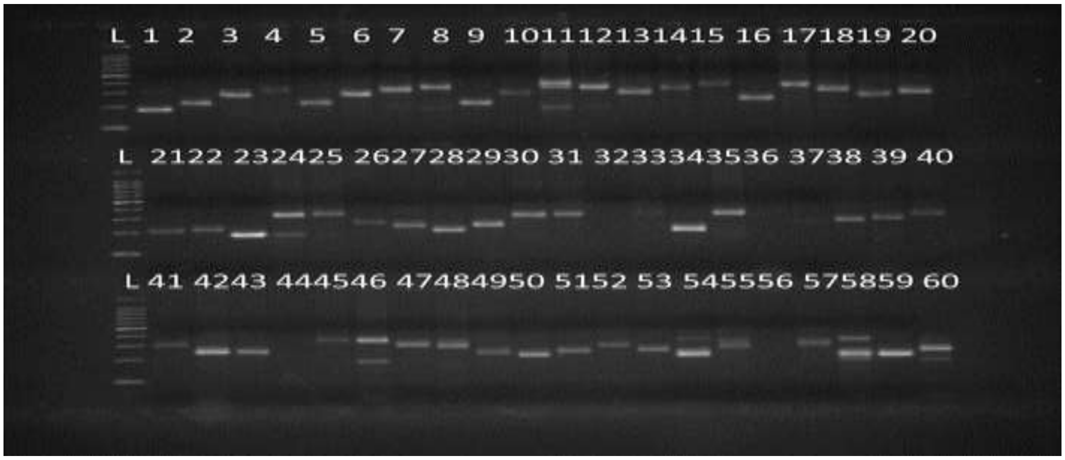


Fig. 1: SSR marker FS_S522 expressed maximum polymorphism among the *U. virens* isolates

The number of alleles of different SSR primers varied from one to ten. Out of 34 SSR primers, primers *viz*., FS_S522 (Fig 1) and FS_ S621 produced ten and nine alleles respectively. Primers FS_S 414 and UvSSR2 produced 8 alleles each. Similarly, FS-S211 also produced 7 different alleles. Five SSR primer pairs namely UvSSR29, UvSSR84, UvSSR32, UvSSR9, and UvSSR26 produced only two allelic bands. Primers *viz*., UvSSR9, UvSSR17, UvSSR22, UvSSR32, and UvSSR37 produced only one allelic band. Among the 34 SSR markers, 29 SSR markers showed 100 percent polymorphism with an approximate product size of 134-250bp. The bands which showed polymorphism were manually scored as binary data.

The presence and absence of data scored as 1 and 0. By using SSR data, constructed a phylogenetic tree with DARwin 6.0 software. The generated phylogenetic tree showed that 60 *U. virens* isolates were divided into 4 clusters. The results revealed that all the isolates from different geographical regions were grouped together in each cluster and exhibited less molecular variations.

Conclusion

The present study results revealed that among the tested SSR primers *viz*., FS_S 522, FS_S621, and FS_S414 can be used to study the genetic variability in *U. virens* isolates. There was no grouping was observed based on the geographical regions.

References

Ladhalakshmi D, GS Laha, R Singh, A Karthikeyan, SK Mangrauthia, RM Sundaram, PThukkaiyannan, and BC Viraktamath. 2012. Isolation and characterization ofUstilaginoidea virens and survey of false smut disease of rice in India.*Phytoparasitica*, 40: 171–176.

Mina Yu, Junjie Yu, Huanhuan Li, Yahui Wang, Xiaole Yin, Huiwen Bo, Hui Ding, Yuxin Zhou, Yongfeng Liu. 2016. Survey and analysis of simple sequence repeats in the *Ustilaginoidea virens* genome and the development of microsatellite markers, *Gene*, 585(1),28-34. https://doi.org/10.1016/j.gene.2016.03.016.

ICSCI 2022/T2/58

Molecular characterization for bacterial blight resistance and yield enhancement in Pranahitha

[1]B. Laxmi Prasanna, [1]B. Srinivas,[1]P. Gonya Nayak, [1]P. Madhukar, [1]N. Balram, [1]S.Ompraksh, [2]Dr.Ch.V.Durga Rani
[1]*Regional Agricultural Research Station, Polasa, Jagtial-505327, PJTSAU, India.*
[2]*Institute of Biotechnology, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad-500030, India.*
Email: laxmiprasanna2010@gmail.com

Introduction

Rice is considered as staple food for more than half of the world's population which make up 20% of the dietary supply. To cope up with the increasing global population at an alarmic rate, there is an utmost need to enhance the rice production. But, due to evolution of new diseases and pests there is an adverse effect on crop performance and survival. Among the biotic stresses, bacteria leaf blight (BB) is one of the serious diseases caused by the pathogen *Xanthomonas oryzae pv. oryzae (Xoo)* which is responsible for significant yield reduction in rice crop, especially in slender varieties; which includes the current targeted variety in this study i.e., JGL11727 (also known as Pranahitha). Despite of its desirable features like medium duration (135-140 days), fine grain type, resistance to gall midge, good cooking quality and suitability for irrigated conditions, JGL 11727 is susceptible to bacterial blight. Apart from disease resistance, yield enhancement is also one of the most important focus, specifically grain yield which is a complex trait controlled by QTLs along with influential environmental factors. A major gene contributing to grain yield enhancement *viz*., *Gn1a* has been functionally characterized by positional cloning. *Gn1a* is first gene to be isolated that controls rice grain yield by regulating cytokinin and number of spikelets (Ashikari*etal*., 2005). In order to cope up with the above-mentioned problems, development of resistant/tolerant breeding lines coupled with yield enhancement is considered as the most effective, economical and environment friendly strategy through molecular breeding strategies. The objective of the present study is to transfer major bacterial blight resistance gene, *Xa21* and yield enhancing gene, *Gn1a* into the genetic background of pranahitha through marker-assisted pedigree breeding coupled with stringent phenotyping for the targeted stress and yield attributing traits retaining the key agromorphological traits of the pranahitha.

Methodology

Crossing was initiated during the wet season 2018, between Pranahitha (developed at RARS, Jagtial, PJTSAU) and pre breeding lines of Improved Samba Mahsuri (Bacterial blight resistant variety) and pre breeding lines of MTU1010(possessing *Gn1a*); both gene contributing lines developed by ICAR-Indian Institute of Rice Research (ICAR-IIRR). The F_1s generated were confirmed for their heterozygosity using target resistant gene specific markers *viz*., pTA248 (specific for *Xa21*; Ronald et al. 1992) and INDEL3 (specific for *Gn1a*);the true F_1 plants were selfed to develop F_2s. Homozygous positive F_2 plants were identified through foreground selection using the target QTLs/gene specific markers mentioned above and advanced further by selfing through pedigree breeding till F_5 generation, based on foreground selection and morphological characterization with Pranahitha. PCR protocols described in Rekha et al. (2018) was adopted for indirect selection of *Xa21*and *Gn1a*respectively. Phenotypic screening was done at F_5 generation against biotic stress, bacterial blight along with the checks at RARS, Jagtial during wet season 2021. Three homozygous positive F_5 lines, which closely resembled Pranahitha in terms of plant type and grain type were selected and further evaluated for their resistance/tolerance to target stress (*viz*., BB) and for key agromorphological traits especially yield.

Results

A total number of 45 true F_1 plants identified through foreground selection were advanced for further generation till F_5 through pedigree breeding strategy following foreground selection at each generation and phenotypic selection for the targeted genes. At F_5 generation, phenotypic screening for the target stress identified that the fifteen improved breeding lines have shown resistant reaction for BB with mean lesion length ranging from 1± 0.3 to 3± 0.3. Among them, three lines *viz*., J 44-4-39, J 44-4-40 and J 44-4-61 exhibited excellent resistance with mean lesion length of 1 ± 0.3 (score 1) like that of the resistant parent Improved Samba Mahsuri, also when evaluated in terms of grain yield, all these lines observed to be better than Pranahitha. Data was recorded for all the parameters and statistical analysis was done using SAS 9.2 (SAS version 9.2 software packages; SAS Institute, Inc.; Cary, NC) software for analysis of Coefficient of variation (CV), Critical Difference (CD), Standard Error (SE) and Analysis of variance (ANOVA).This indicates the success of the strategy for combining marker-assisted selection with phenotyping and the three lines are expected to perform well in areas prone to the BB diseasealong with higher yield levels.

ILLUSTRATION:

PRANAHITHA x NIL of ISM (*Xa21*) x MTU 1010 NIL (*Gn1a*)

Phenotypic screening for bacterial blight resistance using *Xoo* (DX020) culture. ISM- Resistant check; MTU1010 - Susceptible check; Improved breeding lines possessing *Xa21 and Gn1a* (F_5 Generation)

Screening details of Improved F_5 breeding lines for BB resistance and scoring details as per IRRI-SES scale (IRRI 2013)

S. No	Parents and Checks	Reaction against BB DX020	
		Score	HR/R/MR /S/HS
1	MTU1010	9	HS
2	ISM	1	HR
3	Pranahitha	5	MR
	Improved breeding lines (F_5)	Score	HR/R/MR /S/HS
1	12 Entries	5	MR
2	03 Entries	3	R

Improvement of Pranahitha with BB (*Xa21*) &yield enhancing gene (*Gn1a*) was a major challenge in the current study. Development of new rice varieties with biotic stress resistancealong with yield enhacementis a major focus area. Through the current study, it was demonstrated that the strategy of coupling stringent phenotype-based selection along with marker-assisted selection helped in identification of superior lines, where there was ayield enhancement added with BB resistance. Current study has successfully adopted marker assisted pedigree breeding for crop improvement in the present scenario. High-yielding, improved breeding lines (possessing *Xa21* and *Gn1a*) with good grain quality developed in this study could improve rice cultivation and can also serve as good donors for targeted transfer of the major genes/QTL to other elite rice varieties cultivated in Telangana state.

Improved Breeding lines identified to be superior for bacterial leaf blight resistance along with higher yield

S.No	Entry	BB Score	BB resistant gene (*Xa21)*	Yield gene (*Gn1a)*	Single Plant Yield (g)
	Pranahitha Check	5	Moderately Resistant	Homozygous -ve	30.1
1	44-4-39	1	Homozygous +ve	Homozygous +ve	48.2
2	44-4-40	1	Homozygous +ve	Homozygous +ve	47.2
3	44-4-61	1	Homozygous +ve	Homozygous +ve	46.2

Conclusion

In this study, we have successfully improved three breeding lines carrying genes *Gn1a* and *Xa21*viz., J 44-4-39, J 44-4-40 and J44-4-61 were developed, with slender grain type, expected to have good cooking quality besides bacterial blight resistance and higher yield levels, which could be used as donors, parents in the rice breeding program and could serve the farming community as a new variety.

References

Ashikari, M., Sakakibara, H., Lin, S., Yamamoto, T., Takashi, T., Nishimura, A., Angeles, E.R., Qian, Q., Kitano, H and Matsuoka, M. 2005. Cytokinin oxidase regulates rice grain production. *Science*. 309 (5735): 741-745.

Rekha, G., Abhilash Kumar, V., Viraktamath, B.C., Pranathi, K., Koushik, M.B.V.N., Laxmi Prasanna, B., Backiyalakshmi, C., Sinha, P., Ravindra, R.K., Bhaskar, S., Hajira, S.K., Blachiranjeevi, C.H., Swapnil, K., Rambabu, R., Harika, G., Punniakotti, E., Anila, M., Mahadev, H.K., Dilipkumar, T., Yugander, A., Chaitra, K., Praveen, M., Madhavi, K.R., Prasad, M.S., Laha, G.S., Neeraja, C.N., Balachandran, S.M., Senguttuvel, P., Fiyaz, R.A., Badri, J., Giri, A., Subba Rao, L.V., Ravindra Babu, V and Sundaram, R.M. 2018. Improvement of blast resistance of the popular high-yielding, medium slender-grain type, bacterial blight rice variety, Improved Samba Mahsuri by marker-assisted breeding. *Journal of Plant Biochemistry and Biotechnology*. 27 (4): 463-472.

Ronald, P.C., Albano, B., Tabien, R., Abenes, L., Wu, K and McCouch, S.R. 1992. Genetic and physical analysis of the rice bacterial blight disease resistance locus, *Xa21*. *Molecular Genetics and Genomics*. 236 (1): 113-120.

ICSCI 2022/T2/59

Monitoring of Virulence of *Nilaparvata lugens* Using Gene Differentials

P. S. Sarao and V Jhansi Lakshmi[1]
Punjab Agricultural University, Ludhiana 141 004, Punjab, India
[1]ICAR-Indian Institute of Rice Research, Rajendranagar 500030, Hyderabad, India
E mail: preetento@pau.edu; preetento@gmail.com

Introduction

Rice is the staple food for about half of the world population. India ranks first in the world in rice area with 43 million hectares with a production of 110 million tonnes. Among various biotic constrains, insect pests are considered most important. Brown planthopper, *Nilaparvata lugens* (Stål) (Homoptera: Delphacidae) (BPH) is one of the major insect-pest of rice. Besides causing direct damage to the crop it also acts as a vector for transmitting diseases. Both nymph and adult suck sap primarily at the base of tillers from phloem tissues so their presence goes undetected, which leads to yellowing of lower leaves starting from leaf tip backwards, reduced vigour, stunting and ultimately drying of whole plant (Sarao, 2015). Due to its feeding behaviour at the base of the plants, the farmers are not able to control this pest effectively. Although many resistance genes have been identified, studies of their interactions, in terms of their plant-insect interactions in rice through molecular approaches are still at early stages especially in relation to phloem feeding insects. Keeping this objective in mind, the virulence of brown planthopper populations was monitored using the three gene differentials *viz*., Ptb33 (*bph 2, 3 and 32* genes), RP2068-18-3-5 (*Bph33 gene*) and RPBio4918-230S (*Bph39 and 40* genes) and Susceptible check TN1. The number of nymphs hatched from each gene differential, number of adults emerged, their sex and macroptery were recorded on each gene differential under glasshouse conditions.

Methodology

There were two sets of ten pots each, the 1st set of ten pots was only used for BPH infestation, whereas, in the 2nd set all the gene differentials were transplanted at equal distance (6-7 seedlings) in the ten pots. Each hill in a pot represented one differential and all these differentials were labeled. When the transplanted plants were 45 days old, on the day of infestation, they were covered all together in a pot with a single big ventilated mylar tube made of mylar sheet. Each pot was infested with one gravid BPH female with bulged abdomen. The open end of the mylar tube was covered with muslin cloth tied with a rubber band to prevent the escape of the insects. In the 1st set of pots, the infested pots were kept covered with mylar tubes in the glasshouse for three days. On third day, mylar tubes were removed after collection of the BPH females from the plants. In each pot, each gene differential was covered separately with mylar tubes (4 gene differentials with 4 separate tubes). The pots were observed daily for water requirements. After 6 days of the release of BPH females, observerations of the plants in 1st set of pots were recorded for nymphal hatching. Nymphs from each differential were collected and counted separately with the help of aspirator. Meanwhile, in second set of pots, each gene differential was covered separately with a mylar tube. Twenty nymphs were released with the aspirator from a gene differential from the first set onto same gene differential set covered with mylar tubes in the pots of the second set of gene differentials. Nymphs in the first set of pots were counted at two days' interval and this counting was continuous till the nymphs stopped hatching. However, in the second set of pots, where the counted nymphs were released, the emergence of BPH adults was recorded as the number of emerged females and males.

Results

All the females laid eggs on all the gene differentials and nymphs hatched were highest on TN1 and lowest on Ptb33 (Table 1). The egg period ranged from 7 days (TN1) to 9 days (Ptb33 and RP2068-18-3-5) and it was lowest in TN1. The number of nymphs hatched and nymphal survival was highest on TN1 and vice versa in Ptb33, RP2068-18-3-5 and RP4918-230S. The number of females emerged out of released nymphs were highest in TN1, then in other gene differentials. The macropterous adults were more (73.48%) than wingless adults and were more on RP2068-18-3-5 followed by Ptb33 and RP Bio4918-230S (Table 1). Our studies are also corroborated by the research work carried by earlier scientist on insect-plant interactions even at molecular levels (Kobayashi, 2016; J1ng *et al*., 2017).

Table 1. Virulence monitoring of *N. lugens* population on different gene differentials

Biological parameters	Gene differentials			
	Ptb33	RP2068-18-3-5	RPBio 4918-230S	TN1
No. of hatched nymphs/female	32.3	42.8	51.9	108.1
Egg incubation period	9	9	8	7
Nymphal survival (%)	82.5	89.5	94.5	98
Male (%)	49.5	53.1	50.8	35.4
Wing female (%)	31.2	28.1	19.8	26.9
Wing male (%)	46.9	50.8	48.8	34.7

Conclusions

The monitoring of virulence of BPH using three gene differentials revealed that BPH population was more virulent on TN1 in terms of highest fecundity, nymphal hatching, lowest male population and highest percentage of brachypterous adults. The gene differential RP2068-18-3-5, RPBio4918-230S and Ptb33 can be used for pre-breeding programme to develop BPH resistant varieties.

References

Jing S, Zhao Y, Du B, Chen R, Zhu L, He G. 2017. Genomics of interaction between the brown plant hopper and rice. *Current Opinion in Insect Science*, 19: 82-87.

Kobayashi T. 2016. Evolving ideas about genetics underlying insect virulence to plant resistance in rice-brown plant hopper interactions. *Journal of Insect Physiology*, 84: 32-39.

Sarao PS. 2015. Integrated Management of insect-pests of rice and basmati. *Progressive farming* 51(7): 9-12.

Screening of rice entries against brown plant hopper, *Nilaparvata lugens* (stal.) under screen house conditions at Warangal

R. Shravan Kumar, Y. Hari, U. Nagabhushanam, G. Neelima, B. Satish Chandra, Ch. Damodara Raju and R. Uma Reddy
Regional Agricultural Research Station, Warangal
Email: shravanentomology@gmail.com

Introduction

Rice is an important food crop all over the world. Rice crop is infested by more than hundred species of insects and about twenty of them are considered serious pests as they cause significant damage to rice crop. Among the serious pests, brown plant hopper (BPH), *Nilaparvatalugens* (Homoptera: Delphacidae) is one of the most destructive insect pests causing significant yield loss in most of the rice cultivars of Asia. In a congenial climate BPH multiples easily and causes hopper burn in the field. Crop resistance is a cost effective and environmentally friendly approach for pest management. As the BPH is present at the base of the plant, many times insecticidal sprays are unable to reach the target site due to improper spraying and farmers are indulging in repeated spraying. This is resulting in increasing cost of plant protection, insecticide resistance in insects and environmental pollution. Use of resistant varieties is a cost effective and environmentally friendly approach for pest management.

Methodology

A set of 145 rice entries were screened in polyhouse of Regional Agricultural Research Station, Warangal during *Kharif* 2021 by following Standard Seed box Screening Technique (Heinrichs *et al*., 1985). The seeds of selected cultures were soaked in water for 24 hours by placing them in petri plates containing optimum quantity of water. The water was drained out after 24 hours and the soaked seeds were kept in the same petri plate for another 24 hours to allow proper germination. The pre-germinated seeds were planted in the plastic trays of size (45 x 35 x 10 cm) filled with fertilizer enriched puddled soil. The sown seeds were covered with thin layer of soil and watered as and when required. First and second instar nymphs of BPH were released on 12-13 day old seedlings of the test entries by tapping heavily infested plants from oviposition cages on the screening trays, ensuring that each test seedling was infested with at least 6-8 nymphs. The screening trays with BPH nymphs were covered with mylar cages to prevent escape of the nymphs. The trays were rotated by 180˚ at frequent intervals for attaining even reaction of plant response to BPH infestation and to avoid the susceptible germplasm seedlings showing quick reaction compared to resistant. All the test entries were replicated thrice. A maximum of 20 entries with resistant checks at the centre and TN1 susceptible cultivar on either side of the tray was planted/tray. The infested seedlings were monitored until the susceptible check (TN1) seedlings showed 90 per cent mortality. When more than 90 per cent plants of the susceptible check, TN1 were killed, the scoring was done based on 0-9 scale using Standard Evaluation System (SES) developed by the International Rice Research Institute (IRRI, 2014) as detailed in Table 1. After scoring as per Standard Evaluation System

(SES) the standard seed box screening test (SSST) entries were categorized as per Table 2 (Jegadeeswaran *et al*., 2014).

Table 1: Standard Evaluation System (SES) describing the damage score of plant based on its reaction to BPH incidence

Plant State	Damage Score
No damage	0
Very slight damage	1
Lower leaf wilted with two green upper leaves	3
Two lower leaves wilted with one green upper leaf	5
All three leaves wilted but stem still green	7
Plant is dead	9

Table 2: Categorization of levels of resistance based on damage score

Reaction	Damage Score Range
Resistant (R)	1.0-3.0
Moderately Resistant (MR)	3.1-5.0
Moderately Susceptible (MS)	5.1-7.0
Susceptible (S)	7.1-8.9
Highly Susceptible (HS)	9.0

Results

Among the tested rice entries, the test entries *viz*., RPGP-1066-36-12-1-2 scored a damage score of 0.20, WS-18-OYT-72/BPH scored a damage score of 0.82, RPGP-1386-3-1-1-1 scored a damage score of 2.08 and were found to be resistant against BPH. RPGP-2212-8-1-2-2 with a damage score of 3.30, BPT 3025 with a damage score of 3.46, RPGP-1011-100-56-1-4-1 with a damage score of 3.64, KNM 12505 with a damage score of 4.92 and WS-18-AYT-10/BPH with a damage score of 5.00 were found to be moderately resistant against BPH. Damage score was 8.94 in susceptible check TN-1 against BPH. Resistant checks RP 2068-18-3-5 recorded damage score from 0.16 to 2.1 (Avg 1.79), Mo-1 recorded damage score of 3.67, PTB 33 recorded damage score of 3.29 to 8.47 (Avg 7.27). Seed of 23 entries was not germinated and germination was poor in 13 entries hence, they could not be screened against BPH. Seven entries were found to be moderately susceptible with damage score of 5.1 to 7.0 and all other entries were susceptible/highly susceptible against BPH. Udayasree *et al*., (2018) reported that two entries *viz*., RNR 25838 and RNR 20933 (DS 4.6), two entries *viz*., RNR26111 and Sabita (DS 4.7), four entries *viz*., RNR 25993/2, RNR 25792, Sinnasivappu and IET 23993 (DS 4.8) and one entry *viz*., JGL24527 registered damage score 5.0 against rice BPH.

Conclusion

The present investigation has identified 3 resistant and 3 moderately resistant donors which could be useful in breeding for developing resistant varieties against BPH. Molecular study of these promising test entries will provide good information of genes responsible for resistance to BPH and further investigations on presence of other mechanisms of resistance such as antixenosis, antibiosis and tolerance will help in identifying the best genotype among them that could to be used for developing BPH resistant with desirable yield and quality traits. These entries may be used as donors in breeding programmes or can be released as resistant varieties yield and quality traits are satisfied.

References

Heinrichs, E.A., Medrano, F.D. and Rapusas, H.R. 1985. Genetic Evaluation for Insect Resistance in rice. In: Heinrichs E. A., Rapusas H and Medrano F. (eds) International Rice Research Institute, LosBanos, Philippines.1-356.

Jegadeeswaran, M., Anandakumar, C. R and Maheswaran, M. 2014.Phenotypic screening of rice (*Oryza sativa L*.) varieties for brown planthopper [*Nilaparvata lugens (Stal.*)] resistance. Trends in Bioscience. 7 (16): 2257- 2266.

International Rice Research Institute. 2014. Standard evaluation system of rice (SES). 5th Edition.LosBanos; Phillipines.

Udayasree, M., P. Rajanikanth, N.R.G. Varma and Sreedhar, M. 2018. Screening of Selected Rice Genotypes for Their Resistance against Brown Planthopper, *Nilaparvata lugens* (Stal).Int.J.Curr.Microbiol.App.Sci.7(11):3138-3143.

ICSCI 2022/T2/61

Breeding cultivars for low soil P and rainfed environments

Hari Vijaya Teja[1, 2], Vijai Pal Bhadana[1]
[1]*School of Genomics and Molecular Breeding, ICAR- Indian Institute of Agricultural Biotechnology, Ranchi.*
[2]*Division of Genetics, ICAR- Indian Agricultural Research Institute, New Delhi*.
Email: hvteja22@gmail.com

Introduction

India is the largest rice growing country in the world in terms of area with second position in production. Rice yield in favourable irrigated areas has been stagnating for quite some time and hence, increasing yield in rainfed areas is necessary to meet the food requirement of the ever-burgeoning population. Varietal development in rice for rainfed and low input areas did not receive adequate attention in the past and therefore the productivity in these areas continued to be far below the national average. Of late, intensive efforts for the identification of QTLs/genes for performance under drought- *qDTY2.2*, *qDTY4.1* (Swamy et al. 2013) and low nutrient conditions- *Pup1* (Wissuwa et al. 1998) have been made, but very few attempts have been made for pyramiding QTLs for different abiotic stresses. In our study we crossed Swarna × IR 64Drt1 possessing *Pup1*and *qDTY2.2*, *qDTY4.1*respectively for improving low P tolerance and yield under drought stress wherein segregating F_2 plants positive for different QTL combinationswere identified with the help of linked molecular markers, subsequently analysis for different yield parameters revealed promising performance of plants possessing *Pup1* and both *qDTYs* in homozygous conditions.

Methodology

An F_2 population derived from Swarna (MTU 7029) x IR 64 Drt1 (IET 22836) was used for the study. To ensure sufficient quantity of F_2 seeds, F_1s were multiplied by tiller separation. More than three hundred F_2 plants were randomly tagged for phenotypic evaluation and further recording of post-harvest data and genotyping. Phenotypic data includes plant height, flag leaf length, flag leaf width, panicle length, tiller number, effective tiller number, days to 50% flowering, seeds per panicle, seeds per plant, grain yield per plant, 100 seed weight, seed length, seed breadth, length-breadth ratio. Correlation analysis was performed among the yield parameters. For genotyping plant DNA isolation using CTAB procedure was employed. Later quantified and diluted DNA sample was used to perform PCR using the functional marker for *Pup1* and peak markers for *qDTYs*, based on the genotypic data F_2 plants were classified into 18 different QTL groups.

Results

Correlation coefficient analysis revealed that characters *viz*., plant height, tiller number, effective tiller number, grains per panicle are positively and significantly correlated with grain yield per plant. On comparison of performance of plants possessing different QTL combinations it was observed that plants having *Pup1* and both the *qDTYs* in homozygous conditions recorded highest average grain yield per plants, similar trend was observed for total grain number per plants. Presence of *Pup1* invariably enhanced effective tiller numbers. Least variation was recorded for test weight irrespective of presence or absence of QTLs.

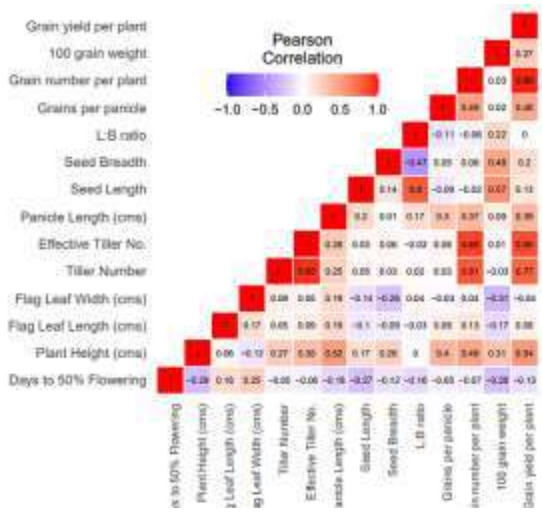


Figure 1- Correlation analysis among the different phenotypic traits

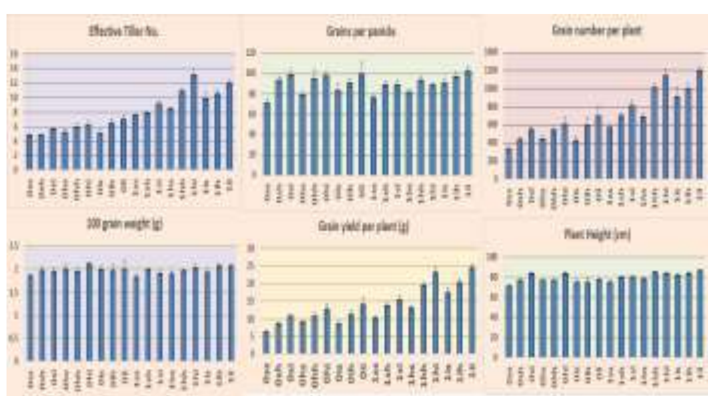


Figure 2- Comparison of Yield contributing and correlated data across the QTL combinations.

1hs

First character represents *Pup1*

Second character represents ***qDTY2.2***

Third character represents ***qDTY4.1***

First character, corresponds to presence (**1**) and absence (**0**) of ***Pup1.*** Second and third characters corresponds to zygosity condition (**i** for homozygous for IR 64 Drt1 allele, **h** for heterozygous, **s** for homozygous for Swarna allele) for ***qDTY2.2*** and ***4.1*** respectively.

Conclusion

More clearly, when *Pup1* was combined with both *qDTYs* in homozygous conditions, plants under this QTL group displayed highest plant height, 2nd highest effective tiller number, maximum grains per panicle, total grains/plant and recorded highest average grain yield, specifically revealing that QTL interaction among *Pup1* and *qDTYs* positive synergy.

References

Wissuwa, M., Yano, M. and Ae, N. 1998. Mapping of QTLs for phosphorus deficiency tolerance in rice (*Oryza sativa* L.). Theoretical and Applied Genetics. 97:777–783.

Swamy BP, M., Ahmed, H. U., Henry, A., Mauleon, R., Dixit, S., Vikram, P., ...& Kumar, A. (2013). Genetic, physiological, and gene expression analyses reveal that multiple QTL enhance yield of rice mega-variety IR64 under drought. *PloS one*, *8*(5), e62795

ICSCI 2022/T2/62

Resistance N22 mutants to rice planthoppers

V. Jhansilakshmi*, K. M. Anjali, S. K. Mangrautia, S. Akanksha and R. M. Sundaram
ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad - 500 030, India.
Email:jhansidrr@gmail.com

Introduction

Rice (*Oryza sativa*) is an important staple food and a source of calories for one-third of the world population. The planthoppers *viz*., brown planthopper (BPH), Nilaparvata lugens (Stål) (Hemiptera: Delphacidae) and Whitebacked planthopper (WBPH), Sogatella furcifera (Horvarh) (Hemiptera: Delphacidae) are very important sucking pests (Normile, 2008 and Heong and Hardy, 2009). These phloem sap feeders are known to be the most destructive and notorious pests of rice throughout Asia and create as high as 60% yield loss under epidemic conditions (Nanthakumar *et al*., 2012). The most crucial step in keeping insect pests under control is host plant resistance. In order to control the pest and create planthopper resistant varieties, it is essential to find suitable novel resistant donors for planthoppers from various sources. In light of this, the current study was designed to assess the brown planthopper and whitebacked planthopper resistance of the EMS mutant lines of rice from the Nagina 22 variety.

Methodology

Brown planthopper and whitebacked planthopper were mass reared on the susceptible rice variety TN1. In order to identify the sources of resistance to BPH and WBPH, two hundred and one Nagina 22 mutants were mass screened under controlled greenhouse conditions as per the technique described by Kalode *et al*. (1975). The test entries were sown in the screening trays along with resistant and susceptible checks and after 12-13 days, first and second instar nymphs of BPH/WBPH were released on the seedlings and the infested trays were monitored regularly for plant damage. When more than 90 per cent plants in the susceptible check were killed, the test entries were scored for the damage reaction, based on the 0-9 scale of International Standard Evaluation System-SES, 2013. All the 201 N22 mutants were screened in three replications.

Results

Out of these 201 N22 mutants screened, thirty-one mutants were resistant to BPH and exhibited a damage score ranging from 1.0- 5.0 and the remaining one hundred and seventy mutants were found susceptible with a damage score of 5.1-9.0. Out of thirty-one BPH resistant mutants, twelve mutants were resistant and nineteen mutants were moderately resistant. In case of WBPH screening, forty-four mutants were resistant and exhibited a damage score (DS) ranging from 0.0 to 5.0 and the remaining one hundred and fifty-seven mutants were susceptible with a damage score of 5.1 to 9.0. Out of forty-four WBPH resistant mutants, three mutants*viz*., NH 663, NH 4963 and NH 4613 were highly resistant, twenty mutants were resistant, and twenty-one mutants were moderately resistant. In addition, twenty-one mutants were resistant to both BPH and WBPH (Table 4). The identified resistant germplasm accessions can be used as donors in the breeding programmes to develop planthopper resistant varieties.

Table 1. N22 mutants' resistant to rice planthoppers

Mutants resistant to BPH		Mutants resistant to WBPH		Mutants resistant to both planthoppers		
Mutants	DS	Mutants	DS	Mutants	BPH	WBPH
NH 4631	1.3	NH 663	0.5	NH 663	1.7	0.5
NH 4963	1.3	NH 4963	0.7	NH 4963	1.3	0.7
NH 4536	1.7	NH 4613	0.9	NH 4613	2.1	0.9
NH 663	1.7	NH 4614	1.1	NH 4614	2.6	1.1
NH 4613	2.1	NH 4535	1.2	NH 4535	2.9	1.2
NH 4859	2.5	NH 4615	1.3	NH 4615	3.8	1.3
NH 4856	2.6	NH 4536	1.4	NH 4536	1.7	1.4
NH 4614	2.6	NH 4828-1	1.7	NH 4828-1	3.7	1.7
NH 4632	2.7	NH 4757	1.7	NH 4757	4	1.7
NH 4857	2.9	NH 4913	1.7	NH 4913	3	1.7
NH 4535	2.9	NH 363	1.9	NH 4632	2.7	2.2
NH 4913	3	NH 4873	2.1	NH 4633	4.1	2.2
NH 4827	3.4	NH 4632	2.2	NH 4516	4.1	2.8
NH 4903	3.5	NH 4633	2.2	NH 4635	4.5	2.8
NH 4828-1	3.7	NH 4860	2.4	NH 4755	4.5	2.9
NH 4858	3.7	NH 4637	2.4	NH 4906	4.4	2.9
NH 4615	3.8	NH 4780	2.5	NH 4856	2.6	3.1
NH 4621	3.8	NH 4634	2.5	NH 4534	4.2	3.5
NH 4624	3.9	NH 4823-1	2.6	NH 4911	4.4	3.8
NH 4647	3.9	NH 4516	2.8	NH 4903	3.5	3.9
NH 4815-1	4	NH 4635	2.8	NH 4756	4.7	4
NH 4757	4	NH 4755	2.9			
NH 4516	4.1	NH 4906	2.9			
NH 4633	4.1	NH 4856	3.1			
NH 4534	4.2	NH 733	3.1			
NH 4906	4.4	NH 4817	3.2			
NH 4911	4.4	NH 4828	3.2			
NH 4755	4.5	NH 4636	3.2			
NH 4635	4.5	NH 4946	3.2			
NH 4756	4.7	NH 4815	3.4			
NH 4789	5	NH 4823-2	3.4			
		NH 4818-2	3.5			
		NH 4534	3.5			
		NH 4812	3.6			
		NH 4522	3.8			

		NH 4911	3.8			
		NH 4903	3.9			
		NH 4756	4			
		NH 4741	4.3			
		NH 4928	4.3			
		NH 4865	4.6			
		NH 4659	4.6			
		NH 4832	4.7			
		NH 4927	4.9			

References

Heong K L and Hardy B (ed.). 2009. Planthopphers: New Threats to the Sustainability of Intensive Rice Production Systems in Asia. IRRI Books, International Rice Research Institute (IRRI), No. 164471.

Kalode MB, Kasiviswanathan PR and Seshu DV. 1975. Standard test to characterize host plant resistance to brown planthopper in rice. Indian Journal of Plant Protection. 3(2): 204-206.

Nanthakumar M, Jhansi Lakshmi V, Bhushan VS, Balachandran SM and Mohan M. 2012. Decrease of rice plant resistance and induction of hormesis and carboxylesterase titre in brown planthopper *Nilaparvata lugens* (Stål) by xenobiotics. Pesticide Biochemistry and Physiology. 102(2): 146-152.

Normile D. 2008.Reinventing rice to feed the world. Science 321: 330-333.

ICSCI 2022/T2/64

Bio-efficacy of entomofungal pathogens against Pink borer, *Sesamia inferens* in Finger millet

G Shyam Prasad, J Stanley, K Srinivasa babu, S Aruna Sai and B Gangaiah
ICAR- Indian Institute of Millets Research, Hyderabad- 500 030, Telangana
Emai: shyam@millets.res.in

Introduction

Finger millet (*Eleusine coracana* L. Gaertn) is one of the most important small millet cultivated in various parts of Asia and African continents. In India, during 2020-21, it was cultivated on 1.17 m ha producing 2.0 million tonnes of grain mainly in the states of Karnataka, Orissa, Uttarakhand, Tamil Nadu, Andhra Pradesh, and Maharashtra. Finger millet grain is known not only for its high calcium, iron contents but also for its richness of dietary fibre, essential amino acids, gluten-free flour and thus have many health-benefits such as hypoglycaemic, hypocholesterolemic and anti-ulcerative effects (Chandra *et al*., 2016; Gupta *et al*., 2017; Chethan and Malleshi, 2007). Among the biotic pressures of finger millet, pink borer (*Sesamia inferens*, Walk) remains the most important yield limiting factors in states of Odisha, Karnataka, Tamil Nadu, and Andhra Pradesh (Jagadish *et al*, 2008) by preventing ear head emergence leading to production of white and chaffy panicle called white ear head Reddy *et al*, 2003). Further, this pest is polyphagous (Baladhiya *et al*., 2018) in nature and from major pest in sugar cane now infecting rice, wheat and other crops (Li *et al*, 2011). Pink borer is greatly susceptible to bio–control agents which are mostly used as best substitutes to the use of chemical pesticides. The entomopathogenic fungus, *Metarhizium anisopliae* and *Beauveria bassiana* infect pink borer through conidia and have established significant attentions as a best substitute to pesticides. Keeping in view the entomofungal formulations of *Metarhizium anisopliae* and *Beauveria bassiana* were evaluated against the Pink borer management in finger millet.

Methodology

Field trails for evaluating oil-based formulations of entomofungal pathogens against pink borer in finger millet (var 5614) were conducted at ICAR-IIMR (Indian Institute of Millets Research), Rajendranagar, Hyderabad Telangana, India during two consecutive *kharif* seasons of 2019 and 2020. The experiment constituted of six treatments (three isolates of *Beauveria bassiana* Bb 5a, Bb 23 and Bb 45), one isolate of *Metarhizium anisoplia* (Ma-35) obtained from ICAR- NBAIR (National Bureau of Agricultural Insect Resources), Bengaluru, Karnataka along with systemic insecticide Carbofuran 3G granules @ 20 kg/ha and standard untreated control. The experiment was laid in randomized block design with six treatments replicated four times with a plot size of 20 m^2. The standard package of practices was followed except for plant protection. The data on dead hearts (DH) and white earheads (WEH) were recorded in % and grain yield (kg/ha) was recorded.

Results

The data of results of the experiments are presented in Table 1 and is discussed below.

Dead hearts (DH): In both the years, there were significant differences in the treatments in terms of % dead hearts (DH) at 40 days after emergence (DAE) of crop. The dead hearts formed in finger millet due to pink borer were 86.9 and 42.3% lower in carbofuran treatment during 2019 and 2020 seasons respectively and over untreated control (14.0% DH). Ma-35 and Bb-45 inoculation that was as effective as carbofuron during 2019 became markedly superior to carbofuron in reducing DH during 2020 (Table 1).

White ear heads (WEH): The data on white ear heads showed similar trend to dead hearts. There was 79.4 and 72.5% reduction in white ear heads formation due to carbofuron granules application over the control (6.6 and 9.1%) during 2019 and 2020 seasons. Bb-45 and Bb-23 inoculation during 2019 and Bb-45 and Ma-35 inoculation during 2020 has provided as effective management as carbofuron 3G granules application to soil @ 20 kg/ha (Table 1).

Table 1. Effect of entomofungal pathogens against pink borer in finger millet

Treatment	Dead hearts (%)		White earheads (%)		Grain yield (kg/ha)	
	Kharif 2019	Kharif 2020	Kharif 2019	Kharif 2020	Kharif 2019	Kharif 2020
Bb-5a (1 x 10^8) @10 ml /lit	4.33^c	5.42^c	3.26^c	4.52^c	3487.5b	3562.5^c
Bb-23 (1 x 10^8) @ 10 ml /lit	3.74^{bc}	4.20^b	2.21^{ab}	3.51 b	4050.0ab	4037.5^b
Bb-45 (1 x 10^8) @ 10 ml /lit	2.55a	3.08^a	1.56^a	2.78^{ab}	4450.0a	4350.0^{ab}
Ma-35 (1 x 10^8) @10 ml /lit	2.62ab	3.31^a	2.45^{bc}	2.68^a	4300.0a	4525.0^{ab}
Carbofuran 3G @ 20 kg/ha	1.84a	4.13^b	1.36^a	2.50^a	4687.5a	4725.0^a
Untreated/Control	14.00d	7.16^d	6.60^d	9.10^d	2462.5c	2562.5^d
CD (0.05)	1.17	0.50	0.97	0.75	716.6	509.1

Bb- Beauveria bassiana; Ma- Metarhizium anisopliae

Grain yield: The DH and WEH (%) impacts were reflected on grain yield. Yield penalty due to pink borer infestation (untreated control) over carbofuron soil application was 47.5 and 45.8% during 2019 and 2020, respectively. All entomopathogenic fungal treatments have produced markedly higher grain yields than the untreated control during both the years. Further, all entomopathogenic fungal treatments except with Bb-5a have recorded at par grain yields as carbofuron granules application to soil @ 20 kg/ha. Entomopathogen Bb-5a inoculation has at par grain yields as Bb-23 (Table 1). The grain yields differences due to entomopathogenic inoculation were significantly and negatively correlated with DH (r = - 0.85**) and WEH (r = - 0.91**)formation.

Conclusion

Based on the reduction in DH, WEH (%) damage and concomitant increase in finger millet grain yields, application of bio-control agents (except Bb-5a) oil based formulation @ 10 ml/lit at 20 & 40 DAE were found as effective as soil application of 20 kg/ha carbofuran 3G, hence recommended for ecological pink borer management in finger millet.

References

Baladhiya, HC, DB Sisodiya and NP Pathan. 2018. A review on pink stem borer, *Sesamia inferens* Walker: A threat to cereals. *J. Entomol. Zool. Stud*. 6(3): 1235–1239.

Chandra D, S Chandra, Pallavi and AK Sharma.2016. Review of finger millet (*Eleusine coracana* (L.) Gaertn): a powerhouse of health benefiting nutrients. *Food Sci. Hum. Welln.*,5, 149–155.

Chethan S and N Malleshi .2007. Finger millet polyphenols: optimization of extraction and the effect of pH on their stability. *Food chemistry*, 105, 862–870.

Gupta S M, S Arora, N Mirza, A Pande, C Lata, S Puranik. 2017. Finger Millet: a "certain" crop for an "uncertain" future and a solution to food insecurity and hidden hunger under stressful environments. *Front. Plant Sci*. 8: 643.

Jagadish PS, HK Mohapatra, MK Chakravarty, N Srivastava and N Nangia. 2008. A compendium of insect pests of Finger Millet and other Small Millets. All India Coordinated Small Millets Improvement Project. ICAR, UAS, GKVK, Bangalore, 8-9.

Li CX, X Cheng and SM Dai. 2011. Distribution and insecticide resistance of pink stem borer, *Sesamia inferens* Lepidoptera: Noctuidae, in Taiwan. *Formosan Entomol*. 31: 39-50

Reddy M, TR Babu, DDR Reddy, M Sreeramalu. 2003. Determination of economic injury and threshold levels for pink borer *Sesamia inferens* (Walker) in maize *Zea mays* L. *International J pest control*, 45(5):260-263.

Validation of parents with reported grain protein markers in rice (*oryza sativa* l.)

G. Prasanna[1], J. Aravind Kumar[2] and L. Krishna[3]
1. Ph. D Scholar, Department of Genetics and Plant Breeding, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad-30.
2. Principal Scientist, Indian Institute of Rice Research, Rajendranagar, Hyderabad-30,
3. Principal Scientist, ARI, PJTSAU, Rajendranagar, Hyderabad-30.
Email: prasannagricos@gmail.com

Introduction

Food with nutritional value is always desired for human health. Rice grain has high biological value for its high calories. Rice breeders have worked for three decades to improve the protein content of rice grain, but significant and stable improvement has not been achieved due to the involvement of many small effect genes/quantitative trait loci (QTLs) that are influenced by environment. The aim of our investigation is to identify high protein lines. The study was conducted at the Indian Institute of Rice Research, Hyderabad.

Methodology

In the present study, RNR 15048 and RDR 1295 are the genotypes having low protein content and JAK 686, JAK 685 are the genotypes having high protein content. They are screened with reported ten SSR markers (RM6712, RM349, RM445, RM418, RM407, RM260, RM309, RM297, RM154, RM7217) linked to grain protein content.

Results

Among them, JAK 686 is showing polymorphism with three markers (RM260, RM297, RM154).

Conclusion

It is concluded that JAK 686 is having high protein content which can be used as donor in hybridization programmes.

ICSCI 2022/T2/66

Delineation of Na^+/K^+ homeostasis in rice landraces under sodic stress

M. Akilan[1*], P. Jeyaprakash[1], M. Shanmuganathan[1], S. Meena[2], V. Rajanbabu[1] and C. Vanniarajan[1]

[1]*Department of Plant Breeding and Genetics, Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Trichy, Tamil Nadu, India- 620 027*

[2]*Centre of Excellence in Sustaining Soil Health, Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Trichy, Tamil Nadu, India- 620 027*

Email: akilanmkarur@gmail.com

Introduction

Rice is one of the prime food crops consumed by majority of the world population. Sodicity is one of the major abiotic stresses that results in significant amount of yield loss. Landraces are reservoir of genetic diversity which confers greater tolerance to several biotic and abiotic stresses. Maintenance of Na^+/K^+ homeostasis in crop plants leads to greater tolerance under salt stress due to lower accumulation of phytotoxic Na^+ ions in plant cells (Zhang *et al.*, 2018). Hence, the present study was formulated to evaluate and elucidate the Na^+/K^+ homeostasis in rice landraces in target production environment for sodicity.

Methodology

Thirty-six landraces were evaluated under sodicity at ADAC&RI, Trichy during September, 2021. The plant samples (shoot) were collected from each genotype during flowering stage, and it was shade dried for 12 to 24 hours to remove water content in the tissue. Further, it was dried in hot air oven at 60°C for 72 hours. The dried samples were then ground into a fine powder. 0.5g of powdered leaf sample from each genotype was taken and it was digested in triple acid mixture containing HNO_3+ H_2SO_4+$HClO_4$ in the ratio of 9:2:1. The digested samples were made up to known volume and the sodium and potassium content were estimated using flame photometer as per the method suggested by Stanford and English (1949).

Results

The results reveal significant amount of variation for Na^+ and K^+ content present in the landraces (Table 1). The range of Na^+ content in rice shoot samples were found between 18.9 (*Mattaikar*) and 135.4 ppm (*Sornavari*). *Mattaikar* found to contain the lowest amount of Na^+ ion concentration followed by *Mikuruvai* (21.5 ppm) and *Vellaichithiraikar* (30.4 ppm).

Similarly, the K^+ ion content was observed between 22.9 ppm (*Karthi samba*) and 120.4 ppm (*Earapalli Samba*). Highest amount of K^+ content was present in *Earapalli Samba* (120.4 ppm) followed by *Sorna kuruvai* (118.6 ppm) and *Vellaichithiraikar* (112.0 ppm). Na^+ and K^+ ions have similar physiochemical properties indicating that they compete to enter the plant system (Wakeel 2013). Since this antagonism is more prominent in sodic soil because of the presence of high amount of Na^+ ions, identification of genotypes that can maintain low Na^+/K^+ ratio, rather than its content, will be highly useful for rice breeding. The Na^+/K^+ homeostasis in all the genotypes under study were presented in Figure 1. The values of Na^+/K^+ ratio was found between 0.22 (*Mikuruvai*) and 5.07 (*Karthi samba*). Lowest values of Na^+/K^+ ratio was found to be in *Mikuruvai* followed by

Vellaichithiraikar (0.27) and *Mattaikar* (0.34). Similarly, the highest amount of Na^{+}/K^{+} ratio was observed to be in *Karthi samba* followed by *Matta kuruvai* (2.81) and *Kaliyan samba* (2.48).

Table 1: Na^{+} and K^{+} content (ppm) of different rice landraces

Germplasm	Na^{+}	K^{+}	Germplasm	Na^{+}	K^{+}
Vellaichithiraikar	30.4	112.0	*Matta kuruvai*	101.0	36.0
Palkachaka	54.7	61.9	*Karuthakar*	49.8	58.9
Sivapuchithiraikar	62.2	108	*Thooyamalli*	83.4	64.1
Kalvalai	55.0	83.5	*Jeeraga samba*	46.9	55.1
Sorna kuruvai	81.4	118.6	*Varakkal*	65.1	99.8
Rasacadam	34.7	89.4	*Mattaikar*	18.9	55.7
Togai Samba	59.5	76.6	*Katta samba*	98.6	101.7
Kattikar	95.9	40.6	*Red sirumani*	93.6	38.0
Shenmolagi	50.1	53.5	*Vadivel*	69.3	55.3
Kattu ponni	120.0	68.8	*Ponmani samba*	55.1	58.5
Godavari Samba	42.5	50.5	*Thattan samba*	84.5	85.7
Earapalli Samba	125.7	120.4	*Kaliyan samba*	80.5	32.4
Mangam samba	44.2	81.5	*Kallimadayan*	59.6	90.3
Sornavari	135.4	73.9	*Chinna aduku nel*	87.8	104
Rama kuruvaikar	64.8	77.1	*Mikuruvai*	21.5	99.0
Seevana samba	72.8	33.8	*Vellai kudaivazhai*	89.5	73.8
Karthi samba	116.0	22.9	*Kodai*	55.1	55.1
Aarkadu kichili	51.9	24.2	*Vadakathi samba*	37.0	74.3

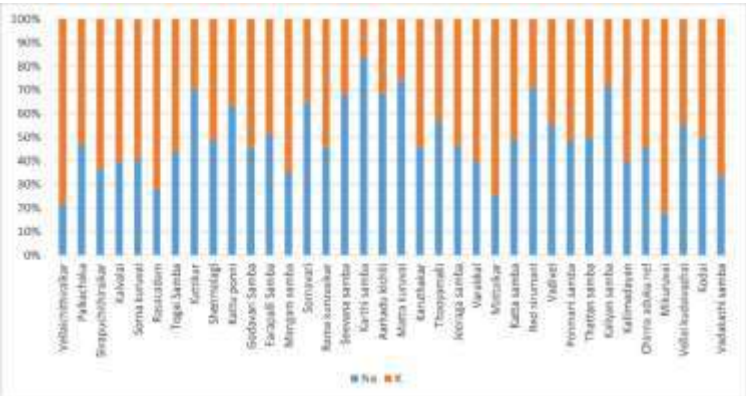


Figure 1 : Na^{+}/K^{+} homeostasis in rice landraces

Conclusion

Identification of tolerant genotypes is the first step towards crop improvement for stress tolerance. The present study revealed the Na^{+}/K^{+} homeostasis of rice landraces as a measure to assess its tolerance. Based on the results, *Mikuruvai*, *Vellaichithiraikar* and *Mattaikar* were found to be sodicity tolerant while, *Karthi samba*, *Matta kuruvai* and *Kaliyan samba* were found to be susceptible. The identified tolerant genotypes can further be crossed with susceptible genotypes for mapping tolerance related QTLs. Also, it could further be used in rice breeding programme for improvement of elite varieties for sodic stress tolerance.

References

Stanford, G, and L English. 1949. "Use of the flame photometer in rapid soil tests for K and Ca." *Agronomy Journal* 41 (9):446-447

Wakeel, A. (2013). Potassium–sodium interactions in soil and plant under saline-sodic conditions. *Journal of Plant Nutrition and Soil Science*, *176*(3), 344-354

Zhang, Y., Fang, J., Wu, X., & Dong, L. (2018). Na^+/K^+ balance and transport regulatory mechanisms in weedy and cultivated rice (*Oryza sativa* L.) under salt stress. *BMC plant biology*, *18*(1), 1-14.

Innovative approach for control of bacterial diseases through endophytic bacteria in rice

Chindam Swathi, Dr. Bharati N. Bhat, Dr. G. Uma Devi, Dr. S. Triveni and S.N.C.V.L. Pushpavalli
Department of Plant Pathology, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad-030, Telangana, India.
Email: swathipathology@gmail.com

Introduction

Rice (*Oryza sativa* L.) is one of the important staple food for the increasing population and grown extensively in the tropical and subtropical regions of the world, out of which, it is prone to several bacterial diseases. Endophytes play an important role in the functioning of the host plant by influencing their physiology and developmental processes. Bacterial endophytes are known to be involved in imparting tolerance or resistance to the host plant from various biotic and abiotic stresses by releasing antimicrobial metabolites, synthesizing phytohormones, siderophore, competing with pathogens for space and nutrients and modulating the plant resistance response. In view of the economic importance of the crop considerable attention has been given on the development of endophytic bacteria as biological control and is the most effective, eco-friendly and economically feasible.

Methodology

Fifty-two endophytic bacterial isolates were isolated from the roots, stem and leaves by serial dilution method The isolates were purified, colony characters were recorded.

Results

The genotype BPT 5204 and KNM supported significantly higher mean endophytic bacterial population. All the isolates were screened for antagonistic activities against Bacterial leaf blight by cross streak method. Fifteen isolates showed inhibition zone. This fifteen isolates were screened for biochemical characterization and plant growth promoting activities like siderophore, HCN, IAA, catalase, citrate, oxidase, hydrogen sulphide, indole, voges prausker's, casein, gelatin, pectinase, cellulose, phosphate solubilisation, IAA, HCN, ammonia tests were performed. Based on biochemical characterization, growth promoting activities, four isolates were effectively showing positive to all growth promoting activities under *in vitro*.

Conclusion

The four isolates can be used for development of consortium and used as biocontrol agents for control of bacterial diseases in paddy. It also increases resistance and growth promoting activities in rice varieties, ultimately increases the yield of the crop which is economically feasible compared to chemicals.

ICSCI 2022/T2/68

Marker assisted backcross breeding in rice variety Aiswarya to improve salinity and submergence tolerance

Meenu M. Nair[1] and Shylaraj K.S.[2]
Rice Research Station, Vytilla, Kerala 682019
Email: Meenu.nair70@gmail.com

Introduction

Rice is the world's leading food crop, supplying 20% of the daily calories for more than half of the world's population (IRRI, 2001), and is grown in a wide variety of climates and environments. In addition to different causes, environmental abiotic stresses such assalinityandsubmergencedecrease plant growthandagriculturalproductivity (Karakas et al., 1997). Salinity is the second-most significant abiotic stress impacting rice growth and productivity in coastal and marginal inland habitats (Todaka et al., 2012). Additionally, extremely mild to moderate salinity (EC= 5–6 dS/m) can cause significant yield losses in rice (Pearson et al., 1966). Rice, a water-loving grain can withstand short periods of flooding. However, prolonged submergence beyond 8–9 days can severely affect plant establishment and rice yield. Quantitative trait loci (QTL) mapping correctly transfers QTLs into common species, and by pyramiding multiple specific QTLs against specific stress-prone environments, enabling future efforts to growvarieties with improved tolerance. Marker-assisted backcross breeding (MABC) is a precise and effective method for single-locus introgression that controls traits of interest while preserving the essential properties of the recurrent parent (RP) (Collard & Mackill 2007). The objectives of the present study were 1. Introgression of the *Saltol* QTL and *Sub1* QTL from the donor parents FL478 and Swarna *Sub1* to the recurrent parent Aiswarya (by MABC) and 2. Phenotypic and genotypic screening of introgressed lines.

Methodology

1. Plant material (Recurrent parent and Donor parent)

The semi-tall high-yielding rice variety Aiswarya was used as recurrent parent. The saline-tolerantricebreeding lineFL-478 wasusedasthedonor of*Saltol* QTL andthe submergence-tolerant rice variety Swarna *Sub1* was used as the donor of *Sub1* QTL.

2.Parental polymorphism assay and breeding scheme

Foreground, Recombinant, and background screening were performed using 590 SSR markers between recurrent parent Aiswarya and donor parents. Using the CTAB technique, pure, complete genomic DNA was extracted from plant tissue in this study. The recurrent parent (RP) Aiswarya and the donor parents (DP) FL-478 and Swarna *Sub1* were hybridized independently to generate a backcrossed generation. The selected plants were phenotypically and genotypically screened.

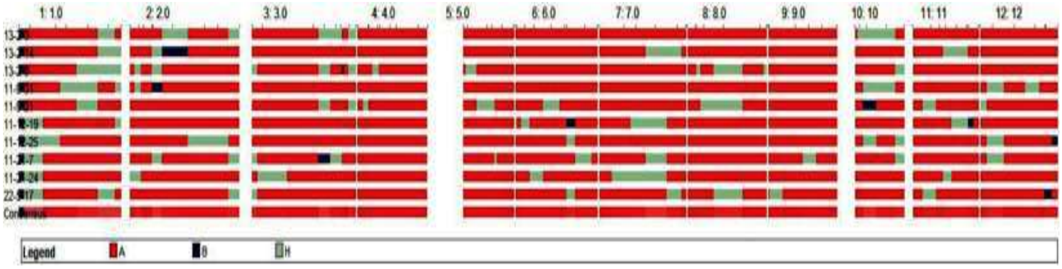
Results

For *Saltol* QTL total of 3 (AP3206, SKC10, RM3412b) foreground markers, 2 (RM10696, RM493) recombination markers, and 88 background markers showed strong polymorphism among the parental lines.

For the *Sub1* gene total of 3 (ART5, Sub1BC2, and Sub1C173) foreground markers, 3 (RM8303, RM23770, and RM24005) recombination markers, and 90 background markers were selected.

1. **Genotypic screening of *Saltol* BC_3F_2 generation**

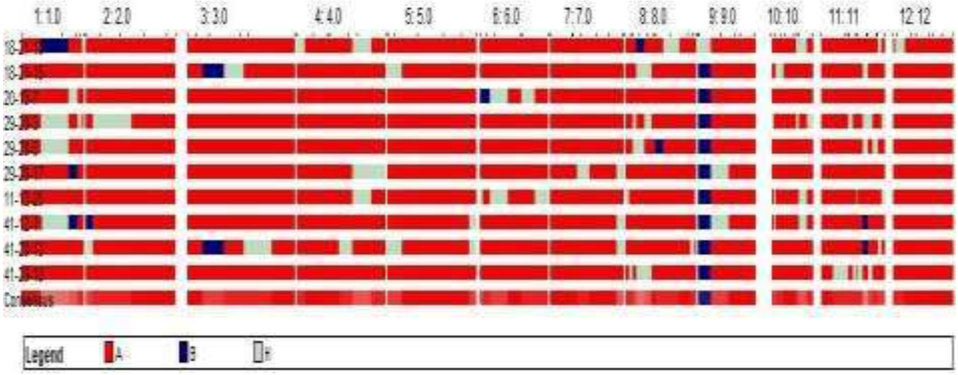
Fig. 1.1 shows a graphical genotype image (GGT) of selected BC_3F_2progenies of all 12 chromosomes



A:Homozygousregiontorecurrentparentgenome(red);B:Homozygousregiontodonorparentgenome(blue);H: Heterozygousregion(green)

2. **Genotypic screening of *Sub1* BC_3F_2 generation**

Fig.2.1 shows a graphical genotype image of selected BC_3F_2 progenies of all 12 chromosomes



A: Homozygous region to recurrent parent genome(red); B: Homozygous regiontodonorparent genome(blue);H: Heterozygous region(green)

Conclusion

The best *Saltol* and *Sub1* gene introgressed lines should next be examined at many field trials to find lines that are promising for each of Kerala's agroclimatic situations.

References

Collard BCY and Mackill DJ.2007. Marker-assisted selection: an approach for precision plant breeding in the twenty-first century. Philosophical Trans Royal Soc B,363:557–572.

IRRI(InternationalRiceResearchInstitute.2001.Websiteathttp://www.irri.org/

Karakas B, Ozias Akins P, Stushnoff C, Suefferheld M, and Rieger M. 1997. Salinity and drought tolerance of mannitol-accumulating transgenic tobacco. Plant, Cell and Environment,20:609-616.

Pearson GA, Ayers A and Eberhard D. 1966. Relative salt tolerance of rice during germination and early seedling development. Soil Science,102(3):151– 6.

Todaka D, Nakashima K, Shinozaki K and Yamaguchi-Shinozaki K. 2012. Towards understanding transcriptional regulatory networks in abiotic stress responses and tolerance in rice Rice,5(1):6.

Screening of sweet corn hybrids against turcicum leaf blight

M. Vani Praveena[1], S.C. Talekar[2], K. Dinesh[3] and Krishnanand S. I[4]
[1]*M. Vani Praveena, Ph.D. Scholar, Regional Agricultural Research Station, Acharya N. G. Ranga Agricultural University, Maruteru -534 122, West Godavari, Andhra Pradesh, India.*
[2]*Dr. S. C. Talekar, Assistant Maize Breeder, All India Coordinated Maize Improvement Project, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad-580 005*
[3]*Dr. K. Dinesh, Assistant Professor, Department of Plant Pathology, Dr. Y.S.R. Horticultural University, Ananthrajupeta-516 105, Andhra Pradesh, India.*
[4]*Krishnanad S.I., Ph.D. Scholar, Department of Plant Pathology, University of Agricultural Sciences, Dharwad-580 005, Karnataka, India.*
Email: vanipraveenamadhunapantula@gmail.com

Introduction

Turcicum leaf blight caused by *Exserohilum turcicum* is one of the devastating foliar diseases in corn. It leads to significant yield losses of about 50-90% among different specialized corn. Due to high abundance and genetic diversity of the pathogen in tropical conditions, there is every chance of breakdown of resistance leading to inflated disease severity. The productivity of corn including green maize is less due to biotic stresses like Northern corn leaf blight (TurcicumLeaf Blight/TLB), Maydis Leaf Blight, Downy mildew, charcoal rot and infestation of major insects like stem borer, armyworm and earworms including the new invasive pest fall armyworm (Praveena et al., 2022); and sweet corn is more susceptible to TLB among diseases. Therefore, with an objective to identify high yielding hybrids with resistance to TLB, a study was conducted for observing the reaction of hybrids to TLB under artificial epiphytotic condition.

Methodology

The material for the study was obtained from Winter Nursery Centre, Hyderabad, ICAR-Indian Institute of Maize Research (IIMR), which comprised of seven sweet corn inbred lines selected out of thirty-seven lines, based on phenotypic uniformity, days to tasseling and silking so as to achieve synchronization of the lines during crossing program. Crossing among seven inbred lines was done in 7 × 7 diallel fashion to produce 42 F_1 hybrids including reciprocals during *rabi* 2018. To identify a high yielding hybrid with resistance to TLB, a separate set of all hybrids were sown during *kharif* 2019 in RBD with two replications at All India Coordinated Maize Improvement Project, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad and the reaction of hybrids to TLB was studied under artificial epiphytotic condition. The fungus *Exserohilum turcicum* (Pass.) Leonard and Suggs.wasisolated by isolating the pathogen from the TLB infected leaves followed by transferring sterilized leaf bits to petri plates containing PDA media. The inoculated petri plates were incubated at room temperature (25 ± 1˚C) and observed periodically for fungal growth. The pathogen was purified for further mass multiplication. Mass multiplication of *E. turcicum* was carried out using sterilized sorghum grains (Joshi *et al.*, 1969). The whorl inoculation of fully colonized sorghum grain culture was done at 30 and 45 days after sowing and light irrigation was given to create the humid conditions to facilitate the growth of the pathogen. The intensity of turcicumleaf blight was recorded by scoring all randomly selected plants in each treatment at silk drying stage as per the 1-9 scale and expressed as percent disease severity.

Results

The percent disease severity in parents ranged from 43.94% to 77.02% and from 35.26% to 64.76% in hybrids. None of the parents showed resistant reaction, while moderate resistance was observed in SC Sel 1 (43.91%)

and susceptible reaction was observed in KH1831 (77.02%) and SC Sel 2 (77.02%). Out of 42 hybrids, five showed resistance reaction, 28 showed moderately resistant reaction and 9 hybrids showed moderately susceptible reaction while none of the hybrids showed susceptible reaction. The inbred lines SC Syn (-4.63) followed by MRCSC9 (-3.19) and SC Sel 3 (-2.32) expressed significant *gca* effects in desirable negative direction. Out of 12 hybrids exhibiting significant negative *sca* effect four crosses *viz*., SC Ind × MRCSC9, SC Ind × SC Syn, SC Sel 3 × KH1831, SC Sel 1 × MRCSC9 recorded significantly higher *sca* effects indicating the prevalence of additive and non-additive gene action in controlling this trait (Nedi *et al.*, 2018). Out of the forty-one hybrids that expressed negative heterobeltiosis, the significance was observed in only two hybrids *viz.*, MRCSC9 × SC Syn (-4.33%) and SC Sel 1 × SC Sel 3 (-3.67%). Nevertheless, economic heterosis in negative direction over the best check Misti was observed in five hybrids MRCSC9 × SC Sel 1 (-5.22%), SC Ind × MRCSC9 (-5.22%), MRCSC9 × SC Sel 2 (-5.09%), SC Sel 3 × MRCSC9 (-5.09%) and SC Syn × SC Ind (-5.09%). In addition, heterosis over the third check Madhuri in desirable negative direction was observed in MRCSC9 × SC Sel 1 (-0.14%) and SC Ind × MRCSC9 (-0.14%). None of the crosses showed significant negative heterosis over all the three standard checks.

Conclusion

From this study three parents namely SC Syn, MRCSC 9 and SC Sel 3 with significant gca effects in the direction favourable for TLB were identified and different hybrid combinations involving these parents showed significant *sca* effects and heterotic effects for the trait. Hence the above parental lines can be used in breeding programme along with high yielding parental lines to develop sweet corn hybrids with better yield and disease resistance.

References

Praveena MV, SC Talekar and RM Kachapur. 2022. Studies on correlation and path co-efficient analysis of single cross hybrids in sweet corn. International Journal of Plant Science, 17(2): 173-179.

Joshi LM, LB Goel and BL Renfro. 1969. Multiplication of inoculums of *Helminthosporium turcicum* on sorghum seeds. Indian Phytopathology 22:146-148.

Nedi G, L Tulu, S Alamerew and D Wakgery. 2018. Combining ability of selected maize (*Zea mays* L.) inbred lines for major diseases, grain yield and selected agronomic traits evaluated at Melko, Southwest Oromia region, Ethiopia. African Journal of Agricultural Research13(38): 1998-2005.

Characterization of bacteriophages and its efficacy study for bio-control of bacterial leaf blight of rice

Lata Jain*, Vinay Kumar and Sanjay K. Jain
ICAR-National Institute of Biotic Stress Management, Baronda, Raipur, Chhattisgarh, India 493225
Email: jain.lata59@gmail.com

Introduction

Bacterial leaf blight (BLB), caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*), is one of the most important destructive diseases of rice worldwide causing more than 50% yield losses (Banerjee et al., 2018). Due to ineffectiveness of chemicals in controlling the disease, development of effective and eco-friendly bio-control Methodology like bacteriophage therapy can be an alternate approach (Nakayinga et al., 2021). Bacteriophages are viruses that infect bacterial cells. Phages are excellent alternative as they are ubiquitous, highly bacterial host specific, self-replicating & self-limiting, free of side effects thus safe for humans, animals and plants. In agriculture, phage therapy research has been conducted in multiple crops as bio-control agents for management of important pathogens (Svircev et al., 2018). In this study, we attempted to isolate the bacteriophage against *Xoo* and explored their protective efficacy against BLB as potential biocontrol agent against BLB in rice pots.

Methodology

Bacteriophages against *Xoo* were isolated by an enrichment method (van Twest and Kropinski, 2009). About 147 water, soil and plant debris samples from rice field were collected from Chhattisgarh and adjoining states and processed for phage isolation against *Xoo*. The isolated phages were characterized for plaque size, plaque forming count (PFU), host range, thermal (range 4 to 90°C) and pH (range 2-12) viability (Jain et al., 2015). For protective efficacy study of selected Xoophage NR08 in pot experiment, seedlings of TN-1 were infected with *Xoo* pathogen (10^8 CFU/ml) using leaf clip inoculation method (Kauffman et al., 1973). After 72 h of BLB infection, plants were treated with single application of NR08 (without any supplement or additive) at concentration 10^7 PFU/ml using spray method. While, the phages untreated rice plants were sprayed with sterile water and considered as untreated infected control. The plants were observed and length of lesions on 10 leaves per treatment were recorded daily up to 21 days for progression of disease symptoms in both the phage treated and infected control groups. The disease suppression efficacy of phage treated group was compared with untreated control group using analysis of variance (ANOVA). Statistical significance was evaluated using Duncan's multiple range test (DMRT) at $p<0.01$.

Results

A total of 19 bacteriophages against *Xoo* were isolated indicated by clear round plaques and clearance of bacterial growth around phage streaked lines (figure 1A). The plaque size of phages varied from 2 to 10 mm in diameter while PFU count ranges from 3×10^6 to 6.2×10^9/ml. Effect of temperature on phage viable count ranged from 100% viability at 4°C to 40°C; 66% at 50°C; 30% at 60°C and less than 1% viability at 70°C or more. Similarly, phages were found to have about 99-100% viability at pH range of 6-8; about 80% at pH 5 and 9; 40% at pH 4 and 20% at pH 10 while they are not viable at pH 2, 3, 11 and 12.

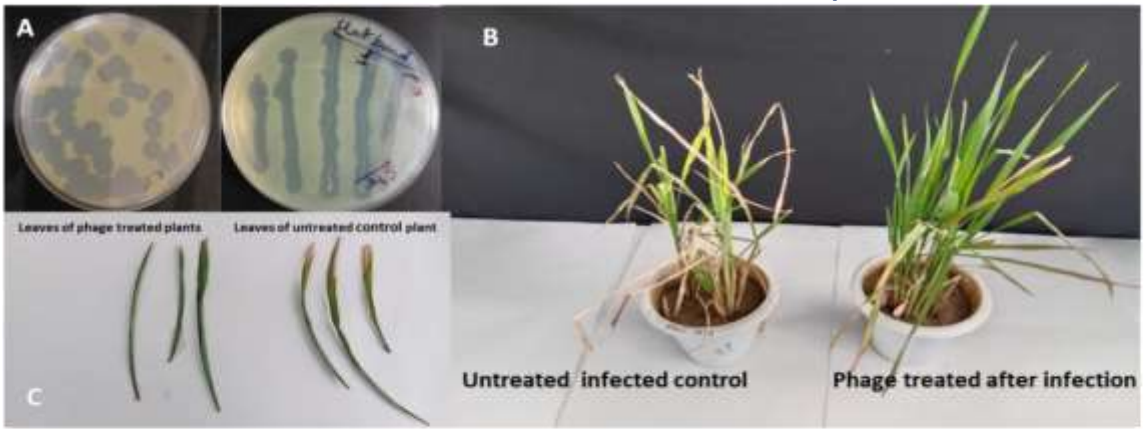


Figure 1: (A) Plaques on overlay agar and Clear zone around streaked lines; (B and C): Significant reduction of BLB symptoms in phage-treated rice plants and its leaves as compared to untreated control plants.

All the 19 phage were highly host specific and they don't even posses any lytic activity for other genera and species of genus *Xanthomonas.* In efficacy study of selected phage NR08, the disease leaf lesion mean length was 3.43 ± 0.63 cm at 21 dpi in NR08 phage treatment group while disease leaf lesion mean length of untreated infected control group was 16.55 ± 3.02 cm at 21 dpi which were significantly different at $p < 0.01$. The NR08 treatment provided a disease control efficacy of 79.27% over the untreated infected control (figure 1 B and C).

Conclusion

In this study, 19 lytic Xoo phages were isolated. All *Xoo p*hages were viable in wide temperature and pH range and were highly genus and species specific and did not show even lytic activity for *X. campestris. In-vivo* protective efficacy in pot trials showed significant reduction in symptoms of BLB in phage treated plants. These isolated phages can be explored in future as bio-control agent for the management of devastating BLB diseaseand development of phage therapy in rice.

References

Banerjee, A., Roy, S., Bag, M.K, Bhagat, S., Kar, M.K., Mandal, N.P., Mukherjee, A. K. and Maiti, D. (2018). A survey of bacterial blight (*Xanthomonas oryzae* pv. *oryzae*) resistance in rice germplasm from eastern and northeastern India using molecular markers. *Crop Protection* 112, 168-176.

Jain, L., Rawat, M., Prajapati, A., Tiwari, A. K., et al., (2015). Protective immune response of aluminium hydroxide gel adjuvanted phage lysate of *Brucella abortus* S19 in mice against direct virulent challenge with *B. abortus* 544.*Biologicals* 43, 369-376.

Kauffman, H.E., Reddy, A.P.K., Heisk, S.P.V., Maraca, S.D. (1973). An improved technique for evaluating resistance of rice varieties to *Xanthomonas oryzae*. *Plant Dis. Rep*. 57, 537–541.

Nakayinga, R., Makumi, A., Tumuhaise, V., Tinzaara, W. (2021). *Xanthomonas* bacteriophages: a review of their biology and biocontrol applications in agriculture. *BMC Microbiol*., 21, 291.

Svircev, A., Roach, D., Castle, A. (2018). Framing the Future with Bacteriophages in Agriculture.*Viruses* 10, 218–230.

Van Twest, R., Kropinski, A.M. (2009). Bacteriophage enrichment from water and soil. *Methods Mol Biol*. 501, 15–21.

ICSCI 2022/T2/71

Assessment of mid early duration fine grain rice culture MTU 1282 suitable for rabi season

Y. Satish*, B.N.V.S.R. Ravi Kumar, P. Venkata Ramana Rao, Y. Suneetha, M. Charumathi, T. Srinivas and G. Jogi Naidu
Acharya N.G. Ranga Agricultural University,
Regional Agricultural Research Station, Maruteru – 534 122, West Godavari, AP, India
Email: y.satish@angarau.ac.in

Introduction

'Rice is life' for more than half of the worlds' population and is the most important food crop in India. Rice is cultivated in an area of 43.79 million hectares with a production of 111.9 million tons of milled rice with an average productivity of 3.38 t/ha in the country. Andhra Pradesh is the rice bowl of the country with a production of 93.23 lakh tons of milled rice during 2019-20. Fine grain rice varieties with intermediate amylose content, gelatinization temperature and good cooking quality are preferred for consumption across India. Therefore, breeding for fine grain rice varieties was initiated at Regional Agricultural Research Station, Maruteru and a series of fine grain cultures were developed for the benefit of rice farming community across India. The main objective of the study is to develop fine grain rice varieties with high yield and good cooking quality suitable for large scale commercial cultivation.

Methodology

A fine grain rice culture was developed by crossing MTU 1001, a dual season rice variety as female parent and KMP 150 as male parent. The material was developed using pedigree breeding method and is being tested in station trials *viz*., OYT, PYT and AYT at RARS, Maruteru during *Kharif*, 2014; *Rabi*, 2014-15 &*Kharif*,2 015 respectively followed by multi location testing during *Kharif*, 2017 and *Kharif*, 2018 across six rice research stations in ANGRAU. The data was compiled and the rice culture MTU 1282 was given for testing in farmers' fields during *Rabi, 2019-20, Rabi, 2020-21 & Rabi, 2021-22* in all the rice growing districts of Andhra Pradesh state.

Results

The culture MTU 1282, recorded an average yield of 7148 kg/ha in station yield trials over the best check variety (6105 kg/ha) with 17.1 percent increase (Table 1). In multi location trials conducted during *Kharif*, 2017 and *Kharif*, 2018 across 10 locations, the culture MTU 1282 recorded an average yield of 6193 kg/ha over the best check (4889 kg/ha) with a yield advantage of 26.7 percent (Table 2). Based on the superior performance of MTU 1282, it was promoted to test the culture MTU 1282 under adaptive minikit testing in farmers' fields with the help of DAATTC centres and Department of Agriculture, Andhra Pradesh in different districts of the state during *Rabi, 2019-20, Rabi, 2020-21 & Rabi, 2021-22.* MTU 1282 was tested in 365 locations across the state and recorded an average yield of 7871 kg/ha with a yield advantage of 7.19 percent over the check variety (Table 3).MTU 1282 has an L/B ratio of 2.94 with 67.9 % of milling percentage and 63.2 % of head rice recovery with intermediate amylose content (24.22), gelatinization temperature and good cooking quality. With an average yield of more than 6.5 to 7.50 t/ha, along with good grain quality and cooking quality.

Table 1: Evaluation of MTU 1282 rice culture in station trials

Name of the trial	Code number	Year & Season	Grain yield (kg/ha)	Check yield (Kg/ha)	Percent increase over best check
OYT-Early	AE 427	Kharif 2014	6974	5874 (MTU 1010)	18.7
PYT-Early	BE 421	Rabi 2014-15	7525	6885 (MTU 1010)	9.3
AYT-Early	CE 371	Kharif 2015	6944	5556 (MTU 1010)	25.0
Mean in station trials			**7148**	**6105**	**17.1**

Table 2: Evaluation of MTU 1282 rice culture in multi-location trials

Name of the trial	Year &Season	Grain yield (kg/ha)	Best Check yield (Kg/ha)	Percent increase over best check
MLT-Slender grain (7 Locations)	Kharif 2017	6533	5508	18.6
MLT-Slender grain (3 locations)	Kharif 2018	5853	4269	37.1
Mean in MLTs		**6193**	**4889**	**26.7**

Table 3: MTU 1282 Compiled data in adaptive minikits during – *Rabi, 2019-20, Rabi, 2020-21 & Rabi, 2021-22*

S. No.	Year & Season	No. of locations tested	Minikit Yield (Kg/ha)	Check Yield (BPT 5204) (Kg/ha)	% Yield Advantage
1	Rabi, 2019-20	149	7893	7338	7.56
2	Rabi, 2020-21	102	8076	7464	8.20
3	Rabi, 2021-22	114	7644	7228	5.76
Mean over 3 years		**365**	**7871**	**7343**	**7.19**

Conclusion

Thus, the rice culture MTU 1282 will be a very good fine grain variety suitable for Rabi season in the state of Andhra Pradesh and other states in India.

ICSCI 2022/T2/72

Evaluation of MTU 1290, *saltol* introgression line of MTU 1010

Venkata Ramana Rao Puram*, Ravi Kumar B N V S R, Satish Y, Suneetha Y, Charumathi M, Srinivas T, Veronica N and Jogi Naidu G
Acharya N.G. Ranga Agricultural University,
Regional Agricultural Research Station, Maruteru – 534 122, West Godavari, AP, India
Email: pv.ramanarao@angrau.ac.in

Introduction

Rice (*Oryza sativa* L.) is one of the most needed cereal crop and is considered as the staple food for more than 2.7 billion people on a daily basis. Among the abiotic stress constraints affecting rice, salinity is the second most important constraint after drought. Rice is the most salt sensitive among cereal crops with assorted response at different developmental growth stages. Development of rice varieties tolerant to salt stress at different growth stages is a viable and ecofriendly approach to increase the productivity in salinity areas. Introgression of '*Saltol*', a major QTL for seedling stage salinity tolerance and *qSSISFH8.1* a QTL for reproductive stage salinity tolerance with linked molecular markers into mega varieties was achieved through marker-assisted backcross breeding (MABB). To evaluate the *Saltol* introgression line developed through MABB in the genetic background of mega variety MTU 1010.

Methodology

MTU 1290, a *saltol* introgression of line of MTU 1010 was developed through MABB using FL 478, a donor developed at IRRI for seedling stage salinity tolerance. Three cycles of back crosses with MTU1010 followed by three cycles of selfing was done. Genotyping in each generation was carried out using foreground (RM 10694) and recombinant markers (RM 10793, AP 3206) on chromosome 1. All the genotyping work is performed as per Girija Rani *et al* 2019 and electrophoresis was carried out using 3% high resolution metaphor Agarose. Thirty-seven introgression lines were developed and promoted to yield evaluation trials. Based on trials conducted at RARS, Maruteru and multi-environment testing under stress environments (for three seasons), the IL DST38-15-3-1 (MTU1290) was proposed for adaptive minikit testing in seven coastal districts of Andhra Pradesh.

Results

For *Saltol* introgression, a total of 5,400 plants of 30 families of BC_2F_2 were evaluated. Based on phenotyping and genotyping studies in further generations a total of thirty-seven ILs were promoted to yield evaluation trials (Venkata Ramana Rao *et al.* 2015). Out of these 37 ILs, DST38-15-3-1 (MTU1290) had recorded high yield under normal conditions and high seedling survival percent coupled with high yield under stress conditions. Under station trials, MTU 1290 recorded an average yield of 4822 kg/ha in comparison with the recurrent parent MTU 1010 which recorded 4434 kg/ha and the percent increase was 8.75. (Table 1). MTU 1290 was tested under stress conditions in multi-environment testing with soils having EC ranging from low (0.80) to high (11.95). The multi-environment testing conducted during *Kharif* 2017, *Rabi* 2017-18 and *Kharif* 2018 indicated that MTU 1290 recorded an average yield of 5044 kg/ha while the recurrent parent recorded 3789 kg/ha with 33.12% yield increase. (Table 2). Based on the results obtained in station trials and multi-environment testing, MTU 1290 was promoted to adaptive minikit testing in farmer's fields under salinity. In first year of adaptive minikit testing, the % increase over recurrent parent was 14.62% while it was 12.63% and 12.32 % in second and third years of minikit testing (Table 3). An average yield of 7771 kg/ha was recorded by

MTU 1290 while the recurrent parent had recorded 6866kg/ha. The % increase was 13.18. The culture MTU 1290 has long slender grain suitable for export with a kernel length of 6.09mm and L/B ratio of 3.08 and high HRR of 61.42 %.

Table1: Evaluation of MTU 1290 in Station Trials

S. No	Name of the Trial	Code/ IET No	Year of testing	Grain yield (kg/ha)		% increase
				Entry (MTU 1290)	Recurrent Parent (MTU1010)	
1	OYT-Sal(Normal)	AST67	K 2016	3718	3255	14.22
2	PYT – Sal (Normal)	BST31	R2016	5926	5614	5.55
				4822	**4434**	**8.75**

Table 2: Evaluation of MTU 1290 in Multi-environment testing

S. No	Name of the Trial	Code/ IET No	Year of testing	Grain yield (kg/ha)		% increase
				Entry (MTU 1290)	Recurrent Parent (MTU1010)	
1	MLT Salinity (Pooled)	MST8	K 2017	4356	3219	35.32
2	MLT Salinity (Pooled)	MST24	R 2017	6542	4879	34.08
3	MLT Salinity (Pooled)	MST36	K 2018	4233	3270	29.44
				5044	3789	33.12

Table 3: Evaluation of MTU 1290 under adaptive minikit testing in farmer's field under salinity

S. No	Year	No. of kits given	No. of locations	MTU 1290 Yield (kg/ha)	MTU 1010 Yield (kg/ha)	% increase
1	2019	175	120	7624	6651	14.62
2	2020	115	80	8016	7117	12.63
3	2021	190	59	7674	6832	12.32
Average		**480**	**259**	**7771**	**6866**	**13.18**

Conclusion

The present study was undertaken to introgress *Saltol* into mega variety MTU 1010 for seedling stage salinity tolerance. MTU 1290, an introgression line recorded high seedling survival percentage coupled with high yield under multi-environment testing and adaptive minikit testing.

References

Girija Rani M, Satyanarayana PV, Chamundeswari N, Ravikumar BNVSR, Ramana Rao PV, Pavani L and Deepika V 2019 Molecular breeding of "Swarna", a mega rice variety for lodging resistance. Molecular Breeding:39-55.

Venkata Ramana Rao P, Girija Rani M, Satyanarayana P V, Suryanarayana Y, Kondayya K, Prasad K S N, Anuradha T, Singh N K, Chamundeswari N, Ravi Kumar B N V S R and Renu Singh 2015 Incorporation of *'Satol'* QTL into mega variety MTU 1010 through marker assisted breeding. International rice symposium, IIRR, Hyderabad. 18-20 November, 2015 pp: 11.

Evaluation and identification of landraces resistance to BPH, BLB, Blast diseases through field screening.

B.N.V.S.R. Ravi Kumar*, Vasavi Singareddy, D. Lalitha, K. Sudeepthi, P. Venkata Ramana Rao, Y. Satish, M. Nanda Kishore, A.D.V.S.L.P Anand Kumar, V. Bhuvaneswari, A.V.S. Durga Prasad, P. Ramesh Babu and G. Jogi Naidu
Acharya N.G. Ranga Agricultural University,
Regional Agricultural Research Station, Maruteru – 534 122, West Godavari, AP, India
Email: bnvsr.ravikumar@angrau.ac.in

Introduction

Rice is the most staple food crop grown worldwide and is considered as "Global Grain" which feeds half of world's populace. Biotic factors are the major concern for crop loss, in these Brown plant hoppers (BPH), Bacterial leaf Blight (BLB) and Blast are the most devastating pests and diseases worldwide. BPH is a considerable risk to rice fields carrying 20-90% yield losses. Till date, 37 BPH resistance genes were expressed from distinct resistance sources. Out of these 20 genes are fine mapped and seven genes are cloned and characterized (Balachiranjeevi *et al.* 2019). Currently, 42 BLB R-genes have been discovered in rice. Out of the 42 genes, 14 are recessive while nine have been cloned and characterized (Chukwu Samuel *et al.* 2019) To date, 109 major blast resistance genes have been identified in rice. Out of these, 25 R genes have been successfully cloned and characterized, eight R genes have been fine mapped (Ashkani *et al.* 2016). Although remarkable attainment made so far by identification and introgression of resistance genes into cultivated varieties but quick transformation of virulent pathogens is primary concern. So, screening of rice landraces is extensively important in terms of genetic diversity and have a huge potential for the identification of genetic factors that are valuable for improving the important agronomic traits, biotic and abiotic stress, thus screening of landraces for identification of disease resistance plays an important role. The main objective of the study is to identify new genes in rice landraces for major biotic stresses *viz*., BPH, BLB and Blast.

Methodology

Field screening and SSBT technique for BPH

In SSBT technique seedlings of 2-3 leaf stage was infested with second and third instar nymphs @ 10-12 nymphs/per seedling. In field screening test entries are surrounded by susceptible check TN1. Once the standard susceptible check started wilting (90 %) data was recorded as seedlings survival rate. High BPH score with 9 indicates susceptibility and the lowest score 1 indicates the resistance of the genotype based on scoring system proposed by the International Rice Research Institute (IRRI 1996).

Clip inoculation method for BLAST

Infected Blast and BLB leaf spore suspension will be sprayed over the bed by clip inoculation method with suspension concentration of 10^8/ml. The field observations were recorded after 15 days of inoculation period. High disease incidence with 9 indicates susceptibility and the lowest score 0, 1 indicates the resistance of the genotype (IIRR 2022).

Results

Screening of Landraces for BPH

- During2020, 500 landraces were screened for BPH at field level and SSST method at RARS Maruteru.
- In 2020, eight landraces were identified as resistant with score 3 and 5 through field level and SSST screening.

IC NUMBER	MTU SSST Score 2020	MTU Field score 2020
IC 125755	5	3
IC 206282	3	3
IC 379627	5	5
IC 218454	5	5
IC 516681	3	5
IC 217924	5	5
IC 218176	3	5
IC 218800	3	5

Field screening for BPH

SSBT screening

Screening of Landraces for BLAST (Leaf & Neck Blast)

- During *Rabi* 2020-21, 500 landraces were screened for Blast (leaf & Neck) in field conditions at RARS Maruteru.
- Two landraces were identified with score 1 for leaf blast and 11 landraces were identified with score 3 for Neck blast

Leaf Blast Promising Entries 2020	Score
IC 206810, IC 213833	Score 1

Neck Blast Promising Entries 2020	Score
IC 206999, IC 390528, IC 435142, IC 467267, IC 218311, IC 518703, IC 455301, IC 517398, IC 135523, IC 126445, IC 378152	Score 3

Conclusions

During 2020, 500 landraces were screened for BPH, BLB, BLAST traits, twelve landraces were identified as resistant to moderately resistant to both BPH and Blast with scores 3 & 5, while none of the landraces showed resistance to BLB. Crosses were initiated with identified resistant landraces using TN1 as a female parent to develop RIL population, which are now at F_1 stage to identify new BPH QTLs/ genes through GWAS.

References

Ashkani M, Rafii MY, Shabanimofrad M, Ghasemzadeh A, Ravanfar SA, Latif MA (2016) Molecular progress on the mapping and cloning of functional genes for blast disease in rice (Oryza sativa L.): Current status and future considerations, critical Reviews in Biotechnology, 36:2, 353-367

Balachiranjeevi CH, Prahalada GD, Mahender A, Jamaloddin Md, Sevilla MAL, Mafori-Nazarea CM, Vinarao R (2019) Identification of a novel locus, *BPH38*(t), conferring resistance to brown planthopper (*Nilparvatha ligens Stal*.) using early backcross population in rice (*Oryza sativa* L.). Euphytica.; 215:185

Chukwu Samuel, Rafii M, Izan Shairul, Ismail Izera, Yusuff Oladosu, Okporie Emmanuel, Onyishi Godwin, Utobo Emeka, Ekwu Lynda, Swaray Senesie, Jalloh M (2019). Marker-assisted selection and gene pyramiding for resistance to bacterial leaf blight disease of rice (Oryza sativa L.). Biotechnology & Biotechnological Equipment. 33

IRRI (International Rice Research Institute). Standard Evaluation System for Rice (SES).5th edition Los Banos (Philippines). 2014

IIRR (Indian Institute of Rice Research), ACRIP, Hyderabad, 2022

ICSCI 2022/T2/74

Development and evaluation of medium duration fine grain rice culture MTU 1271

B.N.V.S.R. Ravi Kumar*, P. Venkata Ramana Rao, Y. Satish, Y. Suneetha, M. Charumathi, T. Srinivas and G. Jogi Naidu
Acharya N.G. Ranga Agricultural University,
Regional Agricultural Research Station, Maruteru – 534 122, West Godavari, AP, India
Email: bnvsr.ravikumar@angrau.ac.in

Introduction

Rice is an important staple food crop for more than 60 % of Worlds' population. Globally, it is the second most important cereal crop adding 30 to 50 % of agricultural income to the farming community. Different rice varieties/hybrids with varying grain quality parameters are consumed in differentrice growing areas of the country. In South India, generally fine grain rice varieties with intermediate amylose content, gelatinization temperature, and good cooking quality are preferred for consumption. Therefore, breeding for fine grain rice varieties was initiated and a series of fine grain cultures were developed for the benefit of the rice farming community, not only in the state of Andhra Pradesh but also for Telangana, Karnataka and Tamilnadu. The main objective of the study is to develop rice varieties with high yield, fine grain and good cooking quality suitable for commercial cultivation.

Methodology

A fine grain rice culture was developed by crossing MTU 1075, a medium duration rice variety as female parent and MTU 1081, a pre-release culture as male parent. The material was stabilized using pedigree breeding and is tested in station trials *viz*., OYT, PYT and AYT at RARS, Maruteru, followed by multi location testing during *Kharif*, 2017 and *Kharif*, 2018. The data was summarized and the rice culture MTU 1271 was given for testing in farmers' fields during *Kharif*, 2019; *Kharif*, 2020 and *Kharif*, 2021 in most of the rice growing districts of Andhra Pradesh.

Results

The culture MTU 1271, recorded an average yield of 5881 kg/ha in station yield trials in comparison with the best check variety (5671 kg/ha) with 3.70 percent increase (Table 1). In multilocation trials conducted during *Kharif*, 2017 and *Kharif*, 2018 across 15 locations, the test culture MTU 1271 recorded an average yield of 6736 kg/ha in comparison with best check (5243 kg/ha) with a yield advantage of 28.47 percent (Table 2). Owing to the superior performance of the culture it was decided to test the culture MTU 1271 under adaptive minikit testing in farmers' fields with the help of DAATTC coordinators and Department of Agriculture, Andhra Pradesh in different districts of the state during *Kharif*, 2019; *Kharif*, 2020 and *Kharif*, 2021. Accordingly, the culture was tested in 914 locations and MTU 1271, recorded an average yield of 6439 kg/ha with a yield advantage of 9.95 percent over the check variety (Tables 3).MTU 1271 has an L/B ratio of 3.23 with 67 % of milling percentage and 62 % of head rice recovery with intermediate amylose content, gelatinization temperature and good cooking quality.

Table 1: Evaluation of MTU 1271 rice culture in station trials

Name of the trial	Year & Season	Grain yield (kg/ha)	Best Check yield (Kg/ha)	Percent increase over best check
OYT (Medium)	*Rabi* 2015-16	5943	5935	-
PYT (Medium)	*Kharif* 2016	5919	5531	7.02
AYT (Medium)	*Rabi* 2016-17	5780	5547	4.20
Mean in Station Trials		**5881**	**5671**	**3.70**

Table 2: Evaluation of MTU 1271 rice culture in multi-location trials

Name of the trial	Year & Season	Grain yield (kg/ha)	Best Check yield (Kg/ha)	Percent increase over best check
MLT-SG (I year) Overall (7 locations)	Kharif 2017	7040	5401	30.35
MLT -SG (II year) Overall (8 locations)	Kharif 2018	6431	5084	26.50
Mean in MLTs		6736	5243	28.47

Table 3: MTU 1271 Compiled Data in adaptive minikits during – *Kharif*, 2019; *Kharif*, 2020 and *Kharif*, 2021

S. No.	Year & Season	No. of locations tested	Minikit Yield (Kg/ha)	Check Yield (BPT 5204) (Kg/ha)	% Yield Advantage
1	Kharif 2019	330	6695	5976	12.03
2	Kharif 2020	200	6266	5701	9.91
3	Kharif 2021	384	6357	5716	10.08
		914	6439	5798	9.95

Conclusion

With an average yield of more than 6.0 to 6.5 t/ha, along with good grain quality and cooking quality, the rice culture MTU 1271 can be a good fine grain variety for the state of Andhra Pradesh and other South Indian states.

ICSCI 2022/T2/75

Detecting brown plant hopper damage in rice using hyperspectral radiometry

M Prabhakar[1], V Jhansi Lakshmi[2], Ch Padmavathi[2], KA Gopinath[1], U Sai Sravan[1], M Thirupathi[1] and YG Prasad[3]

[1]*ICAR-Central Research Institute for Dryland Agriculture, Hyderabad, Telangana – 500 059, India,*
[2]*ICAR-Indian Institute of Rice Research, Hyderabad, Telangana – 500 030, India*
[3]*ICAR-Central Institute for Cotton Research, Nagpur, Maharashtra – 440 010, India*
Email: M.Prabhakar@icar.gov.in

Introduction

Rice is the most staple food for more than 60 per cent of the world's population and its yield is mostly limited by various biotic and abiotic stresses in the post rainy season in India. Among the various biotic stresses, Brown Plant Hopper (BPH), *Nilaparvata lugens* (Homoptera: Delphacidae), is responsible for large-scale devastation to rice, resulting in yield losses up to 75% (Kumar et al., 2022). By the time plant damage is visible there will be significant yield loss. Hence, timely detection of its incidence in rice is vital for effective pest management. Remote sensing offers immense scope to distinguish healthy plants from stressed based on the reflectance "spectral signatures". Earlier studies in China (Yang et al., 2007) and North India (Prasannakumar et al., 2013) found that damage severity by BPH in rice can be measured through changes in reflectance in visible and NIR regions on the spectral domain. The attempts of spectral signatures of BPH in rice is very scanty in Southern India, therefore, this study was taken up to detect the BPH damage in rice using hyperspectral radiometry and to identify the sensitive bands.

Methodology

Rice fields of farmers in Miryalaguda, Nalgonda district, Telangana were surveyed during November, 2017 (post rainy season) when higher infestations of BPH was observed. Ground truth data along with GPS readings was collected from 56 farmers' fields using stratified random sampling. According to the extent of damage based on visual symptoms, the BPH damage incidence was categorized into 6 scales as described in INGER (1996) *viz*., scale 0 (no damage), scale 1 (slight yellowing of plants), scale 3 (leaves partially yellow but no hopperburn), scale 5 (leaves with pronounced yellowing and 10-25% of plants with hopperburn, remaining plants severely stunted), scale 7 (more than half plants wilting or with hopperburn, remaining plants severely stunted) and scale 9 (all plants dead). About 10-15 rice plants from each severity scale in each field were sampled to collect canopy reflectance data using FieldSpec-3 Hi-Res hyperspectral spectroradiometer (spectral range: 350-2500 nm, ASD Inc., USA). Spectral data were interpolated using ASD ViewSpecPro software in the post processing to produce values at each Nanometer. The data were used in multinomial logistic regression analysis (MLR) and identified sensitive bands specific to BPH damage.

Results

The mean canopy reflectance of different BPH severity scales from the field based hyperspectral radiometry studies showed a discrete variance between healthy and BPH infested plants at different severity levels (Figure 1).

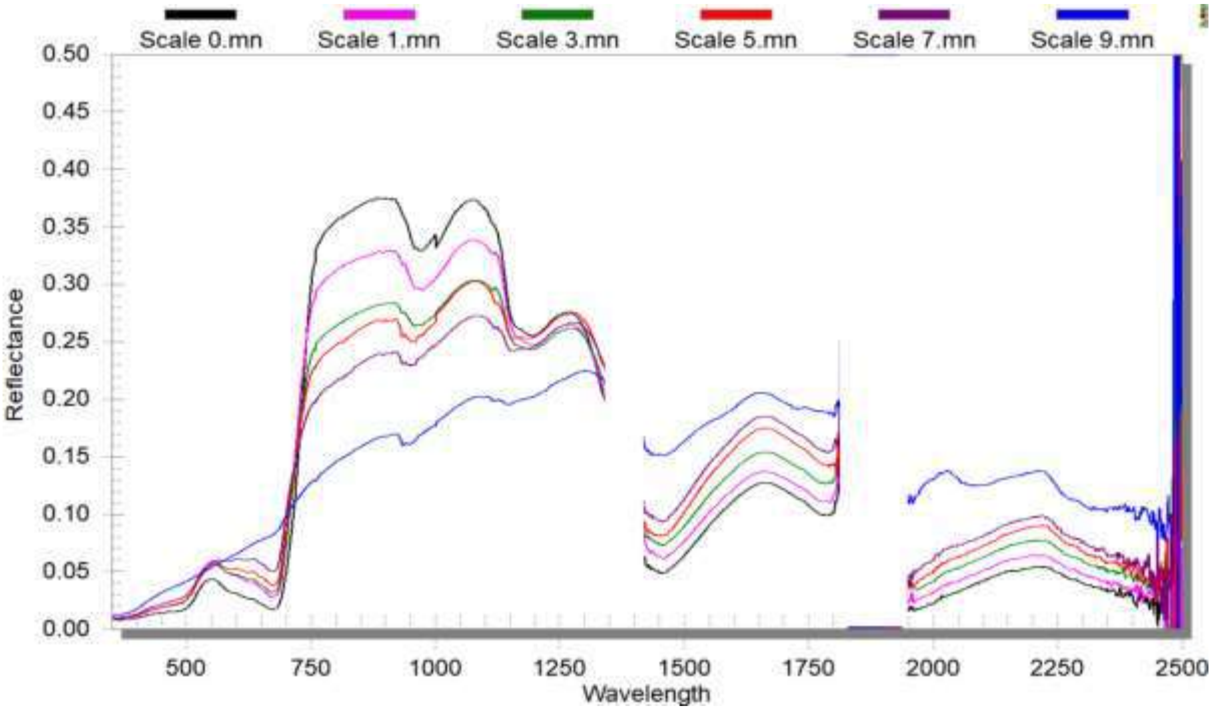


Fig. 1. Ground-based hyperspectral reflectance spectra of rice plants under different severity scales of BPH infestation

The reflectance from BPH infested plants was high in visible region (400-750 nm) compared to healthy plants. Moreover, the reflectance was lower in near infra-red region (750-1100 nm) in infested plants. As the infestation severity increased, the crop reflectance decreased in NIR region. Sensitivity analysis of narrowband hyperspectral data showed that bands at 491 nm, 547 nm, 672 nm, 760 nm, 1454 nm and 1784 nm were highly sensitive to BPH infestation. The hyperspectral bands identified specific to BPH were considered for building multinomial logistic regression models. Further, the model fit statistics (AIC: 408.43, SC: 527.68) suggested that reflectance bands better explained the variation in severity scales. Further, the classification accuracy of multinomial logistic model using the hyperspectral bands were calculated and the percent correct classification was in the range of 50 to 85%. The model was validated using independent data sets. The overall percentage of correctly classifying the plant into severity scales was similar in both calibrated (66.37%) and validated (63.72%) data sets.

Conclusion

This study characterized the reflectance spectra of BPH in rice and identified the sensitive wavebands specific to BPH damage. Further, by using the spectral data in MLR models it was possible to assess the BPH severity with reasonable degree of accuracy. This study demonstrates the feasibility of using hyperspectral radiometry to assess area-wide assessment of BPH damage in rice.

References

INGER Genetic Resources Center. 1996. Standard evaluation of system for rice. Manila (Philippines): International Rice Research Institute. 20 p.

Kumar S, Singh H, Patel A, Patel JN, Kant C. 2022. Brown plant hopper, *Nilaparvata lugens* (Stal) (Insecta: Delphacidae) a major insect of rice in India: A review. Journal of Entomological Research. 46(2): 333-338.

Prasannakumar NR, Chander S, Sahoo RN, Gupta VK. 2013. Assessment of Brown Planthopper, (*Nilaparvata lugens*) [Stål], damage in rice using hyperspectral remote sensing, International Journal of Pest Management, 59(3): 180-188.

Yang CM, Cheng CH, Chen RK. 2007. Changes in spectral characteristics of rice canopy infested with brown plant hopper and leaf folder. Crop Sci. 47:329–335.

ICSCI 2022/T2/76

Identification of resistant Samba Mahsuri mutants and mutant derivatives against brown plant hopper, *Nilaparvata lugens*

Pradeep Goud Ayeella, Madhavilatha Kommana, Vamshi P, Sumeeth C, Ganesh Ch, Sravan M, Prashanth Varma E, Sandeep K, Nakul D Magar, Kalyani M Barbadikar, Jhansi Lakshmi and K, Sheshu Madhav M*

ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad-500030, India

Email: sheshu24@gmail.com

Introduction

The brown plant hopper (BPH) (*Nilaparvata lugens* Stål) is one of the most devastative insect pests, causing an economic yield loss varying from 20% to 80%. In rice, BPH causes "hopper burn" directly by sucking xylem and phloem tissues, and indirectly causes diseases such as "grassy stunt virus" and "ragged stunt virus" by transmitting plant viruses (Cheng *et al* 2013). Chemical insecticides like imidacloprid is used to control, which is most expensive as well as hazardous to health and environment. This leads to the development of insecticide resistant BPH biotypes by killing natural predators (Tanaka *et al* 2000). Way to overcome chemicals is through developing genetic resistance. Hence the present investigation is carried out for screening of BPT5204 mutants and mutant derivatives for BPH tolerance which can be used for further breeding programmes.

Methodology

Screening of stable EMS treated mutant lines for BPH was performed during *kharif*-2022 in the standard seed box screening test in three replications. The varieties TN-1 and PTB-33 were used as susceptible and tolerant checks respectively. Sprouted seedlings were kept in seed box and were allowed to grow to two-leaf stage. Then the cultured second/third instar BPH nymphs were introduced into the seed boxes through patting. The nymphal population should be @ approximately 8–10 nymphs for each seedling. Then the nymphs are allowed to feed on seedlings till the susceptible check (TN-1) gets completely dried which will take approximately 10-12 days. Once TN-1 is completely wilted the tests were terminated and the damage of all individual seedlings in box was scored according to Standard Evaluation Scale (SES), IRRI (Gopi *et al* 2021).

Results

During *kharif*-2022, in the standard seed box screening test, the mutants and mutant derived lines showed a significant difference for resistance to BPH varying from 0.0 to 4.1. A total of 64 stabilized mutants, wild type (BPT-5204) and 15 mutant derivatives were screened against BPH in three replications. The wild type (BPT-5204) showed susceptible (9.0 score) response. Out of 64 mutants screened, seven were resistant and six were moderately resistant. Among 15 mutant derivatives one line (SP-M-MS-70) showed immune response and two were moderately resistant.

High yielding mutant derivative SP-M-MS-70 showed zero damage percentage. Mutants TI-112 and TI-113 were resistant to BPH having 2.1 and 2.4 score and possessing complete panicle exsertion (CPE) trait, while wild type (BPT 5204) is having incomplete panicle exsertion. TI -112 also has better root system architecture (Aerobic condition) (IIRR, Newsletter, 2020). TI -139 showed resistance to BPH with a 2.4 score along with leaf folder resistance (Javvaji *et al* 2021). TI-140 has a long slender grain type with a better yield and showed 3.3 score against BPH.

Table 1: **Mean damage (caused by *Nilaparvata lugens)* score of Mutants and its derivatives**

S.No	Entry	SCORE
	PTB-33	Resistance Check
	TN-1	Susceptible check
1	SP-M-MS-70	0.0
2	TI-112	2.1
3	TI-139	2.4
4	TI-113	2.4
5	TI-140	3.3
6	TI-145	3.6
7	TI-41	4.0
8	TI-40	41

Conclusion

Mutation breeding generated a mega variability which has helped in developing resistance against BPH. The resistant lines can be utilized as donor parents in marker-assisted breeding programs to introgress the trait into the high-yielding susceptible cultivars for increasing rice productivity.

References

Cheng XY, Zhu LL, He GC. Towards understanding of molecular interactions between rice and the brown planthopper. Mol Plant.2013; 6: 621–634.

Tanaka K, Endo S, Kazano H. 2000. Toxicity of insecticides to predators of rice planthoppers: Spiders, the mirid bug and the dryinid wasp. Appl Entomol Zool, 35(1): 177-187.

Potupureddi Gopi, Balija V, Ballichatla S, C. G. G, Awalellu K, Lekkala S, et al. (2021) Mutation resource of Samba Mahsuri revealed the presence of a high extent of variations among key traits for rice improvement. PLoS ONE 16(10): e0258816.

Sumalatha Javvaji, Uma Maheswari Telugu, Ramana Damarla Bala Venkata, Maganti Sheshu Madhav, Santhosha Rathod & Padmavathi Chintalapati. 2021. Characterization of resistance to rice leaf folder, Cnaphalocrocis medinalis, in mutant Samba Mahsuri rice lines. *Entomologia Experimentails et Applicata*. 1-17. 10.1111/eea.13082.

ICSCI 2022/T2/77

Estimation of total protein and protein classes of promising EMS Samba Mahsuri mutants

N. Siromani[1], G. Niharika[2], B. Suneel[1], M Sheshu Madhav[1], D. Sanjeeva Rao[*]
[1]. ICAR-Indian Institute of Rice research, Rajendranagar, Hyderabad-500030, India
[2.]G. Niharika, Assistant Professor, Department of Food Science and Technology, GITAM University, Hyderabad
Email: sraodurbha@gmail.com

Introduction

Rice is the most important cereal crop of the world's population. Carbohydrates are the major source of energy in human diet. Rice is easily digestible, rich source of starch followed by proteins and lipids as major components. In addition, it also contains minerals, vitamins and simple sugars in small amounts. Pre-germinated brown rice has protein two times more than white rice *i.e.*, 14.6 g/100 g (brown rice) vs 7.3 g/100 g (white rice). Rice proteins are present in storage organelles called as protein bodies (PBs) that are located in outer coatings (bran) of the starchy endosperm and the germ. PB are of two types namely type I (PB-I) and type II (PB-II). PB-I has a lamellar structure, is spherical in shape and is rich in prolamin, whereas PB-II has a crystalline structure, displays an irregular shape and contains predominantly glutelin (Bechtel and Juliano, 1980). Endosperm storage proteins comprise 60-65 % of PB-II, 20-25 % of PB-I and 10-15 % albumin and globulin in the cytoplasm (Ogawa *et al.* 1987).

Rice proteins are categorized into albumin (water-soluble), globulin (salt-soluble), glutelin (alkali/acid-soluble), and prolamin (alcohol-soluble) according to their solubility (Osborne 1924). Albumin and globulin exist in the outer layers of the brown rice amounting to 4-22 % and 5-13 % of total protein respectively (Hoogenkamp, 2017). Glutelin (oryzenin) and prolamin constitute 80 % and 20-25 % of rice endosperm protein respectively. The biological value of rice protein was higher than of most other cereal proteins. The lysine content of rice protein is higher than other staple cereals. Rice protein is rich in glutamine and aspargine like other cereal proteins.

Varieties like SambaMasuri, Swarna, IR64, PusaBasmati1121,etc.are popular among consumers and farmers. Among the non-aromatic rice with medium slendergrain type, SambaMahsuri is highlypopularin Southern and Eastern parts ofIndia. Itholdshighest acreage inthestatesof Andhra Pradesh, Telangana, Tamilnadu and Karnataka.Itshowsbestcooking quality withgoodyield. Many breeding programmes aimed to reach similar cooking quality by using Samba mahsuri as one of the parents or subjecting it to mutagenesis to get better yield with same cooking quality. Hence EMS Samba Mahsuri mutants are screened for Protein and Protein classes. Considering the above, EMS Samba Mahsuri mutants were developed and the best mutant lines were screened for total protein content and protein categories.

Methodology

Samba Mahsuri ethyl methane sulphonate (EMS) mutant lines were developed jointly by IIRR and CCMB. Based on the morphological and yield parameters, 98 mutants were selected for evaluating total protein content. Total proteins and their classes were extracted by Lowry *et al.* (1951) method.

Results

In the 98 promising mutant lines, total protein content ranged from 1.9% to 11.4%. Two mutant lines viz. TI-128 and TI-60 noted the highest total protein content of 11.4%, followed by TI-40 (10.3%), TI-3 (10%) and TI-49 (9.6%). Among the protein categories, globulins were at the highest concentration followed by glutelins, albumins and prolamines. Globulins content ranged from 1.4% (TI-60) to 10.3% (BB-134). Glutelins ranged from 0.08% (SM-70) to 8% Albumin content range from 0.37% (TI-41) to 3.12% (TI-48). Prolamines ranged from 0.0076% (TI-27) to 0.25% (TI-4 & TI-10). The two mutant lines TI-128 and Ti-60 noted protein content higher than the threshold value (≥10.0%) of AICRIP biofortification trial.

Conclusion

Two mutant lines TI-128 and TI-60 were found promising for total protein content.

References

Bechtel, D. B and Juliano, B. O. 1980. Formationofproteinbodiesinthestarchyendosperm of rice (*Oryza sativa* L.): A re-investigation. *Annals of Botany*.45: 503-509.

Cagampang, G.B., Cruz, L.J., Espiritu, S.G., Santiago, R.G and Juliano, B.O. 1966. Studiesonthe extractionand composition of rice proteins. *Cereal Chemistry*.43: 145.

Day, L. 2013. Proteins from land plants – potential resources for human nutrition and foodsecurity. *Trends in Food ScienceTechnology*.32:25-42.

Eggum, B.O., Juliano, B.O., Perez, C.M and Acedo, E.F.1993.The resistant starch, undigestible energy and undigestible protein content sofraw and cooked milled rice. *Journal of Cereal Science*.18(2): 159-170.

Juliano, B.O. 1972. Physico-chemical properties of starch and protein and their relation tograin quality and nutritional value of rice. International Rice Research Institute RiceBreeding(Proceedings ofSymposiumLosBaños).389-405.

Lowry, O.H., Rsenbrough, N.J., Farr, A. L and Randall, R.J. 1951.Protein measurement with the Folin Phenol Reagent.*Journalof BiologicalChemistry*. 193:265-275.

ICSCI 2022/T2/78

High protein rice variety Gujarat Rice-23 (Navsari Paushtik) for cultivation in Gujarat

P. B. Patel, K. S. Mungra, V. A. Patil and P. B. Patel
Main Rice Research Centre, NAU, Navsari, 396450, Gujarat, India
Email: pbp_swm@nau.in

Introduction

Rice is the staple food and main source of nutrition for about 50% world and 70% of Indian population. Protein malnutrition is predominant in Asia and Africa. Although rice is deficient in protein (6-8%), due to the higher digestibility and better nutritive value of glutelins, major fraction of seed protein of rice is nutritionally superior to other cereals (Juliano, 1985). Therefore, the impact of increasing the protein content in rice would be enormous, particularly in the scenario where more than one-third of world's children are affected by protein-energy malnutrition (EM). In addition, rice protein content (RPC) can also affect the physico-chemical properties of cooked rice (Hamaker & Griffin, 1991). Therefore, enhancing RPC has increasingly become one of the main breeding objectives in improving rice nutritional quality. Substantial variation for RPC has been detected among indica varieties with a range from 4.9 to 19.3 per cent and japonica varieties from 5.9 to 16.5% (Lin *et al*., 1993), and this variation has been shown to be quantitatively inherited (Shi *et al*., 1999). The Major objective of the current experiment was to develop high yielding biofortified (high protein and zinc-containing) rice variety.

Methodology

Hybridization was carried out between IET-19384 and NAUR-1 at Main Rice Research Centre, Navsari Agricultural University, Navsari, Gujarat during 2008-09. The proposed culture GR-23 (Navsari Paushtik) was bulked during *kharif*-2013. The male parent NAUR-1 is a cross between GR-4 and IET-1750. The female parent IET-19384, is a cross between AD93019 and ADT41. The variety GR-23 (Navsari Paushtik) was bulked in its F_5 generation and evaluated for its performance in a *kharif* season from 2014 to 2021 in the preliminary evaluation trial (PET), small scale varietal trials (SSVT) and large-scale varietal trial (LSVT) trials at different locations under transplanted field condition of Gujarat under supervision and guidance of authors of Main Rice Research Centre, NAU, Navsari. The yield data of various trials were statistically analyzed according to Panse and Sukhatme (1967).

Results

The biofortified rice variety GR-23 (Navsari Paushtik) was evaluated at different locations in Gujarat. The performance of GR-23 (Navsari Paushtik) at different locations of Gujarat is presented in table-1, where it exhibited 5584 kg/ha grain yield on overall basis with grain yield advantage of 25.3, 37.6, 10.9 and 12.9 % over the check varieties GNR-2, GR-11, GAR-13 and GNR-7, respectively under irrigated transplanted condition (Table-1). The variety was nominated in AICRIP trial under the bio-fortified group during *kharif*-2017 where it recorded 6223 kg/ha grain yield with yield advantage of 28.0, 20.8, 66.7 and 51.7% over BPT 5204 (NC), IR 64 (YC), Kalanamak (MNC1) and Chittimuthyalu (MNC2), respectively (Anon, 2017).

Table 1. Comparative performance of rice culture GR-23 in Gujarat

Expt. and Year	Location	Grain yield (kg/ha)					S. Em±	CD at 5%	CV %
		GR-23	GNR-2[a](C)	GR-11[b] (C)	GAR-13[c] (C)	GNR-7[d] (C)			
PET, 2014	Navsari	5500	4431				432	1220	16.3
	Mean	**5500**	**4431**						
	% Increase over		**24.1**						
SSVT, 2015	Navsari	6718[a]	4962				228	643	7.1
	Vyara	7499[a]	5081				398	1121	12.2
	Waghai	2972	3000				175	493	9.4
	Mean	**5730**	**4348**						
	% Increase over		**31.8**						
LSVT-Fine, 2016	Navsari	4766	4929				220	633	7.8
	Vyara	5312	6323				446	1281	14.1
	Waghai	6524[a]	4160				347	997	10.7
	Bardoli	4444	4733				280	860	10.1
	Mean	**5262**	**5036**						
	% Increase over		**4.5**						
LSVT - ML- F-II, 2017	Navsari	5158[b]	4996	3843	4988		267	763	9.0
	Waghai	5182[abc]	3846	3584	3781		157	449	6.9
	Nawagam	5152[ab]	3495	3136	5780		349	995	12.7
	Dabhoi	5019	4567	4697	5120		329	940	10.7
	Mean	**5128**	**4226**	**3815**	**4917**				
	% Increase over		**21.3**	**34.4**	**4.3**				
LSVT - ML - Fine, 2018	Navsari	6228[abc]	5099	4466	4904		341	966	10.3
	Vyara	7772[abc]	4769	4479	4744		364	1031	12.8
	Nawagam	5012[ab]	3040	3230	5115		252	712	9.7
	Dabhoi	7114[ab]	6236	6231	6829		265	750	6.9
	Mean	**6532**	**4786**	**4602**	**5398**				
	% Increase over		**36.5**	**41.9**	**21.0**				
LSVT – ML-Fine, 2019	Navsari	5119	5078	4685	5048	5283	333	947	10.7
	Vyara	4194[abcd]	2084	2630	3071	2856	248	705	13.3
	Nawagam	5159[ab]	3399	3641	4897	4267	431	1228	17.4
	Dabhoi	4714[a]	3620	3996	4402	4342	351	1025	11.3
	Mean	**4797**	**3545**	**3738**	**4355**	**4187**			
	% Increase over		**35.3**	**28.3**	**10.2**	**14.6**			
LSVT - ML - F-II, 2020	Navsari	5985[ab]	5217	4664	5280	5307	267	764	8.7
	Vyara	6734[abcd]	5539	5306	5530	5429	376	1077	12.1
	Nawagam	4672[b]	3814	3737	5171	4497	311	892	12.2
	Dabhoi	5821[abd]	4684	4818	5182	4504	228	652	8.3
	Mean	**5803**	**4814**	**4631**	**5291**	**4934**			
	% Increase over		**20.6**	**25.3**	**9.7**	**17.6**			

LSVT - ML - F- II, 2021	Navsari	6308[ab]	5116	3381	5414	5434	316	901	9.9
	Vyara	6460[abd]	3741	3884	5514	5063	335	955	12.1
	Nawagam	6033[b]	5527	4019	5942	5664	345	983	10.8
	Dabhoi	4786[ab]	3291	3419	4829	5812	355	1042	12.1
	Mean	**5897**	**4419**	**3676**	**5425**	**5493**			
	% Increase over		**33.4**	**60.4**	**8.7**	**7.3**			
Overall Mean (M1)		**5584**	**4456**						
Overall % increase over check			**25.3%**						
Overall Mean (M2)		**5631**		**4092**	**5077**				
Overall % increase over check				**37.6%**	**10.9%**				
Overall Mean (M3)		**5499**				**4872**			
Overall % increase over checks						**12.9%**			
Total number of frequency in a top non-significant group		18/28	4/28	0/20	3/20	3/12			

[a]Statistically superior than GNR-2; [b]Statistically superior than GR-11; [c]Statistically superior than GAR-13; [d]Statistically superior than GNR-7

Table 2. National Level [All India Coordinated trial (AICRIP)]

Expt. & year	Name of entry	Grain yield (kg/ha)	% increase over check			
			NC	YC	MNC1	MNC2
IVT-Biofort *Kharif-2017* (23 locations in 13 states)	**IET-27167 (GR-23)**	6223	28.0	20.8	66.7	51.7
	BPT 5204 (NC)	4862				
	IR 64 (YC)	5151				
	Kalanamak (MNC1)	3734				
	Chittimuthyalu (MNC2)	4103				
	CD at 5%	301				
IVT-Biofort *Kharif-2017* (4 locations in Zone VI)	**IET-27167 (GR-23)**	5257	30.1	10.5	51.0	26.8
	BPT 5204 (YC)	4040				
	IR 64 (YC)	4757				
	Kalanamak (MNC)	3482				
	Chittimuthyalu (MNC)	4145				
	CD at 5%	568				

Source: IIRR, Hyderabad Annual Progress Report, 2017 Vol. I- Varietal Improvement, Page No. 1.319-1.353.

Table-3. Grain quality characteristics of the GR-23

Sr. No.	Name of the culture	Protein content (%)	Zinc content (ppm)	Amylose content (%)	Hulling Recovery (%)	Milling recovery (%)	HRR (%)
1.	GR-23	12.18	20.4	24.80	80.1	68.30	60.80
2.	GNR-2 (C)	6.53	14.6	21.78	79.8	64.52	58.20
3.	GR-11 (C)	6.46	14.0	27.60	79.1	60.79	56.10
4.	GAR-13 (C)	6.52	15.6	27.60	79.9	66.04	58.61
5.	GNR-7 (C)	6.48	15.2	24.20	80.1	65.60	58.80

Table –4. Reaction of GR-23 against major diseases of rice

Year	Name of culture	BLB		ShR		GD		FSm		BL	
LSVT -ML- F-II, 2021(Protected)	**GR-23**	3		5		5		0		0	
	GNR-2	5		7		5		0		0	
	GR-11	7		7		5		0		0	
	GAR-13	5		5		7		0		0	
	GNR-7	5		5		5		0		0	
Disease Screening Nursery (Unprotected), 2019		NVS	NWG	NVS	NWG	NVS	NWG	NVS	NWG	NVS	NWG
	GR-23	5	1	3	0	5	0	0	-	3	1
	GNR-2	7	3	5	3	5	1	1	-	5	3
	GR-11	7	7	5	5	7	5	5	-	5	5
	GAR-13	7	1	5	1	5	0	0	-	5	1
	GNR-7	5	3	5	3	5	0	0	-	4	3

SES,2013

Table – 4. Reaction of GR-23 against major insect-pests of rice

Year	Name of culture	BPH(NVS)		SB		LF		ShM	
LSVT -ML- F-II, 2021 (Protected)	**GR-23**	0		0		0		0	
	GNR-2	0		1		1		0	
	GR-11	0		0		0		0	
	GAR-13	0		0		0		3	
	GNR-7	0		0		0		0	
Disease Screening Nursery (Unprotected), 2019		NVS	NWG	NVS	NWG	NVS	NWG	NVS	NWG
	GR-23	0	3	1	3	0	1	1	-
	GNR-2	0	5	5	5	1	1	7	-
	GR-11	0	5	7	7	7	1	3	-
	GAR-13	0	5	5	5	0	1	1	-
	GNR-7	0	5	3	3	5	1	1	-

SES,2013

It contains a high amount of protein content (12.18 %), an intermediate amount of zinc content (20.4 ppm), amylose content (24.80 %) and high head rice recovery (60.80%) as compared to checks GNR-2, GR-11, GAR-13 and GNR-7 (Table-3). The rice variety GR-23 is mid-tall in plant stature (125-135 cm plant height), medium in duration (125-130 days), non-lodging and non-shattering grain type. The variety GR-23 (Navsari Paushtik) possesses 8.05 mm grain length with 2.50 mm grain width and has a L/B ratio of 3.22 which is enough to categorize it in the medium slender grain group. GR-23 possesses a long panicle length (26.2-28.8 cm), more productive tillers (10-12) and more grains per panicle (290-320). The variety was tested for important pests and diseases of rice (Table 4 & 5), where it was found moderately resistant against bacterial leaf blight, grain discoloration, sheath rot and leaf blast. It showed a tolerant reaction against brown plant hopper, whereas moderately resistant reaction against stem borer, leaf folder and sheath mite.

Conclusion

Biofortified rice variety GR-23 (Navsari Paushtik) recorded an average grain yield of 5631 kg/ha in Gujarat, which was 25.3, 37.6, 10.9 and 12.9 % higher over the check varieties GNR-2, GR-11, GAR-13 and GNR-7, respectively. It has medium slender grains, a long panicle, more productive tillers and more grains per panicle. It contains high protein content (12.18 %), intermediate amount of zinc content (20.40 ppm) and amylose content (24.80 %) with high head rice recovery (60.80%). The variety is moderately resistant against bacterial leaf blight, grain discoloration and leaf blast diseases whereas tolerant reaction against brown plant hopper and leaf folder pests. The rice variety GR-23 (Navsari Paushtik) was recommended for cultivation in irrigated transplanted rice growing areas of Gujarat.

References

Anonymous 2017. Annual Progress Report Vol. I- Varietal Improvement, Indian Institute of Rice Research, Rajendranagar, Hydrabad1.319-1.353.

Hamaker, B. R. & V. K. Griffin, 1991. Potential influence of a starch granule- associated protein on cooked rice stickiness. *J. Food Sci.*, 56: 1327–1329.

Juliano, B.O., 1985. Rice Chemistry and Technology, 2nd edn. *American Association of Cereal Chemists*, St. Paul, Minnesota.

Lin, R., Y. Luo, D. Liu & C. Huang, 1993. Determination and analysis on principal qualitative characters of rice germplasm. In: C. Ying (Ed.), Rice Germplasm Resources in China, pp. 83–93. Agricultural Science and Technology Publisher of China, Beijing.

Panse V. G. and Sukhatme P. V., 1967. Statistical methods for agricultural workers, Publication and information division, Indian Council of Agricultural Research, New Delhi

SES 2013. Standard Evaluation System for Rice (5th Ed.). International Rice Research Institute, Manila, p:21. Retrieved from (*http://www.clrri.org/ver2/uploads /SES_5th_edition.pdf*) [Accessed on 15th May, 2020].

Shi, C. H., J. Zhu, X. E. Yang, Y. G. Yu & J. Wu, 1999. Genetic analysis for protein content in *indica* rice. *Euphtica* 107(2): 135–140.

ICSCI 2022/T2/79

Haplotype analysis for grain size candidate genes in a subset of 3K indica accession

Aparna Eragam, Chilkuri Sumeeth Reddy, Gireesha C, Kalyani M Barbadikar and M. Sheshu Madhav*

ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad-500030, India

Email: aparnareddy003@gmail.com

Introduction

Rice yield and quality are strongly influenced by two main factors such as grain size and weight, which are governed by the grain's three-dimensional structure (length, width, and thickness), as well as the level of grain filling. The size and weight of the grain have always been significant agronomic parameters for human care and selection in the context of crop domestication and artificial breeding. Several crucial genes that control grain form have been discovered in recent years (Zhang et al., 2012; Ishimaru et al., 2013). The developed genomic resources, particularly the re-sequencing of several germplasm lines, would enable the exploitation of genetic diversity by assisting in the discovery and exploration of allelic/haplotype variations. In the end, this would open the door to discovering novel donors and novel alleles linked to the desired qualities, which can be used to improve crops (Varshney et al., 2018). Allelic diversity for crucial genes may be found in the rice gene bank collections. The 3K RG re-sequencing effort has considerable potential in this regard for utilizing genomic variation in rice (Li et al., 2014). In this study, we used 273 Indian origin entries from the 3K Panel to analyse the haplotype diversity of about 25 potential genes that affect grain size features.

Methodology

The grain length (GL), grain width (GW), grain area (GA), grain perimeter (GP) and Length breath ratio (LB ratio) were performed using the image analyzer Biovis PSM-S2000 for 273 Indian origin accession from 3K Panel. The mean value of each genotype was used for haplo-pheno analysis. The Haplotype groups were identified by employing SNP seek database, Plink 1.09v and Haploview4.1 tools using non synonymous SNPs and other default parameters for k-group determination for selected candidate genes.

Results

In the current study, a diverse set of 3 K sub-panel of rice consisting of 273 Indian-origin accessions was evaluated for grain traits such as Grain length, Grain width that contributes grain size using the grain image analyzer Biovis PSM-S2000. Further, 25 cloned genes were selected for haplotype diversity analysis to identify the superior haplotypes for the target traits where haplotypes range from 2 (GW2- *Os02g0244100*, GS5- *Os05g0158500*, GL5- *Os05g0447200*) to 5 (GW8- *Os08g0531600*). Six of 25 genes viz. *OsGW2*, *GL5*, *GW7*, *GW8*, *GS9*, *SCP46*, showed significant differences between haplotypes for the governed trait. For grain weight, the candidate gene *OsGW2* encodes for a RING-type E3 ubiquitin ligase that maintains grain size showed two haplotype groups with one non-synonymous variation among 273 accessions. The gene *OsGL5* control grain length has two Haplogroup (C-Hap1; T-Hap2) and hap1 has a significantly higher grain length than Hap2. For the *OsGW7* control grain weight has two haplogroups (Hap1-TG, Hap2-CA) with significance at P>0.05 level. The gene *OsGW8* has five haplo group among hap5-CGTG showed significantly higher grain width followed by Hap3-CGGG and Hap1-AGTG. Another gene *OsGS9* controls grain width and length has two haplogroups (Hap1-TC, Hap2-CG) and for the traits grain length, Hap1 has significantly longer grain than Hap2. Another gene, *OsSCP46* gene controls grain width showed that hap3-TT (superior haplotype) has significantly higher grain weight than Hap1-CC and Hap2 TC. Superior haplotypes were identified for grain width genes such as *GW2* (Hap2-2.93mm), *GW7* (Hap-3.2mm) *GW8* (Hap5-3.3mm) and *SCP46* (Hap3-3.33mm) and for grain length genes such as GS9 (Hap2-10.1mm) respectively. In this investigation, we also identified better donors for Grain width (IC25690 with 3.45mm and ARC 11768 with 3.24 mm) and grain length (ARC 12490 with 13.23mm, Sufaldhula with 11.72mm and Synthetic sativa with 12.237 mm) among 273 Indian accessions.

Conclusion

The identified superior donors possessing superior haplotype combinations may be utilized in haplotype-based breeding to develop next-generation tailor-made high-yielding rice varieties.

References

Zhang X, Wang J, Huang J, Lan H, et al. (2012). Rare allele of OsPPKL1 associated with grain length causes extra-large grain and a significant yield increase in rice. Proc. Natl. Acad. Sci. USA 109: 21534-21539.

Ishimaru K, Hirotsu N, Madoka Y, Murakami N, et al. (2013). Loss of function of the IAA-glucose hydrolase gene TGW6 enhances rice grain weight and increases yield. Nat. Genet. 45: 707-711

Varshney, R.K., Singh, V.K., Kumar, A., Powell, W. and Sorrells, M.E. (2018) Can genomics deliver climate-change ready crops? *Curr.Opin.Plant Biol.* 45, 205– 211.

Li, J.-Y., Wang, J. and Zeigler, R.S. (2014) The 3,000 rice genomes project: new opportunities and challenges for future rice research. *Gigascience*, 3, 8.

ICSCI 2022/T2/80

High zinc rice variety Gujarat Rice-15 (GR-15) for cultivation in Gujarat

K. S. Mungra, P. B. Patel, V. A. Patil and P. D. Ghoghari
Main Rice Research Centre, SWMRU, NAU, Navsari,396450 Gujarat, India
Email: ksmungra@nau.in

Introduction

Rice is the dominant cereal crop in many developing countries like India and is the staple food for more than half of the world's population. Currently, polished rice contains an average of only 2 parts per million (ppm) iron (Fe) and 12 ppm of zinc (Zn). In many Asian countries, rice provides 50-80 per cent of the energy intake of the poor but it does not provide enough essential micronutrients to eliminate "hidden hunger", in particular iron deficiency anemia (IDA) and zinc deficiency. In many of these same Asian countries, IDA affects nearly 60 per cent of the population. Worldwide Micronutrient malnutrition, and particularly Fe and Zn deficiency affect over three billion people worldwide, mostly in developing countries (Sperotto *et al.* 2010). Because of the high per capita consumption of rice in Asian countries, improving its nutritive value by increasing iron and zinc levels in the grain can have significant positive health outcomes for millions of people. Today the problem of micronutrient malnutrition in rice consuming countries is widely recognized. Currently iron, vitamin-A and zinc deficiency has been identified as major health hazards associated with a rice based diet. Over 300 enzymes in our body use zinc as an essential component in their action. Zinc is essential in supporting our immune system, in synthesizing (and degrading) DNA, in wound healing and several other activities. Zinc deficiency causes growth retardation, causes diarrhea, hair loss, lack of appetite, hypogonadism, immune dysfunction, cognitive impairment and other health issues (Prasad 2013). An estimated 17.3% of the world's population is at risk of inadequate zinc intake (Wessells *et al.* 2012). In Gujarat, rice occupies about 5% gross cropped area and it is being grown in 6.5 to 7.0 lakh hectares. Rice is a staple food in the tribal belts of the state. Main objective of experiment was to provide nutritional (high zinc) rich rice variety through bio-fortification.

Methodology

Hybridization was carried out between Bhura rata x NAUR-1 at Main Paddy Research Station, Soil and Water Management Research Unit, Navsari Agricultural University, Navsari, Gujarat during 2005-06. Proposed culture GR-15 was bulked from the advanced generation in the year 2011. The male parent NAUR-1 is a cross between GR-4 and IET-1750. The female parent Bhura Rata having high zinc content, is a introduced from Maharashtra state. The variety GR-15 was bulked in its F_6 generation and evaluated for its performance in a *kharif* season from 2012 top 2017 in the preliminary evaluation trial (PET), small scale varietal trials (SSVT) and large scale varietal trial (LSVT) trials at different locations under transplanted field condition of South Gujarat and Middle Gujarat under supervision and guidance of authors of Main Rice Research Centre, NAU, Navsari. The yield data of various trials were statistically analyzed according to Panse and Sukhatme (1967).

Results

GR-15 (Bhura Rata x NAUR-1) was evaluated at different locations of South Gujarat and Middle Gujarat. The performance of GR-15 at different locations presented in table-1, where it exhibited 5540 kg/ha grain yield on overall basis with grain yield advantage of 10.6, 19.9 and 16.1 % over the check varieties Dandi, NAUR-1 and GNR-3, respectively under irrigated transplanted condition. The variety was nominated in AICRIP trial under bio-fortified group during *kharif*-2015 where it recorded 5269 kg/ha grain yield with yield advantage of 10.4 and 1.2% over MTU 1010 (NC) and Akshyadhan (ZC), respectively (Anon, 2015) and promoted to AVT 1-IME. Proposed variety tested in AVT 1-IME during kharif-2016 and recorded 5339 kg/ha grain yield with yield advantage of 10.3 and 9.0% over IR-64 (NC) and Karjat-7 (ZC) (Table-2) (Anon, 2016).

GR-15 contains high amount of zinc content (21.58 ppm), intermediate amount of amylose content (24.81 %), good amount of protein content (5.48%)and high head rice recovery (61.2%) as compared to checks GNR-2, GR-11, GAR-13 and GNR-7 (Table-3). The rice variety GR-15 is mid tall in plant stature (125-135 cm plant height), medium in duration (125-130 days), non-lodging and non-shattering grain type. The variety GR-15 posses 8.5 – 8.8 mm kernel length with 2.19 mm kernel breath and having L/B ratio of 2.76 which is enough to categorized it in long bold group. GR-15 possess long panicle length (27-29 cm), more productive tillers (9-11) and a greater number of grains per panicle (260-280). The variety was tested for important pest and diseases and pets of rice under protected condition as well as under unprotected condition at Main Rice Research Centre, Navsari (Table 4 & 5)), where it found moderately resistant against bacterial leaf blight, grain discoloration, sheath rot and leaf blast. It showed tolerant reaction against brown plant hopper, whereas moderately resistant reaction against stem borer, leaf folder and sheath mite.

Table –1. Comparative performance of Rice culture GR-15 in Gujarat

Expt. and Year	Location	Grain yield (kg/ha)				CD at 5%	CV %
		GR-15	Dandi(C)	NAUR-1(C)	GNR-3(C)		
PET, 2012	Danti	6952[b]	5857	5286	-	1517	12.9
	Navsari	6357	5583	5333	-	1326	11.9
	Mean	**6655(2)**	**5720(2)**	**5310(2)**	**-**		
	% Inc. over		**16.3**	**25.3**	**-**		
SSVT, 2013	Danti	5649	6746	5736	6356	839	7.9
	Hansot	2929[abc]	2255	1986	1919	424	6.1
	Nawagam	4092[c]	3497	4241	2381	1038	9.8
	Mean	**4223(3)**	**4166(3)**	**3988(3)**	**3552(3)**		
	% Inc. over		**1.4**	**5.9**	**18.9**		
LSVT, 2014	Danti	4903	5350	5220	5408	857	10.8
	Hansot	6595[c]	6321	5437	5067	1181	12.2
	Nawagam	5802[ac]	4568	4630	4506	1242	12.3
	Mean	**5767(3)**	**5413(3)**	**5096(3)**	**4994(3)**		
	% Inc. over		**6.5**	**13.2**	**15.5**		
LSVT, 2015	Navsari	6009[abc]	5081	4592	5224	557	6.3
	Umbharat	6584[ab]	5231	5233	5718	914	9.7
	Danti	5610[ab]	4841	4852	5855	748	9.2

	Hansot	5878[ab]	5186	4997	5745	684	7.6
	Nawagam	4613[bc]	5208	3795	3571	596	9.7
	Mean	**5739(5)**	**5109(5)**	**4694(5)**	**5223(5)**		
	% Inc. over		**12.3**	**22.3**	**9.9**		
LSVT, 2016	Umbharat	5954[ab]	4899	4955	5170	937	11.0
	Danti	5745[bc]	5249	4403	4637	788	10.0
	Hansot	5900	5589	4472	4576	1446	17.1
	Mean	**5866(3)**	**5246(3)**	**4610(3)**	**4794(3)**		
	% Inc. over		**11.8**	**27.3**	**22.4**		
LSVT,2017	Navsari	5284[ab]	4213	4054	5084	814	10.6
	Vyara	4885[bc]	4325	3387	3536	845	12.5
	Danti	5023[bc]	4752	4108	4416	676	9.2
	Umbharat	4931	4808	4299	4355	1198	16.0
	Hansot	4832	3965	4285	4328	930	13.3
	Mean	**4991(5)**	**4413(5)**	**4027(5)**	**4344(5)**		
	% Inc. over		**13.11**	**23.95**	**14.90**		
Over all Mean		**5540**	**5011**	**4621**			
Over all % increase over checks			**10.6 %**	**19.9 %**			
Over all Mean		**5317**			**4581**		
Over all % increase over check					**16.1 %**		
Total number of frequency in top non-significant group		16/21	2/21	1/21	2/19		

(Figure in parenthesis indicates number of trials); a - Statistically superior than Dandi, b - Statistically superior than NAUR-1 , c - Statistically superior than GNR-3

Table-2. Performance of IET- 25336 (GR-15) under IVT-IM and AVT-1-IME trials at National Level (All India Coordinated trial (AICRIP)- 26 locations)

Expt. & year	Name of entry	Grain yield (kg/ha)	% increase over	
			National check	Zonal check
IVT-IM *Kharif-2015*	**IET-25336 (GR-15)**	**5269**	10.4	1.2
	MTU 1010 (NC)	4772		
	Akshayadhan (ZC)	5204		
AVT-1-IME *Kharif-2016*	**IET-25336 (GR-15)**	**5339**	10.3	9.0
	IR-64 (NC)	4841		
	Karjat-7 (ZC)	4896		

Source: IIRR, Hyderabad Annual Progress Report, 2015 Vol. I- Varietal Improvement, IIRR, Hydrabad, Page No. 1.143-1.154 and IIRR, Hyderabad Annual Progress Report, 2016 Vol. I- Varietal Improvement, IIRR, Hydrabad, Page No. 1.121-1.133.

Table-3. Grain quality characteristics of the culture GR-15.

Name of Character	GR-15	Dandi (C)	NAUR-1 (C)	GNR-3(C)
Zn content (ppm)	21.58	12.7	14.62	15.7
Protein content (%)	5.48	4	4.3	5.52
Amylose content (%)	24.81	22.76	24.6	21.6
Hulling recovery (%)	78.2	74.2	77.1	77.2
Milling recovery (%)	72	70	66.9	74.9
Head rice recovery (%)	61.2	60	58.8	64

Table – 4. Reaction of GR-15 against major diseases of paddy (Protected and Unprotected field condition)

ear	Name of culture	BLB	LB	GD	FSm	ShR
LSVT, 2017 (Protected)	**GR-15**	3	0	3	0	3
	Dandi	3	0	3	0	3
	NAUR-1	3	0	5	0	7
	GNR-3	3	0	5	0	3
Disease Screening Nursery (Unprotected), 2017	**GR-15**	3	1	3	0	3
	Dandi	5	3	3	0	7
	NAUR-1	5	3	7	0	5
	GNR-3	5	3	5	0	7

Table – 5. Reaction of NVSR-6121 against major insect-pests of paddy (Protected and Unprotected field condition)

Year	Name of culture	BPH (NVS)	SB	LF	ShM
LSVT, 2017 (Protected)	**NVSR-6121**	0	3	3	3
	Dandi	0	3	1	1
	NAUR-1	0	1	3	3
	GNR-3	0	1	1	3
Disease Screening Nursery (Unprotected), 2017	**NVSR-6121**	0	1	3	5
	Dandi	0	1	3	0
	NAUR-1	0	1	3	1
	GNR-3	0	1	3	1

Conclusion

Biofortified rice variety, GR-15 (5540 kg/ha) performed very well in Gujarat state and it exhibited overall 10.6 %, 19.9 % and 16.1 % grain yield superiority with easy threshability over the checks Dandi, NAUR-1 and GNR-3, respectively. It has long bold grain, long panicle, more productive tillers and more number of grains per panicle. It contains high zinc in grains (21.58 ppm) than check varieties (Dandi:12.7 ppm, NAUR-1: 14.62 and GNR-3: 15.7 ppm) along with other good quality characters. GR-15 is moderately resistant against bacterial leaf blight, grain discoloration and sheath rot. It is tolerant to brown plant hoppers and moderately resistant to stem borer, leaf folder and sheath mite. This variety GR-15 recommended for transplanted rice growing areas of Gujarat.

References

Anonymous 2015. Annual Progress Report Vol. I- Varietal Improvement, Indian Institute of Rice Research, Rajendranagar, Hydrabad, 1.143-1.154.

Anonymous 2016. Annual Progress Report Vol. I- Varietal Improvement, Indian Institute of Rice Research, Rajendranagar, Hydrabad, 1.121-1.133.

Panse V. G. and Sukhatme P. V., 1967.Statistical methods for agricultural workers, Publication and information division, Indian Council of Agricultural Research, New Delhi.

Sperotto, R. A., T. Boffa, G. L. Duartea, L. S. Santosb, M. A. Grusakc and J.P. Fett. 2010. Identification of putative target genes to manipulate Fe and Zn concentrations in rice grains. *J. Plant Physiol.*, 167:1500–1506.

SES 2013.Standard Evaluation System for Rice (5th Ed.). International Rice Research Institute, Manila, p:21. [Accessed on 15th May, 2020].

Prasad A. S. 2010. Discovery of human zinc deficiency: its impact on human health and disease. *Adv Nut*r., 1;4(**2**):176-90.

Wessells K. R., Brown K. H. 2012. Estimating the global prevalence of zinc deficiency: results based on zinc availability in national food supplies and the prevalence of stunting.*PLoS One*, 7(**11**):e50568.

ICSCI 2022/T2/81

Sublethal phosphine fumigation induces transgenerational hormesis in a factitious host, *Corcyra cephalonica*: Mechanisms and prospects for mass-rearing of parasitoid, *Habrobracon hebetor*

Basana Gowda G[1]*, Anshuman Nath[2], Ravi Prakash Maurya [2], Naveenkumar B Patil[1], Totan Adak[1], Guru Pirasanna Pandi G[1], Aishwarya Ray[1,3], Annamalai Mahendiran[1], Prakash ChandraRath[1]

[1] *Crop Protection Division, ICAR-National Rice Research Institute, Cuttack, Odisha, 753006, India*
[2] *Department of Entomology, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar-263145 (U.S. Nagar), Uttarakhand, India.*
[3]*Department of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chattisgarh, 492001, India*
E-mail: basanagowda.g@icar.gov.in

Introduction

Hormesis is well documented in pest insects, but for natural enemies of pests, limited efforts have been made. Chemicals that kill and harm insects at higher doses can stimulate certain biological processes in insects at lower doses (Guedes and Cutler 2014; Guedes et al. 2022). This biphasic dose-response condition of high-dose inhibition and low-dose stimulation during or after toxicant exposure is called hormesis (Calabrese and Baldwin 2003).

Methodology

Sublethal (LC_5), low lethal (LC_{25}), and median lethal (LC_{50}) phosphine concentrations, as well as untreated control, on the biological characteristics of *C. cephalonica* over two generations (G1- first-generation and G2- second generation) was studied. Parental generation (G0) was treated and exposure consequence in successive unexposed generations (G1 and G2) was studied. The total protein, total lipids, and total carbohydrates reserves of *C. cephalonica* were estimated using standard methods. The larval body volatiles of *C. cephalonica* larvae were extracted using Solvent assisted extraction (SAE) method and orientation of *H. hebetor* using a 2-arm 'Y' type glass olfactometer was studied (Pezzini et al. 2020). Metagenomic sequencing of sublethal phosphine treated *C. cephalonica* larval gut microbiome was also carried to understand gut microbiome of different concentrations of phosphine treated larvae.

Results

Stimulatory effects were observed for different biological traits of *C. cephalonica* like the adult duration, oviposition days, moth emergence, and increased egg hatchability whenexposed to LC_5 of phosphine (Table 1). The total protein, lipid, and carbohydrate contents of *C. cephalonica* were also found to be significantly influenced by LC_5 in both generations. GC-MS characterization of larval body volatile profile revealed 10, 16, 10 and 15 compounds specific to LC_5, LC_{25}, $LC_{50,}$ and untreated control treatments, respectively. Parasitoid, *H. hebetor* made the significant number of entries towards larval body extract and spent the highest time when compared to untreated control for all the treatments. The microbial diversity of LC_5 treated larval gut was higher and found to be different from the rest of the treatments. This is the first study to show that hormesis to fumigant insecticide.

Table 1. Sublethal effects of phosphine on the developmental and population parameters of *C. cephalonica*

Developmental parameters							
Developmental parameters	**Generations**	**Mean ±SE *, #**					
		C	**LC_5**	**C**	**LC_{25}**	**C**	**LC_{50}**
Egg period (days)	G1	3.2 ± 0.2**Aa**	3 ± 0.31**Aa**	3.2 ± 0.2**Aa**	3.6 ± 0.24**Ba**	3.2 ± 0.2**Ab**	4 ± 0.31**Ba**
	G2	3.6 ± 0.24**Aa**	2.6 ± 0.24**Ab**	3.6 ± 0.24**Ab**	5.6 ± 0.6**Aa**	3.6 ± 0.24**Ab**	6.2 ± 0.37**Aa**
Larval period (days)	G1	25.4 ± 0.51**Aa**	24.6 ± 0.51**Aa**	25.4 ± 0.51**Aa**	26.6 ± 0.81**Ba**	25.4 ± 0.51**Ab**	27.8 ± 0.58**Ba**
	G2	25 ± 1.30**Aa**	23.8 ± 0.91**Aa**	25 ± 1.30**Ab**	32.8 ± 0.58**Aa**	25 ± 1.30**Ab**	33.6 ± 1.16**Aa**
Pupal period (days)	G1	7.8 ± 0.37**Aa**	7 ± 0.15**Ab**	7.8 ± 0.37**Ab**	9 ± 0.31**Aa**	7.8 ± 0.37**Ab**	9.4 ± 0.74**Aa**
	G2	7 ± 0.31**Aa**	6.4 ± 0.24**Ba**	7 ± 0.31**Aa**	7.5 ± 0.28**Ba**	7 ± 0.31**Ab**	9 ± 0.44**Aa**
Pre-adult period (days)	G1	36 ± 0.70**Aa**	34 ± 0.70**Ab**	36 ± 0.70**Ab**	39.2 ± 1.2**Ba**	36 ± 0.70**Ab**	41.2 ± 0.73**Ba**
	G2	36 ± 1.30**Aa**	33.4 ± 0.87**Aa**	36 ± 1.30**Ab**	45 ± 1.36**Aa**	36 ± 1.30**Ab**	48.8 ± 1.24**Aa**
Adult longevity (days)	G1	9.6 ± 0.24**Ab**	11 ± 0.44**Ba**	9.6 ± 0.24**Aa**	9.8 ± 0.37**Aa**	9.6 ± 0.24**Aa**	8 ± 0.31**Ab**
	G2	10 ± 0.31**Ab**	12.8 ± 0.66**Aa**	10 ± 0.31**Aa**	7 ± 0.70**Bb**	10 ± 0.31**Aa**	7.6 ± 0.4**Ab**
APOP (days)	G1	0.5 ± 0.05**Aa**	0.5 ± 0.08**Aa**	0.5 ± 0.05**Aa**	0.5 ± 0.03**Aa**	0.5 ± 0.05**Aa**	1.00 ± 0.75**Aa**
	G2	0.67 ± 0.30**Aa**	0.34 ± 0.03**Aa**	0.67 ± 0.30**Aa**	0.34 ± 0.31**Aa**	0.67 ± 0.30**Aa**	0.67 ± 0.30**Aa**
TPOP (days)	G1	36.00 ± 2.28**Aa**	34.00 ±1.52**Aa**	36.00 ± 2.28**Aa**	41.00 ±2.28**Aa**	36.00 ± 2.28**Aa**	42.00 ± 2.28**Ba**
	G2	37.33 ± 1.08**Aa**	35.33 ± 0.30**Aa**	37.33 ± 1.08**Ab**	45.67 ±1.56**Aa**	37.34 ± 1.08**Ab**	51.34 ±0.79**Aa**
Oviposition days	G1	5.00 ± 0.25**Aa**	5.00 ± 0. 37**Ba**	5.00 ± 0.25**Aa**	5.67 ± 0.60**Aa**	5.00 ± 0.25**Aa**	5.67 ± 0.30**Aa**
	G2	5.67 ± 0.63**Aa**	6.00 ± 0.37**Aa**	5.67 ± 0.63**Aa**	3.00 ± 0.38**Bb**	5.67 ± 0.63**Aa**	3.00 ± 0.76**Bb**
Fecundity (offspring/individual)	G1	234.67 ± 0.34**Ba**	240 ± 0.577**Ba**	234.67 ± 0.34**Ba**	232.5 ± 2.5**Aa**	234.67 ±0.34**Ba**	201.67 ±2.02**Ab**
	G2	314.00 ± 2.0**Ab**	330.00 ± 2.0**Aa**	314.00 ± 2.0**Aa**	165.67±1.20**Bb**	314.00 ± 2.0**Aa**	133.00 ± 2.0**Bb**
Population parameters							
***r* (d^{-1})**	G1	0.11 ± 0.009**Aa**	0.12 ± 0.006**Aa**	0.11 ± 0.009**Aa**	0.10 ± 0.01**Aa**	0.11 ± 0.009**Aa**	0.09 ± 0.01**Aa**
	G2	0.13 ±	0.13 ±	0.13 ±	0.09 ±	0.13 ±	0.07 ±

		0.01**Aa**	0.007**Aa**	0.01**Aa**	0.009**Ab**	0.01**Aa**	0.009**Ab**
λ **(d^{-1})**	G1	1.12 ± 0.01**Aa**	1.13 ± 0.008**Aa**	1.12 ± 0.01**Aa**	1.11 ± 0.01**Aa**	1.12 ± 0.01**Aa**	1.10 ± 0.01**Aa**
	G2	1.14 ± 0.01**Aa**	1.12 ± 0.007**Aa**	1.14 ± 0.01**Aa**	1.09 ± 0.01**Ab**	1.14 ± 0.01**Aa**	1.07 ± 0.009**Ab**
R_0 **(offspring/female)**	G1	118.4 ±37.07**Aa**	143.7 ± 36.47**Ba**	118.4 ± 37.07**Aa**	93.9 ± 35.63**Aa**	118.4 ± 37.07**Aa**	60.7 ± 28.01**Aa**
	G2	156.9 ± 49**Aa**	198 ± 50.41**Aa**	156.9 ± 49**Aa**	92.9 ± 35.29**Aa**	156.9 ± 49**Aa**	39.8 ± 18.26**Ab**
T **(d)**	G1	38.37 ± 0.95**Bb**	44.6 ± 0.67**Aa**	38.37 ± 0.95**Bb**	43.59 ± 1.06**Ba**	38.37 ± 0.95**Ba**	37.02 ± 1.4**Ba**
	G2	40.8 ± 0.72**Aa**	38.3 ± 0.26**Bb**	40.8 ± 0.72**Ab**	48.21 ± 1.03**Aa**	40.8 ± 0.72**Ab**	54.32 ± 0.77**Aa**

*Standard error determined through bootstrap technique with 100,000 re-samplings.
#Significant differences between generations and two treatments were estimated using paired bootstrap test in TWO-SEX MS Chart (*P*<0.05). (G1 refers to the first generation; G2 refers to the second generation.) APOP: Adult preoviposition period; TPOP: Total preoviposition period; LC: Lethal concentration; C: Untreated

Conclusion

Overall, the present study comprehensively establishes the mechanisms and demonstrated phosphine-induced hormesis at LC_5 in the host *C. cephalonica,* which might help improve the quality of mass rearing of the parasitoid *H. hebetor*.

References

Guedes RNC, Rix RR and Cutler GC. 2022. Pesticide-induced hormesis in arthropods: Towards biological systems. *Current Opinion in Toxicology*, 29: 43-50

Desneux N, Decourtye A and Delpuech J-M. 2007. The sublethal effects of pesticides on beneficial arthropods. *Annu. Rev. Entomol*. 52:81-106.

Management of rice stem borer by using newer insecticides

V.N. Jalgaonkar, S.B Bhagat and A.L Narangalkar
Regional Agricultural Research Station Karjat, Dist- Raigad (MS)
Email. vinayakjalgaonkar@gmail.com

Introduction

About 128 species of insects have been reported attacking the rice crop. of these 15 to 20 insect species are known to be more damaging and are regularly noticed in tropical Asia. Rice stem borers cause great loss in rice crop every year. Its damage can reduce the number of reproductive tillers. At late infection, plants develop whiteheads. Yellow stem borer damage can lead to about 20% yield loss in early planted rice crops, and 80% in late-planted crops. White stem borer is an important pest in rainfed wetland rice. there is no any full proof method to get rid of Yellow Stem Borer either through a resistant variety or through certain biological agents, the use of insecticides becomes unavoidable. Pesticides are an important tool in an integrated pest management (IPM) program to curtail crop losses. For quick knock down effect, the application of judicious dose of insecticides is desired to save the crop from toll of insects. By changing in the resistance level of pest and discovery of new chemicals with insecticidal activities always provide room to convey field trials to evaluate their efficacy. Keeping in view of the above, in the present study, an attempt has been made to evaluate the efficacy of certain new promising insecticides against Yellow Stem Borer in transplanted rice.

Methodology

One blanket application of chemicals was made at 15 DAT. Dead hearts, total tillers from 20 randomly selected hills from each treatment were counted to arrive at per cent stem borer infestation at 30 and 50 days after transplanting (DAT). At 50 DAT, insecticide application was done. Then white ears and total panicles from 20 randomly selected hills from each treatment were counted to arrive at per cent stem borer infestation at pre- harvest stage. The grain yield in each net plot was also recorded and converted into q/ha. The data thus obtained were subjected to statistical analysis.

Results

The result indicated that the infestation of stem borer alongwith dead hearts symptoms was ranging between 4.23 to 4.99 at 30 DAT. The insecticide application was done at 30 DAT, when population was observed maximum (reach the ETL) After insecticide application, all the treatments were found significantly superior over untreated control. After first spraying of insecticides the result revealed that Dinotefuran 20 SG@ 200 g was found most effective which recorded 4.23 per cent dead hearts and at par with the treatment Fame 48 % SC(w/v) @ 50 ml (4.41 %). incidence followed by treatment DPX -RAB 55 @ 0.75gm/lit (4.63%), Spinetoram 6% W/V 5.66W/W + methoxyfenzoide WV (28.3 WW) SC 36SC @375ml (4.64%), Acephate 95% SG @ 526 g (4.74%), Rynaxypyr 20 SC @ 150 ml (4.75%), Spinetoram 6% W/V 5.66W/W) + Methoxyfenozide 30% WV/(28.3%WW) SC 36 SC@ 400 ml (4.77%) symptoms of dead hearts. The maximum stem borer incidence was recorded in untreated control i.e. (4.99%). After Second spraying result revealed that Treatment Dinotefuran 20 SG@ 200 g was found most effective treatment for management of stem borer with minimum (0.35%) dead hearts incidence followed by treatment Fame 48 % SC(w/v) @ 50 ml (0.42%), Spinetoram 6% W/V 5.66W/W) +Methoxyfenozide 30% WV/(28.3%WW)SC 36 SC@ 400 ml

(0.69%), Spinetoram 6% W/V 5.66W/W)+Methoxyfenozide 30% WV/(28.3%WW)SC 36 SC@ 375 ml (0.84%), Rynaxypyr 20 SC @ 150 ml (0.86%) incidence. The remaining all the treatments were found significantly superior over untreated control. The maximum stem borer incidence was recorded in untreated control i.e. (2.76%). Regarding yield of crop, highest yield (45.33 q/ha) was recorded in treatment Dinotefuran 20 SG@ 200 g followed by treatment Fame 48 % SC(w/v) @ 50 ml (44.02q/ha), Spinetoram 6% W/V 5.66W/W) +Methoxyfenozide 30% WV/(28.3%WW) SC 36 SC@ 400 ml (41.59q/ha), DPX-RAB55 106SC @ 237.5 ml(32.43q/ha). The lowest yield was recorded in untreated control plot i.e. (25.39q/ha).

Table 1: Efficacy of some new insecticides against rice stem borer

S. No.	Treatment	Stem borer incidence (%)			Yield (q/ha)
		Dead hearts (Pre-treatment)		W.E. (Post-treatment)	
		30 DAT	50 DAT		
1	Spinetoram 6% W/V 5.66W/W)+Methoxyfenozide 30% WV/(28.3%WW)SC 36 SC@ 375 ml	4.64 (12.39)	0.84 (5.13)	0.00 (0.00)	31.53
2	Spinetoram 6% W/V 5.66W/W)+Methoxyfenozide 30% WV/(28.3%WW)SC 36 SC@ 400 ml	4.77 (12.66)	0.69 (4.48)	0.00 (0.00)	41.59
3	DPX-RAB55 106SC @ 237.5 ml	4.63 (12.39)	1.00 (5.74)	0.12 (1.81)	32.43
4	Fame 48 % SC(w/v) @ 50 ml	4.41 (12.11)	0.42 (3.72)	0.00 (0.00)	44.02
5	Rynaxypyr 20 SC @ 150 ml	4.75 (12.52)	0.86 (5.44)	0.00 (0.00)	32.30
6	Acephate 95% SG @ 526 g	4.74 (12.52)	0.95 (5.44)	0.00 (0.00)	32.04
7	Dinotefuran 20 SG@ 200 g	4.23 (11.83)	0.35 (3.14)	0.00 (0.00)	45.33
8	Water Control	4.99 (12.92)	2.76 (9.63)	1.05 (5.74)	25.39
	S.E. ±	0.20	0.34	0.57	8.94
	C.D. at5 %	0.43	0.73	1.24	19.18

DH = Dead heart; WE = White ear; DAT = Days after transplanting

*Figures in parentheses are arcsine transformed values.

Fig.1 Efficacy of some new insecticides against rice stem borer

Conclusion

The above research on Evaluation of Efficacy of some new insecticides against rice stem borer revealed that Treatment Dinotefuran 20 SG@ 200 g was found most effective treatment for management of stem borer with minimum (0.35%). Regarding yield of crop, highest yield (45.33 q/ha) was also recorded in Dinotefuran 20 SG@ 200 g.

References

Rajpoot SKS, Prasad V, Dixit S, Verma DK, Giri SP, Singh RA and Kumar T. Evaluation of pesticide computability against stem borer, leaf folder and sheath blight of rice in irrigated ecosystem. *International Journal of Chemical Studies* 2019; SP6: 936-939.

Tiwari A, Pandey JP, Tripathi K, Pandey D, Pandey B, Shukla N. Effectiveness of Insecticides and Biopesticides against Gundhi Bug on Rice Crop in District Rewa (M.P.*). India. International J. Scientific and Res. Publ.* 2014; 4:1-4.

Bhuvaneshwari, V., Krishnam, Raju, S., 2013. Compatibility of fungicides and insecticides targeting sheath blight and major rice pests. *Journal of Rice Research* 6(2), 64–71.

Pal, R., Biswas, M.K., Mandal, D., Naik, B. S., 2015. Management of sheath blight disease of rice through bio control agents in west central table land zone of Odisha. *International Journal of Advanced Research* 3(11), 747–753.

Seni, A., Naik, B.S., 2017. Evaluation of some insecticides against brown plant hopper, *Nilaparvata lugens* (Stal) in Rice, Oryza sativa L. *International Journal of Bio-resource and Stress Management* 8(2), 268–271.

Seni, A., Pal, R., Naik, B.S., 2017. Studies on the compatibility of insecticides and fungicides against major insect pests and diseases of rice. *International Journal of Current Microbiology and Applied Sciences* 6(10), 930–936.

Karthikeyan, K., Christy, M.M., 2014. Efficacy of Chlorantraniliprole 18.5 EC against major pests of rice. *Indian Journal of Plant Protection* 42(4), 379–382.

ICSCI 2022/T2/83

The unsung role of microbial secondary metabolites for disease management in organic rice

Vanama Sowmya[1], Uma Devi G[1], Pesari Maruthi[2] and Kannan C[2]*
[1]*Plant Pathology, PJTSAU, Hyderabad 500030, Telangana*
[2]*ICAR-Indian Institute of Rice Research, Hyderabad, Telangana, 500030*
Email:agrikannan@gmail.com

Introduction

Synthetic pesticides are invariably used to manage plant diseases, posing serious threat to human and cattle health, as well as causing widespread environmental damage. Further non-judicious and irrational use of synthetic pesticides leads to development of fungicide resistance in phytopathogens. These major concerns have led the researchers to focus on use of biological control agents as an environment friendly and sustainable alternative strategy for the protection of crops against phytopathogens. These antagonistic bioagents are highly diverse and are a natural source of indefinite chemical substances including microbial metabolites that can be used as a substitute for chemical fungicides, especially in organic farming as biopesticides. Thus, biological control of plant diseases through microbial secondary metabolites is an eco-friendly and effective means of reducing crop loss with very minimal damage to the environment. Antimicrobial secondary metabolites produced by different bacteria and fungi are the potent new source of potential biopesticides and their retro synthesis leads to development of new biomolecules with unique mode of action. The objective of the study is to summarizethe role of microbial secondary metabolites for disease management in organic rice.

Methodology

Microbial Metabolites

Microorganisms produce diverse metabolites that include primary and secondary metabolites. Primary metabolites are synthesized during growth phase due to energy metabolism, are responsible for carrying out primary physiological functions that support the growth and development of the producers. They include alcohols, amino acids, nucleotides, antioxidants, organic acids, polyols, and vitamins. In contrast, secondary metabolites are low-molecular weight compounds, formed near to the stationary phase of growth, when the nutrient source for the microbes gets depleted and the microbes are subjected to stress. Secondary metabolite production is controlled by special regulatory mechanisms which are triggered by the nutrient, pH, and temperature. Major microbial secondary metabolites include antibiotics, siderophores, hormones, exopolysaccharides, pheromones and toxins. This which varies between the microbial species or genera and it is commonly observed during microbial interaction of antagonistic microorganisms and pathogens. Application of secondary metabolites as biopesticides has several advantages over the application of whole microorganisms, including their suitability to various kinds of soil, broad spectrum and ease to handle when compared to the microbes themselves. Once the structure of the potential metabolites is known, they may be retro synthesized in industries to avoid the cumbersome work of culturing the microbes and extracting from them. This allows the compounds to be mass produced at economical costs and time.

Classification of secondary metabolites

1. Terpenoids and steroids: These are major group of compounds derived biosynthetically from isopentenyl diphosphate.
2. Fatty acid-derived substances and Polyketides: There are over 12,000 known compounds of alkaloids, and their basic structures consist of an amine group and are derived from amino acids.
3. Alkaloids: More than 10,000 compounds are identified and are biosynthesized from simple acyl precursors such as propionyl CoA, acetyl CoA, and methyl malonyl CoA
4. Non-ribosomal polypeptides: These amino acids derived compounds are biologically synthesized by a multifunctional enzyme complex without direct RNA transcription.
5. Enzyme cofactors: Enzyme cofactors are nonprotein, low-molecular enzyme component

Mode of action of secondary metabolites

Secondary metabolites from different microbes have diverse mode of actions and few are listed below (i) competitive weapons against other livings such as animals, plants, insects, and microorganisms (ii) metal transporting agents (iii) agents for symbiotic relation with other organisms (iv) reproductive agent and (v) differentiation effectors (vi) agents of communication between organisms (vii) interference in spore formation, viability and germination (viii) antimicrobial and antiparasitic agents, enzyme inhibitors, immunosuppressive and antitumor agent.

Table 1: Prominant secondary metabolites and the microbes producing the metabolites that are used in suppression of major rice diseases (Charul Verma, et al., 2020)

S.No	Source	Metabolite	Target pathogen
1	*B. subtilis GB03*	Surfactin	*Rhizoctonia solani*
2	*T. koningii, T. harzianum, and T. aureoviridae*	Koninginin D	*R. solani*
3	*T.harzianum, T. aperellum*	6-pentyl-2H-pyran-2-one	*Rhizoctonia solani, Sclerotium oryzae, Xanthomonas oryzae*
4	*P. fluorescens Burkholderia cepacia*	Cyclic lipopeptides like viscosinamide tensin, and amphisin	*Rhizoctonia solani*
5	*Pseudomonas spp., Serratia spp., Stenotrophomonas spp., etc*	Volatile organic compound	*Many soil borne fungal pathogens*
6	*Bacillus vallismortis ZZ185*	Bacillomycin D	*Rhizoctonia solani Pyricularia oryzae*
7	*Bacillus subtilis*	Iturin A	*Rhizoctonia solani, Sclerotium oryzae*
8	*Burkholderia cepacia*	Pyrrolnitrin, pseudane	*Rhizoctonia solani Pyricularia oryzae*
9	*T. viride*	Viridepyronone	*Sclerotium* spp
10	*T. harzianum*	Harzianopyridone	*R. solani*
11	*T. harzianum*	T22azaphilone	*R. solani*
12	*T. viride, T. hamatum*	Gliotoxin	*R. solani*
13	*Serratia marcescens*	Chitinase enzyme	*Sclerotium* spp.

14	*T. harzianum strain T22*	Azaphilone	*Rhizoctonia solani*
15	*Trichoderma harzianum M 10*	Harzianic acid	*Sclerotium* spp.

Conclusion

Biological control of plant pathogens using microbial secondary metabolites is an attractive substitute for chemically synthesized pesticides especially in organic rice cultivation. Their specificity and non-persistence paves way for an eco-friendly plant disease management strategy and enables us to produce agricultural crops organically. Besides, the use of these microbial metabolites and their derivatives as lead molecules for the synthesis of novel plant protective chemicals opens new avenues for researchers, entrepreneurs and industrialists. Newer scientific approaches such as microbial metabolic engineering in identifying novel agro active metabolites is yet to be followed vigorously. It can be the rich resources of biologically active substances with significant agricultural potential as well as eco-friendly without any detrimental effects on humans.

References

Thirumurugan, D., Cholarajan, A., and Vijayakumar, S. S. R. a. (2018). An Introductory Chapter: Secondary Metabolites. Intech Open. https://doi.org/10.5772/intechopen.79766.

Ankit, K.G., Rakesh, P., Subhendu, J and Subrata Dutta. 2021. Microbial secondary metabolites and their role in stress management of plants. Biocontrol Agents and Secondary Metabolites, Woodhead Publishing, pp 283-319. ISBN 9780128229194, https://doi.org/10.1016/B978-0-12-822919-4.00012-0.

Verma, C., Jandaik, S., Kashyap, N, Gupta, B., Kashyap, S and Kerketta, Anurag. (2020). Microbial metabolites in plant disease management: Review on biological approach. International Journal of Chemical Studies. 8: 2570-2581.

ICSCI 2022/T2/84

Screening of genotypes against bacterial leaf blight of rice under artificial inoculation condition

V. A. Patil[1], P. B. Patel[2], K.S. Mungra[3] and P. D. Ghoghari[4]
Main Rice Research Centre, Navsari Agricultural University, Navsari 396 450, Gujarat, India
Email: vijay.patilagri@gmail.com, vapatil_swm@nau.in

Introduction

Rice bacterial blight (BB) is a known epidemic disease in the few pockets of perennial canal irrigated area of Southern Gujarat, that causes huge quantitative and qualitative losses. Bacterial blight (BB) is one of the major important disease of rice and occurs in more or less intensity causing considerable loss in yield under favourable weather conditions. The BB caused by *Xanthomonas oryzae*pv. oryzae was reported by Srinivasan et al. (1959) from Maharashtra state in India. It is a typical vascular disease, systemic in nature, the disease causes infection in nursery at seedling after transplanting and later at booting or heading stage. The 'Kresek' phase occurring at seedling stage is most destructive (Chahal, 2005). The use of resistant varieties is an economical alternative which also provides a satisfactory eco-friendly control of BLB disease. There is a pressing need to develop rice varieties with desirable traits and inbuilt resistance to important disease.

Methodology

Use of high yielding and identification of resistant/tolerant genotypes/entries is the most viable, environmentally safe and economically sound technique for the management of the disease. Hence, the present investigation was undertaken to find out resistant sources against bacterial blight of rice under artificial condition. Twelve genotypes + two checks were screened under field condition. The screening trial was conducted during *Kharif*- 2019, 2020 and 2021 at Main Rice Research Centre, NAU, Navsari. Two row of 2.1-meter length for each entry, the susceptible check TN-1, Resistant check (I. samba mahsuri) and state susceptible check GR-11 were planted after every 5th test entry. The local susceptible check GR-11 was also planted around the screening nursery. The artificial inoculation of *Xoo* was done by standard clip inoculation technique after 30 days of transplanting. The observation on bacterial leaf blight was taken from five hills from each genotype were randomly selected and considering for grading the severity of disease on standing plants. The labelled plants were observed for disease rating by using 1-9 scale as per SES scale (IRRI, 2013) as mentioned below.

Disease Scale	Description (affected lesion area)	Reaction Categorization
1.	1 - 5 %	Resistant
3.	6 - 12 %	Moderately Resistant
5.	13 - 25 %	Moderately Susceptible
7.	26 - 50 %	Susceptible
9.	51 - 100%	Highly Susceptible

Results

During *Kharif*- 2019, 2020 and 2021 consistent resistant reactions were observed in five entries *viz.*,IRBB-51, IRBB-60, IRBB-66, NVSR-335, NVSR- 706 and Improved Samba Masuri were showed moderately resistant reactions against bacterial blight disease over susceptible check, three entries *viz.*, IRBB-13, IRBB-53 and NVSR-331 were showed moderatly susceptible reactions while, three entries showed *viz.*, IRBB-1, IRBB-3, and IRBB-63 were showed susceptible reaction and state susceptible check GR-11 and national check TN-1 showed highly susceptible reaction against bacterial blight of rice (Table:1). Screening of rice genotypes against *Xoo* was carried out on different varieties by earlier workers. Mahajan et al. (2020) screened sixteen germplasm among them, not a single germplasm was found immune or resistant to the disease, four germplasm were showed moderately resistant. However, Jaya was found to be susceptible to *Xoo* under field condition. The results obtained in this experiment are close with the work of Rao et al. (2007) reported RP Bio-226 variety was resistant to BB. IRBB-21, IRBB-50, IRBB-55, IRBB-56 and IRBB-60 have disease scale 3 (Anon.,2008). The some of the new genotypes screened in the present study, so no specific information available related to screening with respect to bacterial blight of rice.

Table 1: Screening of rice entries against bacterial leaf blight disease during *Kharif* – 2019, 2020 and 2021 (Standard Evaluation System scale 1 – 9).

S. No	Genotype / Variety	Gene combination/cross	Bacterial blight *(1 - 9)						Final Reaction
			Year						
			2019		2020		2021		
			Disease scale	Reaction	Disease scale	Reaction	Disease scale	Reaction	
1	IRBB - 1	*Xa1*	7	S	7	S	7	S	S
2	IRBB - 3	*Xa3*	7	S	7	S	7	S	S
3	IRBB - 13	*xa13*	3	MR	3	MR	5	MS	MS
4	IRBB - 51	*Xa4+xa13*	3	MR	3	MR	3	MR	MR
5	IRBB - 53	*Xa5+Xa13*	5	MS	3	MR	3	MR	MS
6	IRBB - 60	*Xa4+Xa5+Xa13+Xa21*	3	MR	1	R	3	MR	MR
7	IRBB - 63	*Xa5 +Xa7 + xa13*	7	S	3	MR	5	MS	S
8	IRBB - 66	*Xa4 + xa5 + Xa7 + xa13 + Xa21*	3	MR	3	MR	3	MR	MR
9	NVSR -331	IET -19384 x NVSR-177	3	MR	5	MS	5	MS	MS
10	NVSR -335	IET -19384 x NVSR-177	3	MR	3	MR	3	MR	MR
11	NVSR-706	JGL-11470 x P-206	3	MR	3	MR	3	MR	MR
12	Improved Samba Masuri (Resistant check) BLB	*Xa5+xa13+Xa21*	1	R	3	MR	3	MR	MR
13	GR-11 (State Susceptible Check)	Z-31 x IR-8-45	9	HS	7	S	9	HS	HS
14	TN-1 (National Susceptible Check)	Dee Geo Woo Gen/Tai-Yuan-Chan	7	S	9	HS	7	S	HS

***Note:** Screening was done under artificial inoculation conditions. **R –** Resistant; **MR –** Moderately Resistant; **MS-** Moderately susceptible; **S**- Susceptible; **HS –** Highly Susceptible.

Conclusion

Considering the consistent resistant reactions observed in five entries *viz.*, IRBB-51, IRBB-60, IRBB-66, NVSR-335, NVSR- 706 and Improved Samba Mahsuri were showed moderately resistant reactions against bacterial blight disease over susceptible check, three entries *viz.*, IRBB-13, IRBB-53 and NVSR-331 were showed moderatly susceptible reactions while, three entries showed *viz.*, IRBB-1, IRBB-3, and IRBB-63 were showed susceptible reaction. against the bacterial blight. These moderately resistant entries will be used for further breeding programme.

References

Anonymous (2008). Annual Report, National Agricultural Research Project, Pathology., Gujarat Agricultural University, Navsari, p: 71.

Chahal, S. S. (2005). Disease scenario in rice during post green revolution era in Punjab. Plant Diseases Research, 20(1): 2-3.

IRRI (2013). Standard Evaluation System for Rice.INGER. Genetic Resources Centre, IRRI, Manila, Philippines, pp: 20-21.

Mahajan, S., Aryan, P., Kaur, A., Mahajan, D., and Kumar, D. (2020). Screening and management of rice germplasm against *Xanthomonas oryzae*pv. *oryzae*. Journal of Pharmacognosy and Phytochemistry, 9(6): 327-332.

Rao, Y. R.; Laha, G. S.; Veni, D. K. and Reddy, C. S. (2007). Evaluation of breeding lines against three major diseases of rice. Journal of Mycology and Plant Pathology, 37(3): 586.

Srinivasan, M. C.; Thirmulachar, M. J. and Patel, M. K. (1959). Bacterial blight of rice. Current Science, 28(1): 469-470.

ICSCI 2022/T2/85

Genetic analysis in Biofortified cultures

P.B. Vanave, B.D. Waghmode, J.P. Devmore, T.J. Bedse
Regional Agricultural Research Station, Karjat, Dist. Raigad. Maharashtra state
E mail: bharat_breed@yahoo.com

Introduction

World's half of the global population is dependent on rice. Imbalanced supply of essential amino acids, micronutrients, and vitamins leads to their deficiency or accumulation affecting the human metabolism. With the negative impact of zinc deficiency on human metabolism, especially in countries with rice as a major staple food, development of zinc biofortified varieties has become one of the important objectives of crop improvement programs. The success of biofortification relies on the existence of diversity for the target trait in the germplasm of crop, successful recombination of the target trait with yield, and identification of suitable recombinants with yield and target trait through multilocation evaluation. Accordingly, set of biofortified lines received from ICAR- Indian Institute of Rice Research, Hyderabad were evaluated for grain yield, cooking quality characters along with nutritional content such as Iron, Zinc and Protein content.

Methodology

Eleven advanced lines along with checks received from ICAR- Indian Institute of Rice Research, Hyderabad were evaluated in randomized block design to asses their yield and yield attributing traits during kharif 2021. The recommended doe of fertilizers and package of practices were followed during crop growth period. The soil and grain samples were analysed to assess their nutritional status. The cooking quality characters viz; Amylose content was estimated using Juliano, (1971), Gel consistency by Cagampang et al., (1973). The content of micronutrients (Iron and Zinc) in polished rice samples of the test entries was estimated by X-ray fluorescence spectrophotometer (XRF) at IIRR, Hyderabad while protein content was analysed at NRRI, Cuttack utilizing the seed samples. The simple correlation coefficients and genetic parameters of different components were estimated as per the standard procedure.

Results

The soil samples analysed before planting and after harvest revealed differential values for physico-chemical properties tested at Karjat location. The observations of Table 1 indicate that pH and EC of the soil samples revealed negligible difference however, reduction in Iron content at after harvest stage was at greater extent and vice versa Zinc content had increased at greater extent.

Table 1. The soil characteristics details at Karjat location during kharif 2021

Soil Sample details	pH (1:2.5 soil : water)	E.C (dS/m)	Iron (ppm)	Zinc (ppm)
Before planting	7.04	0.11	68.80	0.95
After harvest	7.13	0.12	38.95	2.27

Significant differences were observed for grain yield of the test entries. The test entry 28701 recorded highest grain yield and found to be numerically superior but statistically at par with BPT 5204, 27984, DRR Dhan 45 and 28694. Iron content was ranged between 1.7 to 4.3 ppm, Zinc content 16.2 to 23.0 ppm and Protein content 5.0 to 8.3%. Thus nutritional status revealed that iron content of all the test entries was below standard level of 10 ppm. The only test entry 28703 recorded highest Zin content as compared to National standard of 24 ppm and Protein content was also observed to be below narioal standard of 10%. Cooking quality parameters viz; Alkali Spreading value ranged between 3 to 7, Amylose content 16.6 to 24.52 and Gel consistency 22 (low) to 73 (high). Yield contributing characters such as days to 50% flowering ranged between 82 to 99 days, Plant height 111 to 147 days, No. of panicles M^{-2} 205 to 238.

Table 2: Performance of test entries for different properties.

IET Nos.	Iron (ppm)	Zinc (ppm)	Protein (%)	ASV	AC	GC	DFF	PH	Pan M^{-2}	GY (kg/ha)
28701	2.7	21.5	6.84	3	17.04	73	95	147	227	5112
28714	2.1	20.9	8.3	4	23.4	22	99	111	230	6004
BPT 5204	2.8	18.7	7.05	4	24.49	22	99	129	205	5449
28694	3.1	23.0	7.46	4	21.58	55	87	134	229	5275
28692	2.8	16.2	7.96	4	23.73	25	88	137	215	4792
28703	4.3	24.7	5.96	4	21.61	56	87	124	218	5051
DRR Dhan 45	2.0	21.2	6.69	4	22.41	62	82	130	205	5387
28704	2.4	18.5	6.66	4	23.29	49	84	122	235	4994
IR 64	1.7	17.6	5.35	4	24.52	54	85	129	238	4770
Chittimutyalu	2.9	22.6	5.0	4	22.49	22	99	136	222	2076
27984	2.4	20.6	7.7	7	16.6	50	93	120	230	5443
									CD	864
									CV (%)	11.53

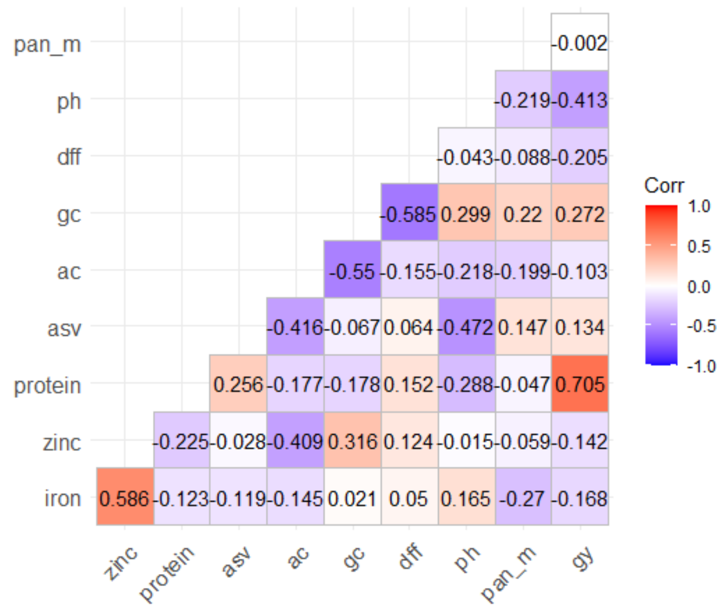
ASV: Alkali Spreading Value; AC: Amylose Content (%); GC: Gel Consistency; DFF: Days to 50% flowering, Ph : Plant height, Pan M^{-2} : Panicles M^{-2}, GY : Grain yield

Table 3: Genetic analysis for different characters

Characters	Maximum	Minimum	ECV	GCV	PCV	h^2	GA	GA% Mean
Fe content	4.3	1.7	2.47	25.55	25.67	0.99	1.38	52.39
Zinc	24.7	15.7	2.36	11.88	12.12	0.96	4.91	24.01
Protein	8.3	5.0	1.68	15.38	15.47	0.98	2.15	31.50
Alkali Spreading value	7.0	3.0	3.58	23.00	23.28	0.97	1.93	46.82
Amylose content	25.0	16.0	1.49	12.67	12.76	0.98	5.68	25.93
Gel consistency	73.0	20.0	1.92	41.82	41.86	0.99	38.18	86.06
Days to 50% flowering	99	81	0.76	7.24	7.28	0.98	13.42	14.84
Plan height	147	110	0.85	7.40	7.45	0.98	19.44	15.14
Panicles M^{-2}	239	201	0.87	5.25	5.32	0.97	23.83	10.67
Grain yield	6005	2076	0.21	20.49	20.50	0.99	2087.57	42.21

All the ten characters were genetic assessed for Environmental, Genotypic and Phenotypic coefficient of variation, heritability and genetic advance (Table 3). Overall estimates of PCV are greater as compared to estimates of GCV. Very meagre component of ECV (0.21) was observed for Grain yield character. Gel consistency has contributed maximum (41.82) towards GCV and PCV (41.86). Broad sense variability was observed to be higher side for almost all the characters under study indicating there is great scope to improve all the characters under study (Rajeswari *et al*., 2010). Genetic advance gives the magnitude of improvement per cycle in the base population by selection. The highest genetic advance was exhibited by grain yield and shows promise to improve at rapid rate. High heritability with high genetic advance as percentage of mean was observed for Gel consistency followed by Fe content. High heritability accompanied with high genetic advance indicates that mostly likely the heritability is due to additive gene effects and selection may be effective

Character association studies: Genotypic and Phenotypic coefficients revealed positive and significant association between protein content and Grain yield. That to significant but negative phenotypic correlation was observed between Plant height and Grain yield. Apart from grain yield Iron and Zinc content have shown significantly positive correlation at phenotypic level. Significantly negative correlation was observed between Gel consistency and Amylose content (Zhang *et al*., 2020), Days to 50% flowering and Gel consistency, plant height with alkali spreading value all at phenotypic level. Else, all other associations are non significantly positive or negative.



References

Rajeswari S., Robin S., Chandirakala R., Premalatha N.and Muthuram S. (2010). Genetic analysis and character association of quality in rice. *Oryza*, 47(2), (86-90).

Welch RM, Graham RD (2004). Breeding for micronutrients in staple food crops from a human nutrition perspective. *J Exp Bot*. 55:3, 53– 64. doi: 10.1093/jxb/erh064.

Zhang A, Gao Y, Li Y, Ruan B, Yang S, Liu C, Zhang B, Jiang H, Fang G, Ding S, Jahan N, Xie L, Dong G, Xu Z, Gao Z, Guo L and Qian Q (2020). Genetic Analysis for Cooking and Eating Quality of Super Rice and Fine Mapping of a Novel Locus *qGC10* for Gel Consistency. *Front. Plant Sci.* 11:342. doi: 10.3389/fpls.2020.00342.

ICSCI 2022/T2/86

Recognition of component lines for different cyto-sterile lines in Rice (*Oryza sativa* L.)

B.D. Waghmode, P.B. Vanave, J.P. Devmore, B.S. Thorat, T.J. Bedse
Regional Agricultural Research Station (Dr. B.S. Konkan Krishi Vidyapeeth), Karjat, Dist. Raigad. Maharashtra state
Email: bharat_breed@yahoo.com

Introduction

Hybrid rice technology has proved in breaking yield stagnation observed over the years. Successful use of hybrid vigour in rice largely depends on the availability of advanced cytoplasmic genetic male sterile (CMS) and restorer lines (Kumar *et al*., 1996). Therefore, it is imperative to identify maintainers and restorers from advanced rice lines for development of component lines in a hybrid programme. Pollen or spikelet fertility or both have been used as an index to fix the restoration ability of the lines (Sutaryo, 1989). So, the present investigation was targeted to identify more maintainers with novel cytoplasmic sources and restorer lines from advanced rice lines having tolerance to biotic and abiotic stresses.

Methodology

One seventy-five test crosses using 20 CGMS lines and 103 advanced lines were transplanted during *Kharif*, 2021 at experimental field of Regional Agriculture Research Station, Karjat (Raigad) & were evaluated for identification of component lines (maintainers & restorer lines) in rice during Rabi, 2021-22. Package of practices Recommended for transplanted rice along with Necessary intercultural operations were carried out during cropping period for proper growth and development of the plants. Hand pollination was practiced to effect test crosses. Necessary measures of bagging and tagging were taken to avoid undesirable pollination. At maturity, crossed seed of 166 test crosses were collected dried seeds were kept in store for further study. All F_1s along with their pollen parents were grown during *Rabi* 2021-22 having 30 plants per entry for testing pollen viability with 20 x 15 cm spacing. Randomly 20 spikelets from just emerged panicle of F_1 plant were collected in a vial containing 70% ethanol for pollen viability test. Anthers were crushed gently by using needle to release pollen grains. After removing debris, a cover slip was placed on crushed grains and pollen fertility status was observed under a compound microscope. One drop of 1% Iodine Potassium Iodide (IKI) stain was put on a glass slide. The entire slide was scanned and pollen fertility was counted. The pollen grains of F_1s were classified as 100% pollen sterility; Completely sterile (CS), 91-99 % ; Sterile (S), 71-90% ; Partially sterile (PS), 31-70% ; Partially fertile (PF), 21-30% ; Fertile (F) and 0-20 % ; Completely fertile (CF) (Virmani *et al*., 1997).

The following formulae were used to calculate pollen sterility and spikelet fertility (%).

$$\text{Pollen sterility (\%)} = \frac{\text{No. of sterile pollens}}{\text{Total no. of pollens}} \times 100$$

$$\text{Spikelet fertility (\%)} = \frac{\text{Filled grains per panicle}}{\text{Total spikelet's per panicle}} \times 100$$

Results

The potential restorers and maintainers were identified and classified on basis of their pollen grain sterility under microscope. Total of 166 crosses revealed differential performance on the basis of pollen sterility performance. Completely sterile pollen was expression was exhibited by 24 lines (14.45%), Sterile 26 lines (15.66%), partial sterile 37 lines (22.28%), Partial fertile 43 lines (25.90%), fertile 22 lines (13.25%) and completely fertile expression by only 14 lines (8.43%). The findings of this investigation were somewhat similar with the results of GobindaRaj and Virmani (1989) who found 40% maintainer and 24% restorer when tested 37 indica, japonica and indica/japonica derivatives against CMS–GA. Out of 166 crosses only 38 crosses contributed directly to identify maintainer and restorer. Other crosses were more or, less of intermediate types, which indicated neither maintainer nor restorer. It is well known that pollen fertility is controlled by one dominant gene (RfRf). If pollen fertility is governed by only one gene the product would be either restorer or, maintainer, no existence of intermediate types. So, there might be modifier genes in different genotypes which interacted with male sterile nuclear genes and resulted intermediate male sterility in the crosses. Total 23 genotypes found to be completely sterile with 100% pollen sterility. Only line IRRI 20 was found to be promising maintainer for RTN 5A and RTN 16A. No other line was found to be common maintainer for two or more CMS lines. The identified complete sterile crosses could be transferred as new CMS line through substitution backcrossing with their respective pollen parents as recurrent parent. Fourteen genotypes were found as completely fertile. None of the genotype was found to be common restorer among all the twenty CMS lines used. Most of the lines are red kernel lines possessing higher nutriotional status than others. These hybrid combinations could be directly evaluated for yield and yield contributing characters with suitable checks to assess their performance.

Table 1. Classification of pollen parents based on Pollen sterility or fertility status of F1s

CGMS lines used	Completely sterile	Sterile (S)	Partially sterile	Partially fertile	Fertile	Completely fertile
RTN 1 A	02	--	--	04	02	--
RTN 2 A	--	02	01	04	02	01
RTN 3 A	01	02	03	02	--	--
RTN 4 A	--	01	03	02	--	--
RTN 5 A	01	--	01	01	01	--
RTN 6 A	01	--	--	--	03	01
RTN 7 A	02	01	02	--	01	--
RTN 8 A	--	--	--	--	02	01
RTN 9 A	--	03	01	01	--	--
RTN 10 A	01	03	02	03	--	--
RTN 11 A	01	03	03	04	03	01
RTN 12 A	--	04	02	01	--	--
RTN 13 A	01	01	02	02	02	--
RTN 14 A	05	01	01	--	02	02
RTN 15 A	03	02	02	02	--	01
RTN 16 A	01	--	02	03	--	01

RTN 17 A	01	--	03	05	01	01
RTN 18 A	01	01	01	04	01	03
KJT CMS 10 A	--	--	03	02	--	--
IR 58025 A	03	02	05	03	02	02
Total	**24**	**26**	**37**	**43**	**22**	**14**

Identified maintainers :

CGMS lines used	**Maintainers**	**Restorers**
RTN 1A	IRRI 15, IRRI 51	--
RTN 2A	--	RR 25
RTN 3A	Amba Pandhri	--
RTN 5A	IRRI 20	--
RTN 6A	RR 32	RR 80
RTN 7A	RR 74, RR 40	--
RTN 8A	--	RR 38
RTN 10A	RR 39	--
RTN 11A	IRRI 62	RR 54
RTN 13A	RR 21	--
RTN 14A	RR 14, RR 36, BR 9, BR 3	RR 24, RR 67
RTN 15A	RR 26, RR72, RR4	RR 45
RTN 16A	IRRI 20	RR 87
RTN 17A	CR 3890-35-1-3-4	NPHX-63
RTN 18A	Amba Pandhari	RP5507-JBB-B-687-2-1-1-1-1, AD 16105, RR 72
IR 58025A	Sort Red, RP 6112-MS-M-140-99-22-6-9- 11-3, RP 6286-Bio Patho 5-156-24-10	RP5507-JBB-B-687-2-1-1-1-1, RR 92

Conclusion

Considering the overall results, 24 F_1s were designated as completely sterile, 26 as sterile, 37 as partially sterile, 43 as partially fertile, 22 as fertile, and 14 as fully fertile (Table 1). Twenty maintainers could be effectively converted into stable CMS lines and fourteen cross combinations can be used as heterotic combinations for further yield performance.

References

GovindaRaj K, Virmani SS. 1989. Maintainer and restorers for different cytoplasmic male sterile systems. Intl. Rice Res.Newsl. 14(5): 7-8

Kumar RV, Satyanarayana PV, Rao MS. 1996. New cytoplasmic male sterile lines developed in Andhra Pradesh, India. Intl. Rice Res. Notes. 21(2-3): 30.

Virmani SS, Viraktamath BC, Casal CL, Toledo RS, Lopez MT, Manalo JO. Hybrid Rice Breeding Manual. International Rice Research Institute, Philippines, 1997.

Screening of mutagenized Samba Mahsuri lines for development of elite lines for Yellow Stem Borer (YSB) resistance

Embadi Prashanth Varma, Chilkuri Sumeeth Reddy, Sravan Manthri, Ganesh Ch, Madhavilatha Kommana, Pradeep Goud Ayeella, Vamshi P, Sandeep K, Nakul D Magar, A P Padma Kumari, Kalyani M Barbadikar, Sheshu Madhav M*
ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad-500030, India
Email: sheshu24@gmail.com

Introduction

Rice being one of the majorly cultivated and consumed cereal crop in the world, the production and productivity of rice should be maintained to meet the demand and supply chain of this exponentially growing population. Rice productivity is greatly reduced by the biotic stress contributing an average annual yield loss of 25%. Yellow stem borer (YSB) being monophagous attacks the crop from seedling to grain filling stage causing a yield loss of 3-95% (Devasena *et al.* 2017). The resistance offered by TKM-6 through antixenosis mechanism by the biochemical resistance factor oryzan one shown to inhibit oviposition by stem borer *Chilo suppresalis* **(**Devasena*et al.* 2017**).** Therefore, inbuilt resistance with an antixenosis mechanism is considered to be the best strategy to surpass the yield loss caused by YSB.We aimed to develop YSB resistant cultivars by crossing ethyl methane sulphonate (EMS) Samba Mahsuri resistant mutants with wild type Samba Mahsuri.

Methodology

A total of 10,500 Samba Mahsuri (BPT 5204) mutants were developed through Ethyl methane sulphonate (EMS) mutagenesis and were screened against YSB as per Devasena *et al*. (2018) during *kharif*- 2013 (Gopi *et al.* 2021). The infestation was given by releasing larvae in ligule under field conditions at both the vegetative and reproductive stages and scored as per IRRI-Standard Evaluation System (SES) scale. From the identified resistant mutants further screening was done during *kharif*-2021, *Rabi*-2021-22 and *kharif*-2022 and two promising lines (SM-74 and SM-48) were used in crossing program with wild type (BPT 5204) to develop resistant lines.

Results

Of the identified resistant lines, two promising lines *viz*., SM-74 and SM-48 were highly resistant to YSB and were crossed with wild type (BPT 5204). A total of 119 F_3 individuals derived from BPT 5204 x SM74 & 162 individuals from BPT 5204 x SM48 were screened at vegetative (dead hearts) and reproductive stage (for white ears) against YSB during *kharif*-2021, *Rabi*-2021-22, and *kharif*-2022. Three entries from the cross BPT 5204 x SM74 with medium bold grain type and four entries from the cross BPT 5204 x SM48 were identified to be highly resistant with early maturity, medium slender grain type, and good yield (Table 1).

Table: 1 YSB scores and yield of entries

S.No.	Entry	YSB score		Yield (g)	Grain type	S.No.	Entry	YSB score	Yield (g)	Grain type
	BPT-5204 x SM-74					**BPT-5204 x SM-48**				
1	19-154-5	0		28.97	MB	1	14-19-3	0	14.33	MS
2	19-169-3	0		27.97	MB	2	14-28-5	0	20.81	MS
3	19-178-3	0		33.68	MB	3	14-32-4	0	17.55	MS
						4	14-156-5	0	14.52	MS

Conclusion

Of the screened entries seven were identified to be highly resistant to YSB showing zero score along with high yield. They also serve as a good source of resistance genes against YSB and can be used as a parent in marker assisted breeding programs for developing YSB resistant lines.

References

Devasena N, Soundararajan RP, Reuolin SJ, Jeyaprakash P, Robin S (2018) Evaluation of Rice Genotypes for Resistance to Yellow Stem borer, Scirpophaga incertulas (Walker) through Artificial Screening Methods. *Journal of Entomology and Zoological Studies* 6:874-87.

ICSCI 2022/T2/88

Genome organization and comparative evolutionary mitochondriomics of brown planthopper, *Nilaparvata lugens* (Stål)

***Guru-Pirasanna-Pandi G, Parameshwarn C, Basana-Gowda G, Annamalai M Naveenkumar Patil and PC Rath**

Crop Protection Division, ICAR-National Rice Research Institute, Cuttack-753006

Email: guru.g@icar.gov.in

Introduction

Nilaparvata lugens is the main rice pest in India (Jena et al., 2018). Until now, the Indian *N. lugens* mitochondrial genome has not been sequenced, which is a very important basis for population genetics and phylogenetic evolution studies. Hence, an attempt was made to sequence two examples of the whole mitochondrial genome of *N. lugens* biotype 4 from the Indian population for the first time.

Methodology

The sequencing was undertaken with an Illumina MiSeq Sequencing System (Illumia Inc., San Diego, CA, USA) and a 2 × 150 bp chemical kit. Sequencing library was created using the Truseq Nano DNA library preparation kit and analyzed using an Agilent Bioanalyzer 2100 with a high sensitivity DNA chip. MiSeq was used to sequence the template fragments in both the forward and reverse directions. The MITOS web server was employed for the prediction of all the mitochondrial gene coding regions, *viz*., protein-coding genes (PCGs), 22 transfer RNAs (tRNAs), and 2 ribosomal RNAs (rRNAs) by keeping the invertebrate mitochondrial genetic code as the base (Bernt et al., 2013). All of the available complete mitogenomes of the members of Delphacidae (19 mitogenomes) were selected as an in-group, and two species of Cicadamorpha and three species of Heteroptera were used as outgroups for the phylogenetic analysis.

Results

The mitogenomes of *N. lugens* (OK585089) are 16,072 bp long with 77.50% A + T contents and it contains 37 genes, including 13 protein-coding genes (PCGs) *(cox1-3*, *atp6*, *atp8*, *nad1-6*, *nad4l*, *and cob*), 22 transfer RNA genes, and two ribosomal RNA (*rrnS* and *rrnL*) subunits genes, which are typical of metazoan mitogenomes (Fig. 1). However, *N. lugens* mitogenome in the present study retained one extra copy of the *trnC* gene. Additionally, we also found 93 bp lengths for the *atp8* gene in both of the samples, which were 60–70 bp less than that of the other sequenced mitogenomes of hemipteran insects. The phylogenetic analysis of the 19 delphacids mitogenome dataset yielded two identical topologies when rooted with *Ugyops* sp. in one clade, and the remaining species formed another clade with *P. maidis* and *M. muiri* being sisters to the remaining species. Further, the genus *Nilaparvata* formed a separate subclade with the other genera (*Sogatella*, *Laodelphax*, *Changeondelphax*, and *Unkanodes*) of Delphacidae. Additionally, the relationship among the biotypes of *N. lugens* was recovered as the present study samples (biotype-4) were separated from the three biotypes reported earlier.

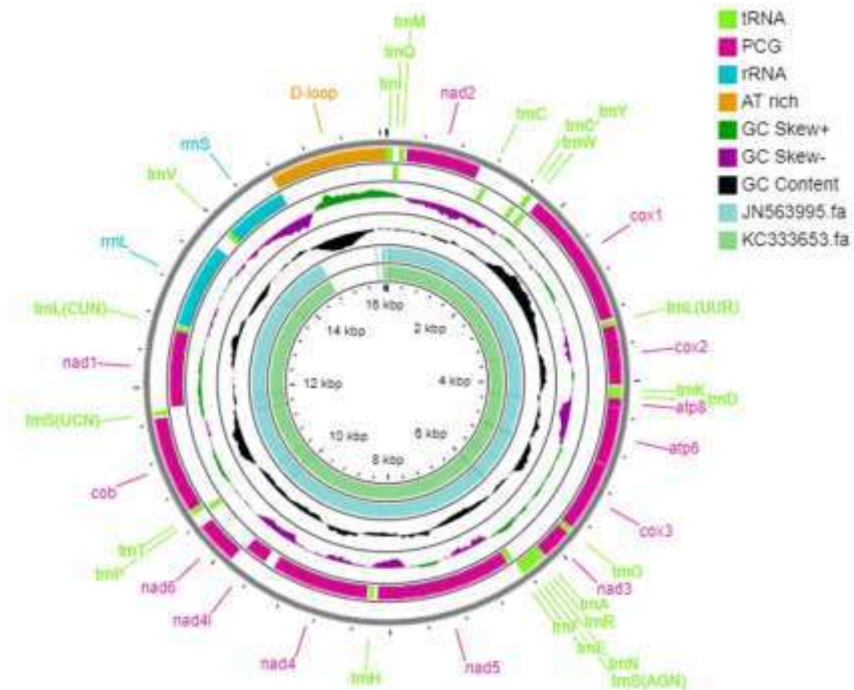


Fig. 1. ***Nilaparvata lugens*** **mitochondrial genome map (PCGs, rRNA, tRNAs& CR) is indicated in the first outer circle. GC content and GC skew are represented in second and third circle, respectively and inner circles are previously submitted sequences biotype 1 (JN563995) and L (KC333653) genome map.**

Conclusion

The present study provides the reference mitogenome for *N. lugens* biotype 4 that may be utilized for biotype differentiation and molecular-aspect-based future studies of *N. lugens*.

References

Bernt M, A Donath, F Jühling, F Externbrink, C Florentz, G Fritzsch, J Pütz, M Middendorf, PF Stadler. 2013. MITOS: Improved de novo metazoan mitochondrial genome annotation. Molecular Phylogenetics and Evolution, 69: 313–319.

Jena M, G Guru-Pirasanna-Pandi, T Adak, PC Rath, G Basana-Gowda, N Patil, G Prasanthi, SD Mohapatra. 2018. Paradigm shift of insect pests in rice ecosystem and their management strategy. *Oryza*, 55: 82–89.

ICSCI 2022/T2/89

Integrated management of bacterial leaf blight disease of rice

Pushpa Patil.B.D. Wagmode.M. S Joshi, H.D. Pawar and S.B. Bhagat
Regional Agricultural Research Station, Karjat -410201, Dist, Raigad (MS)
Email: bharat_breed@yahoo.com

Introduction

Bacterial leaf blight (BLB) caused by *Xanthomonasoyzae*pv*oryzae* is one of the most widespread and destructive diseases of rice in majority of the rice growing countries. BLB was first time noticed by the farmers in Fukuoka Island of Japan in 1884. In India, BLB was noticed for the first time in Kolaba (presently Raigad) district of Maharashtra by Srinivasan *et al*. 1959 (Bhapkar *et al*., 1960). The disease broke out in epidemic from in Shahabad district of Bihar during 1963 (Srivastava and Rao, 1966) and since then it has spread to other rice growing regions of the country often causing considerable yield loss especially in high yielding varieties during rainy season. In addition to reduction in yield; BLB also affect the grain quality by interfering with maturity. This disease is major problem in rainy season crop in rice growing regions of states. The topographic and climatic conditions greatly influence disease incidence and its further development. The disease is mostly prevalent in area with monthly rainfall of more than 200 mm. Rice is the sole crop cultivated in Kharif season and bacterial leaf blight is an increasing under normal climatic conditions but many times it attends the epiphytotic form resulting in diminishing effect on the yield whenever the climate is favourable and the variety is susceptible. Considering the increasing incidence of this disease, it was felt necessary to conduct a research on integrated management of BLB of rice.

Methodology

The experiment was conducted at Regional Agricultural Research Station, Karjat with three replications and ten treatments in randomized block design by using the Palghar 1 variety during 2019.The two sprays of respective treatments were given at 35 and 45 days after transplanting. Observations of the disease was recorded 10 days after second spray and PDI was calculated by 0-9 (SES scale).

Results

Effect of various treatments for management of bacterial leaf blight incited by *Xanthomonasoyzae*pv*oryzae* was studied during kharif 2019 and data narrated in the Table 1.

Table 1: Treatment details

Treatments	**Treatments details**	**PDI**	**Per cent reduction in Disease over control**
T_1	RDF of NPK (100:50:50)	46.50 (42.99)	22.68
T_2	T_1 + 50 kg N/ ha	73.66 (59.19)	-2.15
T_3	T_1 + 50 kg K/ ha	28.40 (32.19)	41.93
T_4	T_1 + 2 sprays of 5% WS silica @ 2 lit / ha	31.69 (34.23)	33.84
T_5	T_2 + 2 sprays of 5% WS silica @ 2 lit / ha	35.80 (36.74)	19.77
T_6	T_1 + 2 sprays of Copper oxy chloride 50% @ 1.25 kg / ha + Streptocycline @ 0.250 kg / ha (500 ppm).	30.86 (33.70)	44.76
T_7	T_2 + 2 sprays of Copper oxy chloride 50% @ 1.25 kg / ha + Streptocycline @ 0.250 kg / ha (500 ppm).	43.21 (41.09)	18.11
T_8	**T_1+ 2 sprays of *P. fluorescens* @ 10 lit / ha**	**25.93 (30.59)**	**40.39**
T_9	T_2+ 2 sprays of *P. fluorescens*@ 10 lit / ha	35.80 (36.74)	24.81
T_{10}	Control	63.21 (41.08)	0.00
	S. E (±m)	**1.31**	
	CD (0.05)	**3.89**	

Conclusion

Among the ten treatments the treatment T_8 (RDF + 2 sprays of *P. fluorescens* @ 10 lit / ha) was found significantly superior for management of bacterial leaf blight disease of rice as over rest of the treatment with the minimum per cent disease intensity (PDI) 25.93 % and maximum per cent disease reduction of 57.39 % over control (62.81 %).

ICSCI 2022/T2/90

Genetic analysis of IR64*1/*Oryza glaberrima* backcross population for weed competitive traits under direct seeded rice condition

Swathy, V[1]., M. S. Anantha[3], Ch. Raveendra[4], M. Prashanth[5], Shruti[6], T. Harisha[7], P. Senguttuvel[8], Santosha Rathod[9]., R. Mehendra Kumar[10], L. V. Subbarao[11], R. M. Sundaram[12], and C. Gireesh*[2]

[1,6]PhD scholar, University of Agricultural Sciences, Raichur, Karnataka, India-584101

[4] Junior Research Fellow, [2,3,8]Senior scientist, [9]Scientist,[10,11]Principal Scientists, [12]Director, ICAR-Indian Institute of Rice Research, Hyderabad, Telagana-500030

[5]PhD scholar, Acharya N.G Ranga Agricultural University, Guntur, Andhra Pradesh- 522034

[7]PhD scholar, Keladi Shivappa Nayaka University of Agricultural & Horticultural Sciences, Shivamogga, Karnataka- 577204

Introduction

Direct Seeded Rice is a newly emerged system that has proved to be an alternative to transplanted cultivation of rice, especially where labour and water shortage is prevalent. However, the major drawback of DSR, which is high weed competition, requires solution. Early Seedling Vigor (ESV) is an imperative trait in DSR system as it helps in outgrowing weeds, thereby providing weed competitiveness. *Oryza glaberrima* is the major source of improvement for *O. sativa* especially for traits like weed competitiveness, drought tolerance and ability to respond to low input conditions (Sarla and Mallikarjuna., 2005). Early seedling vigor refers to the rapid emergence and early-stage growth of plants, which enables quick establishment of plant stand as well as its ground cover (Shi *et al*., 2020). Seedling or shoot length and shoot dry weight are considered as the major contributing traits for ESV. Vigour indices, ESV I and ESV II, may be utilised to assess the vigour of plants at early stages of growth. In this context, the concerned study was conducted using backcross population from IR 64* *Oryza glaberrima*, with the objective of identifying introgression lines that are good performers with high vigor indices.

Methodology

The BC_1F_7 generation of a cross between IR64*CG235 (*O. glaberrima* accession) was evaluated during *Rabi* 2021-22 at Indian Institute of Rice Research. The population consisted of 190 lines grown under weed-free and weedy conditions. The experimental design followed was augmented design. Sabhagidhan, DRR Dhan 44, Samba Mashuri, Brown gora and Sabita were grown as checks. Morphological traits like germination percentage, number of leaves, number of tillers, seedling length, shoot fresh weight, shoot dry weight, leaf dry weight and leaf area were recorded at 15 days and 30 days after sowing (DAS).

Results

The mean values for seedling length, shoot length and leaf dry weight did not show much variation between weedy and weed free condition at 15 DAS. However, at 30 DAS, mean values for these traits were observed to be higher for weed-free condition than weedy condition. Seedling length and shoot dry weight had a range of 28.16 cm and 0.145g in weed-free condition while in weedy condition their range were 25.05cm and 0.106g respectively at 30 DAS. Correlation studies revealed a high positive relation between shoot dry weight and leaf dry weight (0.96). Similarly, a correlation coefficient of 0.7 was observed for seedling length with shoot dry weight and leaf dry weight. Under weedy condition, highest germination percentage (83.33%) were observed for KA 72-2-1 and KA 80-2, while in weed-free condition it was for KA-2 (81.66%). Seedling length and shoot length were recorded highest for KA 40-2 (22.50 cm and 16.33cm) at 15DAS in weed-free condition and 30.55cm and 20 cm respectively at 30DAS. Highest shoot dry weight under weedy condition was observed for KA 177 (0.049 g) at 15 DAS while at 30 DAS, it recorded second highest shoot dry weight (0.109g). Highest shoot dry weight was observed for KA 40-2 (0.153g) at 30 DAS under weed-free against the value of 0.058g at 30DAS in weedy condition. Early seedling vigor I, estimated as product of germination percentage and seedling length, was highest for KA 128 (1514.44) followed by KA 74-2 (1433.33) under weed-free condition, which was much higher than the mean ESV of all checks (426.95). ESV II, which is the product of germination percentage and shoot dry weight, was highest under weed-free condition for KA 69 (11.38) and exceeded the mean value for checks (0.376). In case of weedy state, KA 91-4 exhibited highest ESV I (1333.33) and KA 73-2 had highest ESV II (1.563) both of which were higher than mean values of checks used.

Table 1: Weedfree and weedy treatments for seeds

	ESV I	ESV II	Seedling length (cm)	Shoot dry weight (g)
WEEDFREE				
Mean value of checks	426.95	0.376	15.71	0.011
KA 40-2	1162.5	1.14	22.5	0.019
KA 74-2	1433.33	1.601	20.00	0.011
WEEDY				
Mean value of checks	299.76	0.236	13.41	0.011
KA 40-2	1080	1.343	18.00	0.026
KA 74-2	779.99	0.477	18.00	0.022

Conclusion

Considering the overall vigor performance of entries, the lines KA 74-2 and KA 40-2 were found to be performing good with moderate and high vigor indices respectively. They exhibited better seedling length and shoot dry weight in weedy condition compared to other lines. These may be considered as introgression lines for ESV upon molecular confirmation. This mapping population may be used to identify QTLs associated with weed competitive traits.

References

Sarla N and Mallikarjuna S. 2015. Oryza glaberrima: A source for the improvement of Oryza sativa. Current Science, 89(6): 955-963.

Shi Z, Chang TG, Chen F, Honglong Z, Song Q, Wang M, Wang Y, Zhou Z, Chongrong W, Zhou SC, Wang B, Chen G and Zhu X. 2020. Morphological and physiological factors contributing to early vigor in the elite rice cultivar 9,311. Scientific reports. 10 (1) :14813.

ICSCI 2022/T2/91

Weed population dynamics under different Cotton (*Gossypium hirsutum)* management systems.

D.V.S. Akshay[1], N.D. Parlawar[1], J.P. Deshmukh[1] and A.S. Riar[2]
bioRe-FiBL research trails, bioRe Association, Kasrawad, Khurgone, Madhya Pradesh - 451228
[1]Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola - 444104, India;
[2]FiBL, Switzerland
[1]Email: akshay.duddumpudi02@gmail.com

Introduction

Cotton is one of the most intensively cultivated crops in India which was challenging the natural resources and environmental conditions. Cotton cultivation includes many tillage, inter-cultivation practices and large chemicals usage in the form of fertilizers, pesticides & herbicides. Due to this, there is a considerable gain in the interest of cultivating the organic cotton which includes all eco-friendly and sustainable farming methods. Almost, the same practices are noticed in biodynamic farming also with the addition of eight specific preparations (Koepf *et.al.*, 1976). Weed population dynamics mainly includes; weed seed bank in the soil, germination, seed production and dispersal (Naylor, 2017). Without the proper knowledge on weed population dynamics of a field, it is not possible to manage them (Borgy *et al.*, 2015). Cotton, being a long duration, wide spaced and relatively slow growing crop in early stages, is subjected to a severe weed infestation (Ayyadurai *et al.*, 2013). In order to resolve these issues, in this experiment we compared the weeds that arise and their population dynamics in the field conditions of all the five treatments i.e., organic, biodynamic, conventional Bt, conventional non-Bt farming systems of cotton and the control.

Methodology

A field investigation was conducted at bioRe-FiBL research trails, bioRe Association, Kasrawad during *kharif* season of 2020-21. The present experimental field was under the FiBL Sys-Com project, which has established a long-term experiment (LTE) where, different farming systems were being compared since 2007. Cotton, soybean and wheat production were compared in a two-year crop rotation. The experiment was laid out in randomized block design with five different crop management practices which include organic, biodynamic, conventional, conventional with genetically modified Bt cotton and control; each replicated four times. The treatments were allocated randomly to various plots. In each experimental plot, four quadrants of 1m × 1m ($1m^2$) area were established randomly on the four sides permanently throughout the experiment and the various biometric observations were recorded from each quadrant treatment wise. Two of these quadrants were weeded regularly for every 20 days for taking the required observations and the other two were left unweeded throughout the experiment. The cultivars of cotton used in the experiment were 'Narmada shakti silver'(non-Bt) and 'Rasi-659'(Bt) sown at a seed rate of 0.128 kg $plot^{-1}$ (5 kg ha^{-1}) with a spacing of 106 × 53 cm.

Results

A total of 20 weed species were observed in the experiment. A very few weed species had a major share in terms of composition i.e., 6 weed species including *Panicum dichotomiflorum, Cyperus rotundus, Paspalum dilatatum, Euphorbia hirta, Acalypha indica and Digeria arvensis* occupied (80-90) % of the total composition. In the experiment, percentage of monocot weeds observed was highest in the treatment Conventional Bt and percentage of dicot weeds was highest in the treatment Organic. The dominant weeds observed were *Paspalum dilatatum* in Organic, *Cyperus rotundus* inBiodynamic and Control, *Panicum dichotomiflorum* in Conventional non-Bt and Conventional Bt. Major weed families in the experiment include *Poaceae, Cyperaceae, Euphorbiaceae, Fabaceae* and *Asteraceae*. Weeds under *Poaceae* were about (40-50) % of the total weeds infested in field. In terms of species richness other than Control, Organic treatment was recorded higher number species as compared to the other treatments. The results showed that the cotton field was infested by all the three categories of weeds, which included grasses, sedges and broad-leaved weeds. However, the composition and the number of weed species were not homogeneous. In the field experiment other than Control, the highest weed count was observed in Organic among all the treatments at all the intervals (Table 1). The mean total weed count difference between the organic and biodynamic treatments was found to be non-significant. The conventional treatments were shown less weed count compared to organic and there was no significant difference found in between the Conventional non-Bt and Conventional Bt. In the field experiment, the weed dry matter was found to be highest in the Organic and Biodynamic treatments respectively with no significant difference (Table 2). The lowest weed dry weight was observed in the both of the conventional treatments which were at par with each other. The highest weed control efficiency in the field experiment was found in Conventional Bt at 30 DAS, 90 DAS, 120 DAS and Conventional non-Bt at 60 DAS and at harvest (Table 2).

Table 1. Total weed count m^{-2} of crop as influenced by different treatments

Treatment Details	30DAS*	60DAS	90DAS	120DAS	At Harvest
T1- Organic farming cotton	10.48 (109.71)	8.44 (70.84)	6.88 (46.87)	5.79 (33.12)	3.02 (8.65)
T2- Bio-dynamic farming cotton	9.75 (94.75)	8.36 (69.60)	6.82 (46.13)	5.74 (32.62)	2.97 (8.37)
T3- Conventional farming non-Bt cotton	8.32 (69.37)	7.80 (60.45)	6.29 (39.12)	5.40 (28.85)	2.68 (6.72)
T4- Conventional farming Bt cotton	8.37 (70.06)	7.65 (58.15)	6.25 (38.69)	5.27 (27.50)	2.69 (6.81)
T5- Absolute Control (without fertilizers)	10.89 (118.30)	8.70 (75.56)	7.09 (49.73)	6.09 (36.56)	3.14 (9.41)
SE(m)±	0.34	0.24	0.16	0.17	0.08
CD at 5 %	1.06	0.75	0.48	0.52	0.25
GM	9.56 (92.44)	8.19 (66.92)	6.66 (44.10)	5.66 (31.73)	2.90 (7.99)

(Data are subjected to square root transformation $\sqrt{(x+0.5)}$ and original data are presented in parenthesis.)

Table 2. Dry matter of weeds m^{-2} of crop as influenced by different treatments

Treatment Details	30DAS	60DAS	90DAS	120DAS	At Harvest
T1- Organic farming cotton	4.76 (22.20)	2.86 (7.67)	2.19 (4.31)	1.29 (1.18)	1.09 (0.70)

T2- Bio-dynamic farming cotton	4.70 (21.65)	2.80 (7.37)	2.12 (3.99)	1.27 (1.11)	1.09 (0.68)
T3- Conventional farming non-Bt cotton	4.03 (15.79)	2.31 (4.87)	1.81 (2.79)	1.13 (0.79)	0.95 (0.40)
T4- Conventional farming Bt cotton	4.00 (15.57)	2.36 (5.06)	1.79 (2.73)	1.14 (0.79)	0.95 (0.40)
T5- Absolute Control (without fertilizers)	5.34 (28.02)	3.09 (9.05)	2.39 (5.20)	1.37 (1.39)	1.16 (0.84)
SE(m)±	0.07	0.06	0.04	0.03	0.02
CD at 5 %	0.22	0.18	0.13	0.09	0.05
GM	4.57 (20.64)	2.68 (2.80)	2.06 (3.80)	1.24 (1.05)	1.05 (0.61)

(Data are subjected to square root transformation $\sqrt{(x+0.5)}$ and original data are presented in parenthesis.)

Table 3. Weed Control Efficiency (%) of crop as influenced by different treatments

Treatment Details	Weed Control Efficiency (%)				
	30 DAS*	60 DAS	90 DAS	120 DAS	At Harvest
T1- Organic farming cotton	20.76	14.66	17.06	15.61	16.82
T2- Bio-dynamic farming cotton	22.76	18.03	23.27	19.49	18.75
T3- Conventional farming non-Bt cotton	43.66	45.51	46.36	42.77	51.94
T4- Conventional farming Bt cotton	44.43	43.39	47.40	42.92	52.51
T5- Absolute Control (without fertilizers)	-	-	-	-	-

*DAS= Days after sowing

Conclusion

From the above results we can conclude that the Conventional management of Bt Cotton was found to be most efficient among all the treatments. However, the Organic cotton was observed with high number of overall plant species and best in conserving the plant species biodiversity.

References

Ayyadurai, P., Poonguzhalan, R. and Gokila, J. 2013. Effect of crop weeds competition in cotton (*Gossypium hirsutum L.*). *Agriculture Rev.* 2(34): 157-161.

Borgy, B., Reboud, X., Peyrard, N., Sabbadin, R. and Gaba, S. 2015. Dynamics of weeds in the soil seed bank: a hidden Markov model to estimate life history traits from standing plant time series. *PLoS one* 10(10): e0139278. doi:10.1371/journal. pone.0139278.

Koepf, H.H., Petersson, B.D. and Schaumann, W. 1976. *Biodynamic Agriculture: An Introduction.* 430 pp. Anthroposophic Press, Hudson, New York.

Naylor, R.E.L. 2017. *Encyclopedia of Applied Plant Sciences* (Second Edition). 2017; 3:485-492.

Unraveling the variation for micronutrient content in traditional rice varieties

R. Pushpa, R. Arulmozhi, R. Suresh, R. Manimaran and Dr. K. Subrahmaniyan
Tamil Nadu Agricultural University
Tamil Nadu Rice Research Institute, Aduthurai-612101
Email: pushpa.r@tnau.ac.in

Introduction

Micronutrients deficiency is a global problem contributing to world's malnutrition. This in turn leads to high rate of mortality in women and children (WHO, 1996). Zinc is one of the essential nutrients for increasing the immunity and it works as a cofactor for over 300 enzymes. It also plays a critical role in synthesis of protein and DNA (Rosal et al., 2010). Rice is a major source of dietary carbohydrate for more than half of the world's population in Indian diet, 31 percent of calories diet are supplied through rice. Rice is served as staple food for more than half of the world population which meet at least 50% of the daily calories. But, rice grains usually harbour very minimum amount of Zn (12-15mg kg-1) and Fe (5-6mgkg-1) as compared to the target fixed (Zn: 28-30 ppm and Fe: 40 ppm) to meet the recommended daily allowance (RDA) of 10-12mg Zn. day -1 and 10-15mg Fe.day-1 (FAO/WHO 2000 and Welch and Graham2004). The Rice crop has large genetic variability in micronutrient concentration. As staple foods are eaten in large quantities everyday by malnourished poor, addition of even small quantities of micronutrients is beneficial Iron deficiency associated anaemia, pre – mature delivery, retarded growth of fetus has been reported widely. Hence, along with yield, grain and nutritional quality has also become a primary consideration in rice breeding programs not only in India but also in various rice growing countries across the world. The present study aims to identify the wide variability in micronutrient content present in the rice traditional rice varieties that are best acclimatized for Tamil Nadu ecosystems.

Methodology

The trial was laid out at Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu during the season S*amba* 2020-21. The experimental material comprised of 120 traditional rice varieties. Genotypes were grown under irrigated condition and standard crop production and crop protection practices were followed. The seeds harvested at physiological maturity were dried up to a moisture content of 12-14 %. The grains were husked using lab dehusker for fixed timing to obtain brown rice in all the genotypes. zinc concentrations in rice samples were estimated by Energy Dispersive X-Ray Fluorescence Spectrometry (XRF) method. This instrument is quite useful in non-destructive determination of relative iron and zinc concentrations. Concentration was expressed in microgram per gram (mg/kg).

Results

As staple foods are eaten in large quantities everyday by malnourished poor, addition of even small quantities of micronutrients is beneficial. In the present study, the Iron accumulation in the grains of 120 genetic accessories ranges from (Jaya) 7.80 mg/kg to (Thengai poo samba) 18.30 mg/kg (Fig1.). Similarly, the zinc concentration range was obtained from (Kattu samba)15.30 mg/kg to (Karunkuruvai) 27.60 mg/kg. Based on the iron and zinc content, these 120 genotypes can be classified into three categories, low, moderate and high.by adopting the range followed by Vishnuvarthini *et al.*,2014. For iron content, the genotypes (9 genotypes) with the iron content of 0–9 mg/kg was considered in low category, iron content from 9.1 to 12 mg/kg were grouped in moderate (84 genotypes) and more than 12 mg/kg (27 genotypes) were placed in high category. (Figure 2). The genotypes with the zinc content of 0–12 mg/kg (0 genotypes) was categorized under low zinc content, 46 genotypes with the zinc content from 12.1to 20 mg/kg was grouped in moderate category and the genotypes (74 genotypes) with more than 20 µg/g to 70.1 mg/kg was placed in high category.

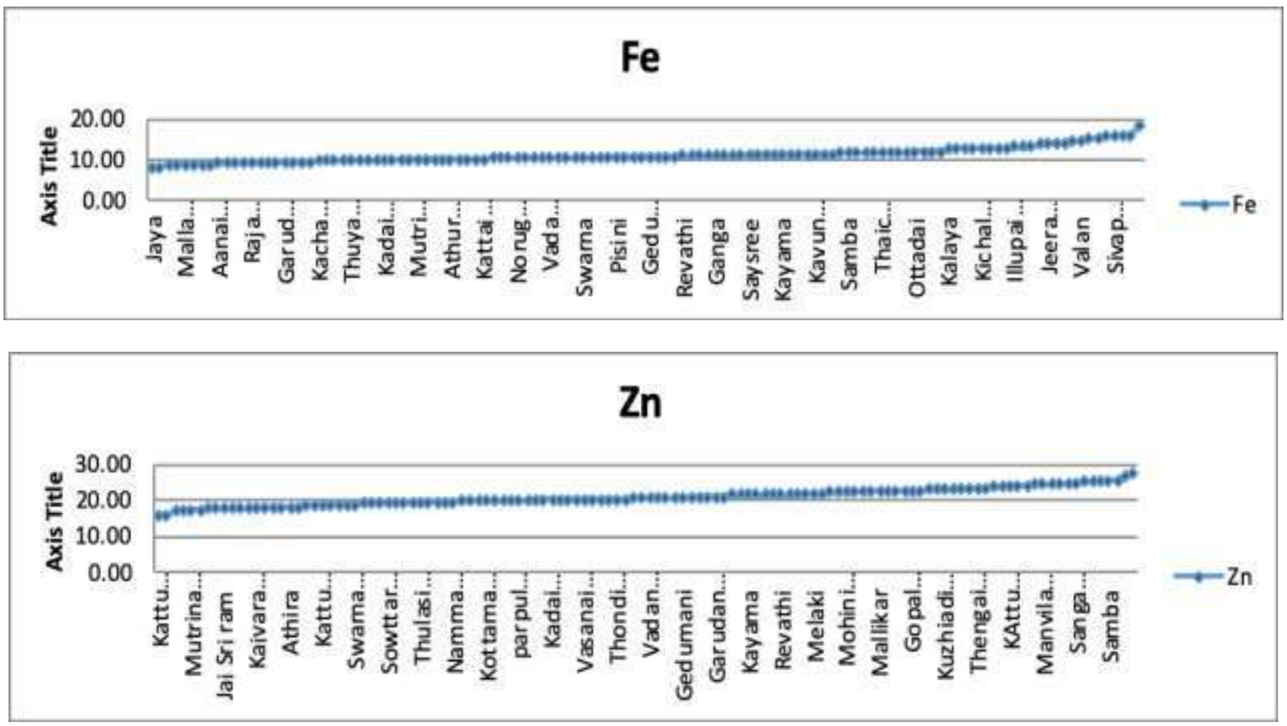


Fig1.Variation of Iron and Zinc content

Fig2. Genotypes classified based on Iron and Zinc content

Conclusion

Screening of germplasm for micronutrients is the initial step of bio fortification. Variability observed in the present study offers scope for further enhancement.

References

Rosal SR, Ribeiro ND, Jost E, Reiniger LRS, Rosa DP, Cerutti T, Possobom M (2010). Potential for increasing the zinc content in common bean using genetic improvement. Euphytica 175: 207 – 210.

Vishnu Varthini, N., Robin, S., Sudhakar, D., Rajeswari, S., Raveendran, M., Subramanian, K.S., Shalini Tannidi, Balaji, Aravindhan Pandian (2014) Genotypic variation for micronutrient content in traditional and improved rice lines and its role in biofortification programme. *Ind J of Sci and Tech.*, 7(9): 1414–1425.

Augmentation of potassium reduce the disease incidence of *Rhizoctonia solani* on rice

K. Chitra*, K Dhanalakshmi, K. Kavitha, N. Indra, N. Rajinimala, R. Nageswari, S. Anandha Krishnaveni, R. Rajeshwari and T. Sivsankari Devi
Tamil Nadu Agricultural University, Coimbatore
**Email: chitrapatho@gmail.com*

Introduction

Rice is an important cereal crop, which is the primary food for half of the human population. In India it is grown in about 40.9 million ha, with an annual production of 82.5 million tonnes. In Tamil Nadu, rice is cultivated in 2.7 m. ha, with an annual production of 5-6 million tonnes. The average annual production of rice in India is 2.8 t ha^{-1}. Rice crop suffers from a number of fungal, bacterial and viral diseases. Among the fungal diseases, sheath blight is a major disease caused by *Rhizoctonia solani* Kuhn. (*Thanatephorus cucumeris* (Frank) (Donk.).

Several workers reported that potassium fertilization reduced the susceptibility of rice to diseases, hastened the maturity and increased the yield. Yamada (1959) reported that the deficiency of potassium and excess of nitrogen were responsible for the incidence of diseases like sheath blight, brown spot, blast and stem rot of rice. Kannaiyan and Prasad (1978) reported that potassium application reduced the sheath blight disease of rice.

Methodology

Czapek's broth was prepared, pH of the medium adjusted to 6.5 to 7.0, distributed in 50 ml quantities in 250 ml Erlenmeyer flasks. The potassic salts *viz*., potassium chloride, potassium nitrate, potassium sulphate and dipotassium hydrogen phosphate were added at 0.01, 0.05, 0.1, 0.5 and 1.0 per cent concentrations of potassium. The flasks were inoculated with one-week-old eight mm fungal mycelial discs and incubated at room temperature (28±1°C) for 15 days. At the end of the incubation period, the biomass from the culture solution was removed by filtration under suction in a previously dried and weighed filter paper. The filter paper with the biomass was dried in 102°C for 24 hrs. and the dry weight was recorded. The intensity of sclerotial formation in the broth was also noticed.

Table 1. Effect of different sources of potassium on the *in vitro* growth and sclerotial formation of *Rhizoctonia solani*

Sl No.	Potassium sources	Per cent concentration	Mycelial* dry weight (mg/50 ml)	Per cent decrease (-) or increase (+) over control	pH
1.	**KCl**	1.0	244	-64.63	6.9
		0.5	349	-49.42	7.0
		0.1	455	-34.05	6.9
		0.05	563	-18.40	7.0
		0.01	668	-3.18	7.1
	SE CD (p=0.05)		0.3416 0.9709		
2.	K_2SO_4	1.0	251	-63.62	7.0
		0.5	359	-47.97	7.1

		0.1	461	-33.18	6.9
		0.05	566	-17.97	7.1
		0.01	671	-2.75	7.0
	SE CD (p=0.05)		2.5232 5.0717		
3.	KNO_3	1.0	260	-62.31	6.9
		0.5	362	-47.53	7.0
		0.1	473	-31.44	7.1
		0.05	575	-16.66	7.1
		0.01	677	-1.88	7.0
	SE CD (p=0.05)		2.3783 1.1832		
4.	K_2HPO_4	1.0	265	-61.59	6.9
		0.5	369	-46.52	7.0
		0.1	472	-31.59	7.1
		0.05	576	-16.52	7.1
		0.01	681	-1.30	7.0
	SE CD (p=0.05)		0.7528 2.1398		
5.	Control		690		

* Mean of three replicates

Results

The effect of different potassic salt *viz*., potassium chloride, potassium sulphate, potassium nitrate and dipotassium hydrogen phosphate at 1.0,0.5, 0.05 and 0.01 per cent concentrations of potassium on the growth and sclerotial formation of *R. solani* was studied **(**Ramasamy (1974)). It was observed that the mycelial growth was enhanced by the salts at the lower concentrations of potassium and inhibited at higher concentrations of potassium. This reduction in mycelial growth may be due to the imbalance caused by very high concentration of one cationic nutrient. The inhibition was maximum in the case of potassium chloride followed by potassium sulphate, potassium nitrate and dipotassium hydrogen phosphate. Potassium chloride exerted good inhibition of the mycelial growth of the pathogen at all the concentrations. Maximum percentage of inhibition was recorded as 64.63 per cent in the case of KCl at one percent concentration. Sclerotial formation was very poor with potassium chloride and potassium sulphate. Maximum inhibition of sclerotial production was observed at 0.5 per cent and 1.0 per cent production was observed at 0.5 per cent and 1.0 per cent concentration of KCl_2 and potassium sulphate respectively. These findings are in line with the results of Prabakaran (1974), Kasirajan (1975).

References

Kannaiyan, S. and Prasad, N.N. (1978). Effect of potassium on the incidence of sheath blight disease of rice. Indian Potash J. 3:1-8.

Kasirajan, C. (1975). Effect of potassium fertilization and *Sclerotium oryzae* Wilt. Inoculation on the physiology and rhizosphere population of rice (*Oryza sativa* L.) and chemical control of the disease. M.Sc.(Ag.) Thesis, Annamalai Univ. India.

Prabakaran, J. (1974). Studies on the morphological and cultural characters and nutritional requirements of four isolates of *Sclerotium oryzae* Coff. and certain biochemcial changes in rice plants response to their inoculation. M.Sc.(Ag.) Thesis, Annamalai Univ. India.

Ramaswamy, K. and N.N. Prasad. (1974). Influences of potassium nutrition on wilt incidence on muskmelon. Potash Newsl, 9: 3.

Yemada, N. (1959). Some aspects of physiology of bronzings. Tropical Agriculturist, 15: 247-249.

ICSCI 2022/T2/94

Identification of rice yield-related QTLs in a RIL population

Renu Khanna*, Gurjeet Singh, Rajvir Kaur, Kumari Neelam, Rupinder Kaur and G S Mangat

Punjab Agricultural University, Ludhiana-141004 Punjab (INDIA)

Email: renukhanna-pbg@pau.edu

Introduction

Rice (*Oryza sativa* L.), a staple food of more than half of the global population and Asian countries, accounts for almost 90% of production and consumption (Pradhan *et al* 2019). An average yield plateau has been reached in the last few years as a result of the narrow genetic base of modern rice cultivars. Modern agriculture does not fulfill the primary productivity to feed approximately 10 billion people by 2050, there is an urgent need to increase rice production by up to 42% from the current level (Hickey *et al* 2019). Moreover, rapid climate change also has a significant impact on food production. In order to achieve sustainable grain yield in agriculture; therefore, the primary focus of rice researchers is to fulfill the increasing food grain demand (Long-ping 2014). Rice grain yield is a complex trait that can be determined by panicle number, grain number per panicle (GNPP), and grain weight. Grain number per panicle is the major contributor to grain yield and is crucial for its improvement and is determined by a series of physiological and biochemical steps. So, the present study was undertaken to study yield-related traits in a RIL population

Methodology

In this study, 190 RILs developed from the cross between PR121 and RYT4050 were phenotyped for GNPP and yield-related traits for two years at Punjab Agricultural University, Ludhiana. Genotyping of RILs was done by GBS (genotyping by sequencing) and sequence data was generated. The phenotypic and sequencing data was subjected to QTL-cartographer for mapping the grain yield QTLs onto the chromosomes.

Results

Pooled data from two seasons showed that GNPP ranged from 120 to 358, thousand-grain weight (TGW) from 19 to 33.3gm, days to flowering (DTF) from 93 to 118, spikelet fertility (SF%) from 56.1 to 91.7% and spikelet sterility (SS%) from 8.3 to 43.9%. A total of 4059 markers were grouped into 12 linkage groups. The maximum number (581) of polymorphic SNP markers was detected in chromosome 10, and the minimum (122) polymorphic SNP markers were detected in chromosome 12. A linkage map analysis identified 19 QTLs (quantitative trait loci) controlling the grain number per panicle (chromosome 12), grain weight (chromosomes 1, 2, 8, and 10), days to flowering (chromosomes 6 and 8), spikelet fertility (chromosome 1 and 2) with phenotypic variation ranging from 6.36% to 12.75%.

Conclusion

The present study shows that considerable variability is present in the RIL population. The QTL for grain weight on chromosome 1 showed maximum phenotypic variation and can be used for introgressing grain weight in advanced lines.

References

Hickey LT, AN Hafeez, H Robinson, SA Jackson, SCM Leal-Bertioli, M Tester, C Gao, ID Godwin, BJ Hayes and BBH Wulff (2019) Breeding crops to feed 10 billion. *Nat Biotechnol* **37**: 744–54.

Long-ping, Y (2014) Development of hybrid rice to ensure food security. *Rice Sci* **21**: 1.

Pradhan SK, E Pandit, S Pawar, SY Baksh, AK Mukherjee and SP Mohanty (2019) Development of flash-flood tolerant and durable bacterial blight resistant versions of mega rice variety 'Swarna' through marker-assisted backcross breeding. *Sci Rep* **9**: 1-15.

ICSCI 2022/T2/95

Identification and evaluating the effectiveness of single gene (*Xa21*, *xa13* and *xa5*), two-gene (*Xa21+xa13*) and three-gene (*Xa21+xa13+xa5*) pyramided lines for bacterial leaf blight resistance in rice

Ch. Raveendra[1&2], A. R. Priyanka[2], P. Aravindhan[2], G. Sneha Leela[2], V. Udaya[1], M. Prasanth[1], V. Swathy[1], Shruti[1], C. Gireesh[1], M. S. Anantha[1], J. Ramalingam[2]

[1] *ICAR – Indian Institute of Rice Research (IIRR), Hyderabad, Telangana - 500030*

[2] *Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu - 641003*

Email: chravindra99@gmail.com

Introduction

Rice is one of the major staple food crops for more than half of the world population and it is providing around 23% of calories shared by different food crops. According to the Food and Agricultural Organization, the global rice production needs to be increased by 42% over the present production to meet the demands of growing population by 2050. However, the rice production is continuously threatened by various biotic and abiotic stresses. Bacterial leaf blight caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) is a major destructive disease of rice, causing an yield loss of up to 80% depending upon on the severity. Development of host-plant resistance is an ideal choice to control the disease, as chemical management is not effective and it is also hazardous to the environment. Till date, about 47 bacterial leaf blight resistance genes have been identified from various sources of rice and only few of them (*Xa4*,*xa5*, *xa13*, *Xa21*, *Xa33*, and *Xa38*) are widely using to breed the cultivars for bacterial leaf blight resistance. The natural allelic variations of the *Xoo* may overcome the resistance conferred by single gene, hence development of two or three-gene pyramided lines would be an solution for effective management of this disease. In cognizance of above information, the present study was formulated with the following objectives 1. Development and identification of Recombinant Inbred Lines (RILs) possessing single gene (*Xa21*, *xa13* and *xa5*), two-gene (*Xa21+xa13*) and three-gene (*Xa21+xa13+xa5*) pyramided bacterial leaf blight resistance genes 2. Comparing the effectiveness of single gene, two-gene and three-gene pyramided lines for bacterial leaf blight resistance 3. Evaluation of grain quality traits of RILs in comparison with parents

Methodology

CO51, an early, medium slender and high yielding variety and having superior grain quality characters was used as female parent. ISM *Pup1*, a near isogenic line of Samba Mahsuri possessing three major bacterial leaf blight resistant genes (*Xa21*, *xa13* and *xa5*) was used as male parent. In the F_2 generation, single gene (*Xa21*, *xa13* and *xa5*), two-gene (*Xa21+xa13*) and three-gene (*Xa21+xa13+xa5*) resistant genes possessing lines were identified through phenotypic and genotypic screening methods and same were self-pollinated to develop the recombinant inbred lines (RILs) (F_6).

Results

The RILs carrying the combination of three resistant genes (*Xa21+xa13+xa5*) were found to have more resistant with a lesion length of 0.5 to 1.0 cm after 21 days of inoculation (DI), while the two-gene (*Xa21+xa13*) possessing RILs have shown a lesion length of 1.5 o 2.0 cm. The RILs carrying *Xa21* alone have shown a lesion length of 2.0 to 2.2 cm, while the RILs with *xa13* gene shown a lesion length of 2.0 to 2.5 cm and the RILs with *xa5* gene shown a lesion length of 3.8 to 4.8 cm. Based on these results, the level of resistance as follows: *Xa21+xa13+xa5 >Xa21+xa13>Xa21>xa13>xa5*.

Table. 1 Details of genotypes possessing different bacterial leaf blight resistant gene combinations

Genotype	*Xa21*	*xa13*	*xa5*	*Xa21+xa13*	*Xa21+xa13+xa5*	-
ISM *Pup1*					0.5 cm	
CO51						12.5 cm
RIL – 2-21	2.0 cm					
RIL – 1-13		2.5 cm				
RIL – 1-7			4.5 cm			
RIL – 1-1				1.5 cm		
RIL – 2-3-1					1.0 cm	

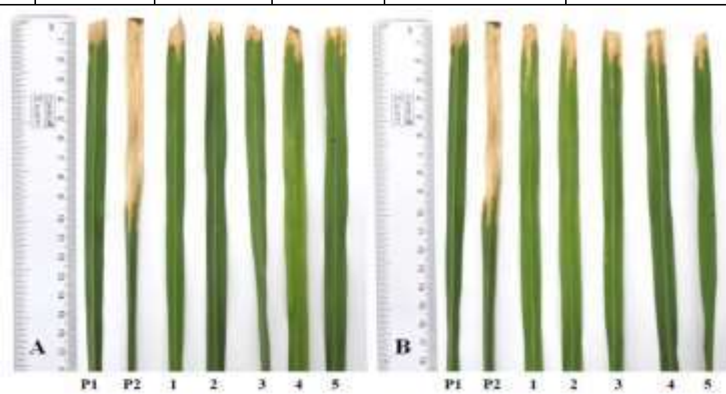


Fig. 1. Images illustrating effectiveness of *Xa21* and *xa13* genes (A) P1 – ISM *Pup1* (*Xa21+xa13+xa5*), P2 – CO51, and 1, 2, 3, 4, and 5 lines are RILs carrying *Xa21* gene. (B) P1 – ISM *Pup1* (*Xa21+xa13+xa5*), P2 – CO51, and 1, 2, 3, 4, and 5 lines are RILs carrying *xa13* gene.

Conclusion

The experimental results have clearly shown that the lines possessing multiple resistant genes are more resistant than the rest of the lines. Due to significant climate changes, it is always better to have multiple resistant genes for effective management of the disease.

References

Ramalingam J, Raveendra Ch, Savitha P, Vidya V, Chaithra TL, Velprabakaran S, Saraswathi R, Ramanathan A, Arumugam Pillai MP, Arumugachamy S and Vanniarajan C. 2020. Gene Pyramiding for Achieving Enhanced Resistance to Bacterial Blight, Blast, and Sheath Blight Diseases in Rice.Frontiers in Plant Science, 11:591457. doi: 10.3389/fpls.2020.591457

Chandavarapu Raveendra, C Vanniarajan, EG. Ebenezar and J. Ramalingam. 2020. Marker-assisted selection for sheath blight resistance in rice (*Oryza sativa* L.). Electronic Journal of Plant Breeding, 11(2): 581-584.

ICSCI 2022/T2/96

Screening of hybrids for resistance to false smut and grain yield of rice

M. K. Barnwal*[1], Ashok Kumar Singh[2], Ekhlaque Ahmad[3] Varsha Rani[3], Binay Kumar[4] and Krishna Prasad[3],

[1]Deptt.of Plant Pathology, [2] Deptt.of Agronomy,[3]Deptt. of Genetics & plant Breeding [4]Deptt. of Entomology, Birsa Agril. University, Kanke, Ranchi, Jharkhand 834 006 (India)

Email: barnwalbau@gmail.com

Introduction

Rice is one of the most widely cultivated important food crops grown in the world and over half of the world population relies on it. Rice production in India has increased from 82.5 m tons during the period of 1997-98 to 114 m tons in 2018-19 (Anon, 2019). But projected figures for future indicate that the present level of production is not sufficient to feed the population of the country. The low productivity of rice in India is due to attack of several biotic and abiotic factors. Among biotic factors diseases like Blast, Bacterial leaf blight, Sheath blight, False smut etc. are severe, wide spread and economically important. False smut caused by *Ustilaginoedea Virens* is a serious threat to HYV/hybrid rice cultivation in India (Roy *et al*., 2016). Earlier false smut of rice was known as minor disease but in recent decades, the disease become major particularly in hybrid rice in rice growing Asian countries like China, India and Burma etc. (Wang *etal*, 2019). False smut disease reduces the grain yield in terms of quality as well as quantity. The disease causes significant yield loss ranged from 2.8 to 81%, in different rice producing areas depending on the variety and diseases intensity (Barnwal, 2009; Ladhalakshmi *et al.*, 2020). False smut disease development is favoured due to the application of high dose of nitrogenous fertilizers, extensive cultivation of rice hybrids, close plant spacing and weather condition such as higher rainfall occurs during booting and heading stage etc particularly in Jharkhand state (Barnwal, 2009). Therefore, the present investigation was conducted in Rice Research Farm, Birsa Agril. University, Ranchi during *Kharif*, 2020-21 and 2021-22 for knowing rice hybrids which are resistance against false smut of rice.

Methodology

Field trials were conducted in randomized block design with three replications for two consecutive crop seasons (Kharif, 2020 and 2022) at rice research farm, BAU, Ranchi-6(Jharkhand). Twenty days old seedlings were transplanted in last week of July in main field of rice The plot size was 5.4m X 3.8 m with spacing of 20 cm X 15cm using one seedling per hill The recommended dose of fertilizers (NPK- 120:60:90 kg/ha) were applied. Plots were inoculated with Chlamydospores od *U. Virens* freshly collected spore balls from rice field**.** Chlamydospores were suspended in water and applied to plots just at booting stage of the crop. When the environmental conditions were favourable for development of the disease during above crop seasons All possible care was taken to prevent the pest attack by spraying suitable insecticides accordingly to the necessity. Infected hills with false smut (%) was observed by randomly taken samples per square meters per plot. Panicle affected with false smut (%) was observed by randomly taken samples per square meters per plot and number of affected florets with false smut per panicle (%) was recorded by randomly taken 20 panicles per plot. at 10 days before harvesting Grain yield was also recorded for each plot after harvesting, threshing, and seven days sun drying.

.

Results

Out of ten hybrids, only one hybrid *i.e.*, Shanti –D 2600 showed moderately resistant reaction against false smut of rice under artificial condition of inoculation. This treatment also showed false smut infected hills /m2 of 3.5%, false smut Infected panicles of 6.0% false smut infected spikelets/ panicle of 4.5% and grain yield of 59.9 q/ha. The hybrid, Arize 6444 Gold showed moderately susceptible reaction against false smut of rice but gave highest grain yield of 59.9 q/ha, false smut infected hills /m2 of 12.0 %, false smut infected panicles of 14.9% and false smut infected spikelets/ panicle of 6.4%. On the basis of grain yield this treatment was followed by Arize 8433 DT which recorded grain yield of 68.3 q/ha, false smut infected hills /m2 of 12.0 %, false smut Infected panicles of 14.9%, false smut infected spikelets/ panicle of 6.4% and showed moderately susceptible reaction against false smut disease.

Table1.Evaluation of rice hybrids against false smut disease and grain yield of rice mean of Kharif, 2020 & 2021

Treatments	*Infected hills/m2 (%)	*Infected panicles (%)	* Infected Spikelets/ Panicle (%)	*Disease Reaction	Grain Yield (q/ha)
Shanti-D 2600	3.5	6.0	4.5	MR	59.9
PAC 807+	11.9	15.5	14.0	MS	57.4
PAC2744+	10.1	12.7	7.0	MS	62.2
Arize 8433DT	21.1	21.1	17.0	MS	68.3
ADV801+	5.1	3.8	7.0	MS	55.0
RRX336	11.4	15.9	14.2	MS	52.7
US380	11.9	16.0	13.4	MS	55.0
Arize 6444 Gold	12.0	14.9	6.4	MS	69.1
Sudha D1100	10.5	15.0	9.2	MS	67.5
LG90303	10.3	9.7	7.9	MS	60.9
CD at 5%	4.2	4.9	5.9		5.4
CV%	15.8	13.0	13.2		17.4
***Mean of three replications**	**Values in per cent were converted into arc sine values before analysis**				

Conclusion

Shanti –D 2600 showed moderately resistant reaction against false smut of rice under artificial condition of inoculation. This treatment also showed false smut infected hills /m2 of 3.5%, false smut Infected panicles of 6.0% false smut infected spikelets/ panicle of 4.5% and grain yield of 59.9 q/ha. The hybrid, Arize 6444 Gold showed moderately susceptible reaction against false smut of rice but gave highest grain yield of 59.9 q/ha, false smut infected hills /m2 of 12.0 %, false smut infected panicles of 14.9% and false smut infected spikelets/ panicle of 6.4%.

References

Anonymous (2019) FAO data http//faostat.fao.org.

Barnwal, M.K., Prasad, M.K.and Agarwal, B.K. and Sharma, R.B (2009) influence of N applied through integrated organic and inorganic sources on incidence of False smut disease in hybrid rice *Environment and Ecology* 27(2): 503-506.

Barnwal M.K. Sah, A. Singh, DN and agarwal, BK (2012) Chemical management of false smut of hybrid rice (*Oryza sativa*) under rainfed lowland ecosystem. *Journal of Research (BAU)*, **13** (2): 61-66.

Ladhalakshmi, D. Preeti, Bhaskar, P., Laha, G.S., Dilip, T., Sundaram, RN., Prakasham, V., and Srinivas Prasad, M. (2020) Incidence of false smut on rice genotypes and the influence of weather factors on the disease. *Journal of Rice Research*, **13** (2): 61-66.

Roy, P., Barnwal, M.K., Kumar, T Ramesh and Ali, N. (2016) False smut: a threating disease of rice and its management through fungicides under rainfed condition of Jharkhand. *Progressive Research***11** (Special) 582-584.

Wang, WM, Fan, J. and Jeyakumar, JMJ (2019) Rice false smut: an increasing threat to grain yield and quality. In: Jia Y., editor. Protecting rice grains in the post-genomic era. London: *Intechopen*., p 89-108.

ICSCI 2022/T2/97

Influence of crop establishment method and sowing time on yield of rice (*Oryza sativa* L.)

Ipsita Kar*, Sanjukta Mohapatra, Rini Pal and Atanu Seni
All India Coordinated Rice Improvement Project, Regional Research and Technology Transfer Station, Odisha University of Agriculture and Technology, Chiplima, Odisha 768025
Email: ipsita.kar06@gmail.com

Introduction

Rice (*Oryza sativa* L.) is the staple food for more than half of the World's population. Among the rice growing countries, India has the largest area (44mha) and is the second largest producer (131million tonnes). Dass et al. 2015 have reported that the rice production should increase by 3 million tones every year in order to meet the growing population. The rice production mainly depends on the environmental factors and greater yield can be achieved by sowing and transplanting paddy in proper time. Yield loss by delayed transplanting has been reported by Kushwaha, UKS (2018). Hence, study on optimization of transplanting time is required. Transplanting is the most important and common method of crop establishment in Asia and in India, 44% of rice area is under transplanting. Among transplanting methods, manual transplanting is done widely which is not only labor intensive but is also time consuming. While mechanical transplanting reduces the labor cost and drudgery of humans (Goswami et al., 2020). Hence, this experiment was framed to study the performance of cultivars under manual and mechanical transplanting under normal and late planting condition.

Methodology

A field experiment was conducted at All India Coordinated Rice Improvement Project, Regional Research and Technology Transfer Station, Odisha University of Agriculture and Technology, Chiplima, Odisha during *Kharif* 2020 and 2021 to identify the suitable seedling age of rice cultivars under different establishment methods. The experiment was laid out in Split plot design and was replicated four times. The main plot comprised of four crop establishments viz. Mechanical Transplanting at normal time, mechanical transplanting at delayed time (15 days late), Manual transplanting at normal time and manual transplanting at delayed time (15 days late) while sub plot consists of two varieties viz. MTU-1156 and MTU-7029. The sowing date for nursery in normal time was July 1^{st} and in delayed time was July 15^{th} in both the years. Accordingly, the transplanting for manual and mechanical was done in normal time and delayed time. The recommended package of practices was done to conduct the experiment.

Results

The establishment methods significantly affected the grain yield and straw yield. The highest grain yield was obtained when mechanical transplanting was done at normal planting time with 15 days old seedling (6.54 t/ha). Delay in mechanized transplanting by 15 days reduced the grain yield by 6.1%. The maximum straw yield was also obtained with mechanical transplanting at normal planting time i.e. 7.30 t/ha. Similar results were obtained by Kushwaha, UKS (2018) who reported that late transplanted rice gives lower yield than normal transplanted rice which may be due to the aged seedlings which takes more time to recover from transplanting shock and root development takes time causing less absorption of nutrients from soil leading to reduced growth. Higher cost of cultivation was observed in manual transplanting under delayed condition (Rs.68652/ha) than all other methods. Similar results were obtained by Sreenivasulu and Reddy, 2014 who reported that the cost of cultivation was reduced in mechanical transplanting over manual transplanting which was due to lower labor cost for nursery raising and transplanting. Similarly the highest B: C ratio was obtained in mechanical transplanting (2.10) compared to manual transplanting (1.90) in normal planting time. Similar results were obtained by Sajitha Rani and Jayakiran, 2010 who also reported higher B:C ratio in mechanical transplanting.

Maximum grain yield was obtained by MTU-7029 (6.35 t/ha) which was 11.2% higher than MTU-1156. Similarly, higher Straw yield (7.32 t/ha) and Harvest Index (46.59%) were also obtained by MTU-7029 than MTU-1156. The maximum B:C ratio was found in MTU-7029 (2.10) compared to MTU-1156 (1.91).

Table 1: Effect of establishment methods with varied planting time on yield and economics of different cultivars (pooled data of 2020 and 2021)

Treatments	Grain Yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)	Cost of Cultivation (Rs/ha)	Gross Return (Rs/ha)	B:C ratio
Main plot (Establishment methods)						
Mechanical transplanting at normal time	6.54	7.30	47.20	63456	133423	2.10
Mechanical transplanting at delayed time	6.14	7.12	46.30	63359	130931	2.07
Manual transplanting at normal time	5.91	7.00	45.78	68556	130611	1.90
Manual transplanting at delayed time	5.62	6.74	45.41	68652	131893	1.92
SE (m)±	0.05	0.08	0.49	1189	2368	0.25
CD (P=0.05)	0.20	0.28	NS	3569	7613	0.72
Sub plot (Varieties)						
MTU-7029	6.35	7.32	46.59	65756	137980	2.10
MTU-1156	5.71	6.76	45.76	66006	125558	1.91
SE (m)±	0.04	0.05	0.24	1178	2354	0.24
CD (P=0.05)	0.14	0.16	0.80	4336	7355	0.75

Conclusion

Mechanical transplanting under normal time was found to be more productive than mechanical transplanting under delayed time as well as manual transplanting under normal and delayed time. The cultivar MTU-7029 gave higher yield and B:C ratio compared to MTU-1156. Hence, it can be concluded that mechanical transplanting can be done over manual transplanting as it not only reduces labor cost and drudgery but also gives higher returns.

References

Dass, A., Chandra, S., Choudhyary, A.K. Singh, G. and Sudhishri. S. 2015. Influence of field responding pattern and plant spacing on rice shoot characteristics, yield and water productivity of two Modern cultivars under SRI Management in Indian Mollisels. Paddy Water Environment.

Goswami, R., Dutta, M. and Borgohain, S.2020. Economic analysis of mechanical and manual transplanting of rice: A comparative study, International Journal of Current Microbiology and Applied Sciences,9(7):392-396.

Kushwaha, UKS. 2018. Delayed transplanting causes the yield difference between experimental plot and farmer's field in rice. Global Journal of Agricultural Research, 6(1): 9-17.

Sajitha Rani, T and Jayakiran, K.2010. Evaluation of different planting techniques for economic feasibility in rice. Electronic Journal of Environmental, Agricultural and Food Chemistry, 9: 150-153

Sreenivasulu, S. and Reddy, PBH. 2014. Effect of mechanized transplanting on yield, yield attributes and economics of rice (*Oryza sativa* L.). The Journal of Research, Angrau, 42(2):9-12.

ICSCI 2022/T2/99

Evaluation of rice genotypes for pre-harvest sprouting resistance

Repudi Shalem Raju[1*], Prashantkumar S Hanjagi[2], Sushma M Awaji[2], Devanna B N[2] and Chittaranjan Sahoo[1]

[1]*Odisha University of Agriculture and Technology, Bhubaneswar, Odisha-751003*

[2]*ICAR-National Rice Research Institute, Cuttack, Odisha-753006*

Email: repudishalemraj@gmail.com

Introduction

Rice yield has been affected severely by incidence of cyclonic storms with week-long rains/heavy rains flooding rice fields during the grain maturation period which results in Pre harvest sprouting or vivipary. Vivipary, germination of seeds on the maternal plant, is observed in nature and provides ecological advantages in certain wild species, such as mangroves. However, precocious seed germination in agricultural species, such as Pre-Harvest Sprouting (PHS) in cereals, is a serious issue for food security. PHS reduces grain quality and causes economical losses to farmers. Hence, it is important to characterize rice genotypes for PHS to prevent yield loss and quality deterioration. Especially in nations where rice is a major agricultural commodity, PHS of rice (*Oryza sativa* L.) results in substantial losses in grain quality and yield. Grain ripening and harvest times are often aided by consistent rainfall and hot temperatures. Dormancy in seeds, which is associated with PHS, reduces the rate at which they germinate even under optimal conditions. Some biological components, endogenous hormones, such as abscisic acid (ABA; promotes dormancy), and gibberellic acid (promotes germination), and some biological tissues such as embryo, endosperm, and maternal tissues, as well as environmental conditions like temperature and humidity, have a role in regulating seed dormancy. (Graeber *et al*. 2012; Basbouss-Serhal *et al*. 2016; Tejakhod and Ellis 2018). Developing PHS-resistant rice types should be a breeding priority. (Kang, 2018). With this background, present study was carried out to evaluate rice genotypes for PHS resistance.

Methodology

A diversified set of 96 rice accessions from the Short Term Gene Bank of ICAR-National Rice Research Institute, Cuttack, representing PB (Western Odisha Collections), HT (Assam Rice Collections) and NHN (popular varieties) were used in the present study.

Evaluation of rice genotypes for vivipary/PHS

To evaluate rice genotypes for PHS, invitro protocol standardized by Hanjagi et al 2022 was followed. Accordingly, 5 panicles from each genotype were harvested at 20, 25, 30, 35 and 40 days after flowering and were sandwiched between two wet blotting papers in aluminum trays of 25 x 25 cm and were incubated for 6 days with 12/12 photoperiod of day/night at 28^{0}C (Figure 1) Optimum moisture content was maintained throughout the treatment period Days to germination was recorded every day for 6 days in all the above two tests Viviparity (number of grains germinated per panicle) was recorded at 20 25 30 35 40 days after flowering under the field and laboratory conditions.

$$\text{Germination percentage} = \frac{\text{Total grains germinated in the panicle}}{\text{Total grains presented in the panicle}} \times 100$$

Fig. 1: Laboratory set up for evaluating rice genotypes for PHS.

Results

Variations in the PHS phenotype

Viviparity was recorded at 20, 25, 30, 35, and 40 DAF in the rice genotypes 6 days after incubation. The varietal distribution was based on the viviparous grain ratio germination on panicle from the invitro test, which was measured 6 days after incubation (Fig. 2a). A wide genetic variability was observed for PHS/viviparous germination among the 96 genotypes (Fig. 2b).

(a) (b)

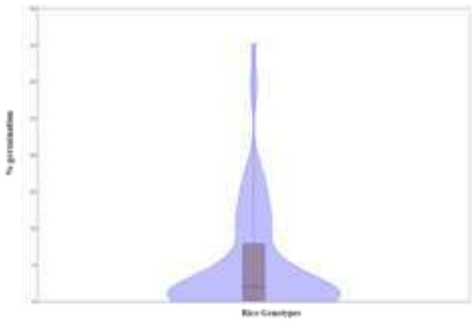


Fig. 2 (a) Viviparous response of rice genotypes as recorded by employing invitro protocol. Lane 1: Highly susceptible genotypes and Lane 2: Highly resistant genotypes. (b) Genetic diversity for viviparous response

Classification of rice genotypes based on phenotypic data:

Based on the percentage PHS exhibition rice genotypes were classified into different groups (Table 1).

Table 1: Classification of rice genotypes based on percent germination

SN	Category of genotypes Based on germination	Number of Genotypes
1	Highly Resistant (0 %)	11
2	Moderately Resistant (0.01-5 %)	22
3	Less Resistant (5.01-10 %)	18
4	Highly Susceptible (>15 %)	36
5	Moderately Susceptible (3.01-5 %)	9

Conclusion

A wide genetic diversity was found for PHS/vivipary among the 96 diverse rice genotypes evaluated. The present identified 11 novel rice genotypes which had very high PHS resistance from the diverse set of genotypes with 0% germination at all the different stages of flowering viz., 20, 25, 30, 35 and 40 DAF.

References

Basbouss-Serhal, I., Leymarie, J., Bailly, C., 2016. Fluctuation of Arabidopsis seed dormancy with relative humidity and temperature during dry storage. Journal of Experimental Botany. 67(1) :119–130. https://doi.org/10.1093/jxb/erv439

Graeber, K., Nakabayashi, K., Miatton, E., Leubner-Metzger, G., Soppe, W.J., Molecular mechanisms of seed dormancy. *Plant Cell Environ*. 2012. 35:1769–1786. https://doi.org/10.1111/j.1365-3040.2012.02542.x.

Hanjagi P S., Repudi S R., Awaji S M., Kumar A and Swain P., 2022. Effective screening protocol for vivipary/pre harvest sprouting in rice genotypes. Ist International Symposium on "Cereals for Food Security and Climate Resilience" Book of Abstracts. 4PPA-37, p176.

Kang, S., Shon, J., Kim, H. S., Kim, S. J., Choi, J.S., Park, J. H., Yoon, Y., Sim, J., Yang, W., 2018. Analysis of genetic variation in pre-harvest sprouting at different cumulative temperatures after heading of rice. Korean J. Crop Sci. 63, 8–17. https://doi.org/10.7740/kjcs.2018.63.1.008

Tejakhod, S., Ellis, R. H., 2018. Effect of simulated flooding during rice seed development and maturation on subsequent seed quality. Seed Sci. Res. 28:72–81. https://doi.org/10.1017/S0960258517000368

ICSCI 2022/T2/100

Phenotypic and genotypic evaluation for bacterial blight and blast resistance in elite genotypes of rice (*Oryza sativa*. L).

L. Krishna*, Y. Chandra Mohan, K. Sai Kylash, T. Virender Jeet Singh, T. Kiran Babu, N. R.G Varma and P. Raghurami Reddy

Institute of Rice Research, ARI, PJTSAU, Hyderabad-500030, Telangana, India

Email: lavuri.krishna@gmail.com

Introduction

Rice (*Oryza sativa* L.) is one of the important and significant cereal crops feeding a majority of the people in Asian countries and more than half of the world's population. Food security has become one of the world's most important problem. Biotic (insects and diseases) and abiotic (drought, salinity, cold and heat stress) stresses are major constraints faced during the crop production. Bacterial leaf blight and rice blast caused by *Xanthomonas oryzae pv. oryzae*(*Xoo*) and *Magnaporthe oryzae* respectively are the two most prevalent and destructive diseases in global rice production. The rice blast affects crops in more than 80 countries, and can lead to yield losses by as high as 50 %. Similarly, rice bacterial blight affects millions of hectares of rice annually, with an estimated crop loss as high as 75 %(He *et al.*, 2022). These diseases are quite difficult to combat, owing to the ability of rapid multiplication of bacteria and the fungal ability to adapt to its host and frequently mutate.The need to breed robust and high-productivity rice varieties is more critical than ever due to increasingly adverse environmental conditions and scarce natural resources. The current experiment was carried out to identify suitable lines possessing resistance to both the blast and leaf blight disease through phenotyping and genotyping.

Methodology

The experiment was conducted at Institute of Rice Research (IRR), Agricultural Research Institute (ARI), Hyderabad, Telangana, India. The material consists of newly bred cultures from IRR, ARI, Rajendranagar and released varieties and checks from different sources as presented in Table 1.

Screening for Bacterial leaf blight: During *kharif*, 2021, the experimental material was planted in two rows of 4 m length each. The bacterial inoculation was carried out at maximum tillering stage (40 DAT) according to the procedure described by Kauffman *et al.*, 1973. Improved Sambha Mahsuri (ISM) was used as the resistant check and TN-1 was used as the susceptible check. The *Xoo* isolate used for screening is the locally available strain maintained at IRR, Hyderabad. The disease reaction was recorded after 14 days of inoculation on 0-9 scale (SES, IRRI 2013)into different categories of Highly Resistant (HR: 0), resistant (R: 1.0), Moderately Resistant (MR: 3.0), Moderately Susceptible (MS: 5.0), Susceptible (S: 7.0), Highly Susceptible (HS: 9.0) based on their response to the bacterial leaf blight disease.

Screening for blast resistance: During *rabi*, 2021-22, the same experimental material was sown in Uniform Blast Nursery (UBN) and 15 days old seedlings were artificially inoculated by spraying the blast pathogen on the foliage using hand operated atomizer. Misting units were deployed to increase the humidity for enabling more disease spread. Leaf blast severity of each plant was recorded after 14 days of pathogen inoculation on individual plant basis using a progressive 0 – 9 scale (SES, IRRI 2013) and genotypes were classified based on their severity to the leaf blast as Highly Resistant (HR: 0), Resistant (R: 1.0), Moderately Resistant (MR: 2.0-3.0), Moderately Susceptible (MS: 4.0-5.0), Susceptible (S: 6.0-7.0), Highly Susceptible (HS: 8.0-9.0). RNR 15048 was used as the resistant check and TN-1 as the susceptible check.

Genotyping studies: During *Rabi*, 2021-22, the leaf samples were collected from all the 26 genotypes and sent to Intertek India Private Limited with technical support from CGIAR-Excellence in Breeding (EiB) low-density genotyping service (EiB-LDSG) (CGIAR, 2021). The genotyping was done for eight SNP markers linked to genes conferring resistance to BLB and blast resistance. Three genes each for BLB *viz*., *xa5*, *xa13* and *Xa 21* and blast *viz*., *Pikh*, *Pi9* and *Pi54* were targeted using eight SNP markers (Table 2).

Table 1: List of the entries along with the source of the material and their response to the screening

S. No.	Entry	Source of material
1	RNR 29322	PJTSAU, Hyderabad
2	RNR 31451	PJTSAU, Hyderabad
3	RNR 31670	PJTSAU, Hyderabad
4	RNR 31672	PJTSAU, Hyderabad
5	RNR 31721	PJTSAU, Hyderabad
6	RNR 31749	PJTSAU, Hyderabad
7	RNR 35105	PJTSAU, Hyderabad
8	RNR 35109	PJTSAU, Hyderabad
9	RNR 35118	PJTSAU, Hyderabad
10	RNR 35131	PJTSAU, Hyderabad
11	RNR 35146	PJTSAU, Hyderabad
18	RNR 37990	PJTSAU, Hyderabad
19	RNR 38125	PJTSAU, Hyderabad
12	PR 121	PAU, Ludhiana
13	PR 124	PAU, Ludhiana
14	PR 126	PAU, Ludhiana
15	PR 127	PAU, Ludhiana
16	PR 128	PAU, Ludhiana
17	PR 129	PAU, Ludhiana
20	ISM (RP Bio 226)	ICAR-IIRR
21	JGL 24423	PJTSAU, Jagtial
22	MTU 1010	ANGRAU, Maruteru
23	NLR 34449	ANGRAU, Nellore
24	RNR 15048	PJTSAU, Hyderabad
25	Tellahamsa	PJTSAU, Hyderabad
26	TN-1	ICAR-IIRR

Table 2: Details of SNP markers used for genes conferring resistance to BLB and blast

S No.	Trait	Gene	SNP marker details
1	BLB	*xa5*	snpOS00054
2	BLB	*xa13_1*	snpOS00493
3	BLB	*xa13_2*	snpOS00494
4	BLB	*Xa21*	snpOS00061
5	Blast	*Pikh_1*	snpOS00488
6	Blast	*Pikh_2*	snpOS00490
7	Blast	*Pi9*	snpOS00451
8	Blast	*Pi54*	snpOS00499

Results

Screening for BLB disease: Lines screened for BLB resistance through leaf clipping were classified based on the response to the disease reaction. These 26 lines were grouped into 4 clusters based on the disease scoring. The data revealed that two entries *viz*., ISM and JGL 24423 were found to have moderate resistance whereas four entries were moderately susceptible, 19 were susceptible and one entry was highly susceptible disease reaction. Genotypic analysis through targeted SNP analysis for BLB resistant genes (*xa5,xa13_1, xa13_2 and Xa21)* revealed that none of the entries had favourable allele for *xa5* gene. Five lines *viz*., PR 121, PR 127, PR 128, PR 129 and ISM had 3 favourable alleles and two lines with 2 favourable alleles. The line, PR 124 had two favourable alleles specific to *xa13* gene. Contrastingly, though five lines had favourable allele, only one line, ISM recorded phenotypic resistance reaction against bacterial blight. Further, an entry JGL 24423 was found to have a score of 3 with moderately resistant reaction, did not have any favourable alleles for any of the three BLB resistant genes indicating the presence of the action of other gene/QTLs which is yet to be studied further by validating with the other SNPs for bacterial blight. Similarly, the lines possessing favourable alleles *viz*., PR 121, PR 124, PR 127 and PR 128 have shown susceptible reaction to bacterial blight which might be due to differences in pathogen and host reaction.

Screening for Blast disease: The entries were classified on the basis of disease reaction in UBN trial. The phenotypic data showed that three entries *viz*., RNR 15048, RNR 31451, PR 127 were found to be moderately resistant whereas 14 entries were moderately susceptible, 8 entries were susceptible and one entry was highly susceptible. Results from SNP analysis (4 SNPs: *Pikh_1*, *Pikh_2*, *Pi9* and *Pi54)* showed that none of the entries had favourable alleles for all the four genes. Whereas, six lines *viz*., PR 121, PR 126, PR 127, PR 128, PR 129 and ISM had one favourable allele specific to *Pi54* gene. Nevertheless, among these six lines, only one line, PR 127 had recorded moderate resistance reaction to blast. Similarly, two lines *viz*., RNR 15048 and RNR 31451 have shown moderate resistance reaction to blast which did not have any favourable alleles for genes studied.

Table 3: Reaction against BLB and blast incidence along with genotypic information of rice genotypes

S. No.	Entry	Disease score		*BLB genes*				*Blast genes*			
		BLB	LB (UBN)	*xa5*	*xa13_1*	*xa13_2*	*Xa21*	*Pikh_1*	*Pikh_2*	*Pi9*	*Pi54*
1	RNR 29322	7 (S)	5 (MS)	A	A	A	A	A	A	A	A
2	RNR 31451	7 (S)	3 (MR)	A	A	A	A	A	A	A	A
3	RNR 31670	7 (S)	5 (MS)	A	A	A	A	A	A	A	A
4	RNR 31672	7 (S)	5 (MS)	A	A	A	A	A	A	A	A
5	RNR 31721	7 (S)	7 (S)	A	A	A	A	A	A	A	A
6	RNR 31749	7 (S)	7 (S)	A	A	A	A	A	A	A	A
7	RNR 35105	7 (S)	7 (S)	A	A	A	A	A	A	A	A
8	RNR 35109	9 (HS)	7 (S)	A	A	A	A	A	A	A	A
9	RNR 35118	7 (S)	5 (MS)	A	A	A	A	A	A	A	A
10	RNR 35131	7 (S)	7 (S)	A	A	A	A	A	A	A	A
11	RNR 35146	7 (S)	5 (MS)	A	A	A	A	A	A	A	A
12	RNR 37990	5 (MS)	5 (MS)	A	A	A	A	A	?	A	A
13	RNR 38125	7 (S)	5 (MS)	A	A	A	A	A	A	A	A
14	PR 121	7 (S)	5 (MS)	A	P	P	P	A	?	A	P
15	PR 124	7 (S)	5 (MS)	A	P	P	A	?	?	A	A
16	PR 126	7 (S)	5 (MS)	A	A	A	A	?	?	A	P
17	PR 127	7 (S)	3 (MR)	A	P	P	P	?	?	A	P
18	PR 128	7 (S)	5 (MS)	A	P	P	P	A	A	A	P
19	PR 129	5 (MS)	5 (MS)	A	P	P	P	A	A	A	P

20	ISM	3 (MR)	7 (S)	A	P	P	P	A	A	A	P
21	JGL 24423	3 (MR)	9 (HS)	A	A	A	A	A	A	A	A
22	MTU-1010	5 (MS)	5 (MS)	A	A	A	A	A	A	A	A
23	NLR-34449	5 (MS)	5 (MS)	A	A	A	A	A	A	A	A
24	RNR-15048	7 (S)	3 (MR)	A	A	A	A	A	A	A	A
25	**Tellahamsa**	**7 (S)**	**7 (S)**	**A**	**A**	**A**	**A**	**?**	**?**	**A**	**A**
26	**TN-1**	**7 (S)**	**9 (HS)**	**A**	**A**	**A**	**A**	**A**	**A**	**A**	**A**

LB-Leaf blast; NB-Neck blast; BLB-Bacterial leaf blight MR-Moderately resistant; MS-Moderately susceptible; S-Susceptible; HS-Highly susceptible; A-Absent; P-Positive; ?-Unidentified.

Conclusion

The results inferred that resistance in these lines might be governed by some other genes which need to be identified through developing mapping population. It was also observed that four samples for *Pikh_1* and six samples for *Pikh_2* specific SNP markers did not have any results due to amplification error. Among the lines studied, none of the entry was found to be resistant or moderately resistant to both the diseases, however, the line ISM for bacterial blight and PR 127 for blast could be used as donors for breeding resistance to these diseases by employing KASP (Kompetitive allele-specific PCR) assays with gene specific SNPs. Further, the lines showing resistance reaction to bacterial light (JGL 24423) and blast (RNR 15048 & RNR 31451) devoid of favourable allele need to be studied to know the novel genes conferring respective resistant genes.

References

CGIAR. 2021. Low-density Genotyping Services. Available at: https://excellenceinbreeding.org/toolbox/services/low-density-genotyping-services-introduction

He, Z., Xin, Y., Wang, C., Yang, H., Xu, Z and Cheng, J. 2022.Genomics-Assisted Improvement of Super High-Yield Hybrid Rice Variety "Super 1000" for Resistance to Bacterial Blight and Blast Diseases. *Frontiers In Plant Science*. 13.

IRRI. 2013. Standard evaluation system for rice. 5th Edition.International Rice Research Institute, Manila, Philippines.

Kauffman HE, Reddya PK, Hiesh SPY, Merca SD. 1973. An improved technique for evaluating resistance of rice varieties to *Xanthomonas oryzae*. *Plant Disease Response*. 57:537–541.

ICSCI 2022/T2/101

Correlation between pushing resistance and yield traits in an F_2 population of mutant and wild-type mega-variety BPT 5204

Pritam Kanti Guha[1,3], B. Suneel[1], B. Vishalakshi[1], M. Latha[1], P. Gopi[1,2], D. Vijaya Lakshmi[3], K.M Barbadikar[1], M.S. Madhav[1]

[1] *Indian Institute of Rice Research Biotechnology Department, Hyderabad* [2] *International Crops Research Institute for the Semi-Arid Tropics, Hyderabad,* [3]*Yogi Vemana University, Kadapa*

Email: sheshu24@gmail.com

Introduction

Semi-dwarf high-yielding varieties in 1960's averted large-scale famine during Green Revolution. One of the major causes behind the so called 'high yields' may be attributed to greater usage of urea and other chemical fertilizers. Under heavy fertilization rice varieties tend to grow tall without being able to develop the culm thickness thereby causing the culms to break under strong wind forces (Hirano et al. 2017). Breeding for strong culm rice is very important while considering from the yield perspective. Two types of lodging are typically observed in transplanted rice one being bending type lodging and the second, being breaking type lodging. Breaking type lodging causes the panicles to fall on the surface, making harvesting difficult. The strength of the culm is dependent upon the pushing resistance of the culm, diameter, and thickness of the culm. The bending stress is in turn influenced by the content of cellulose and lignin present in the culm walls (Mulsanti et al. 2018). The objectives of the present study involved determination of pushing resistance of F2 population of a cross between BPT 5204 and mutant TI-26 and its reciprocal cross and the determination of the correlation between the pushing resistance to yield.

Methodology

BPT-5204 is a mega-variety that supports good palatability and nutrition. However, the variety lacks lodging resistance and the lack of lodging resistance dents its yield. TI-26 is an ethyl methane sulphonate EMS mutagenized line of BPT-5204 that is high yielding and has lodging resistance. BPT-5204 and TI-26 lines were crossed to produce F_1s. The confirmed F_1s were forwarded and F_2s were sown in the cropping season of Kharif 2021 at the ICAR-IIRR plot under established irrigation systems. The TI-26 x BPT-5204 population had 413 lines and BPT-5204 x TI-26 population had 690 lines. Both of the populations were subjected to test the pushing resistance and culm diameter in addition to the single panicle yields. The pushing resistance was measured with the help of a prostrate tester (Daiki-make). The formula used was: Culm strength (gram/stem) = [(test reading/40)] × 1000/No. of tillers (Yadav et al. 2017). The culm diameter was measured at the main tiller approximately 15 cm from the ground with the help of a Vernier calliper.

Results

In the case of either population, the culm diameter was proportional to pushing resistance. Panicle weight was also proportional to the culm diameter (Table 1).

Table 1: Statistical analysis to analyse the correlation between the measured parameters were performed in R

Value	Parameter
BPT-5204 x TI-26 Correlation	**Population size 690**
0.9 to 1	Pushing resistance to culm diameter
0.7 to 0.79	Number of tillers to Prostrate tester reading
0.6 to 0.69	Panicle weight to Culm diameter
0.59 to 0.51	Panicle weight to Pushing resistance
TI-26 x BPT-5204 Correlation	**Population size 413**
0.5 to 0.6	Panicle weight to Culm diameter; Pushing resistance to Panicle weight
0.61 to 0.7	Single Plant Yield to Number of Tillers; Single Plant Yield to Number of reproductive tillers; Single Plant Yield to Panicle Weight
0.71 to 0.8	Prostrate Tester Reading to Number of tillers; Prostrate Tester Reading to Culm diameter; Prostrate Tester Reading to Single Plant Yield
0.81 to 0.9	Culm Diameter to Pushing Resistance

Conclusion

Culm diameter to pushing resistance demonstrated the maximum correlation, followed by panicle weight to culm diameter and panicle weight to pushing resistance.

References

Mulsanti IW, Yamamoto T, Ueda T, Samadi AF, Kamahora E, Rumanti IA, Thanh VC, Adachi S, Suzuki S, Kanekatsu M, Hirasawa T. 2018. Finding the superior allele of japonica-type for increasing stem lodging resistance in indica rice varieties using chromosome segment substitution lines. Rice ;11(1):1-4.

Hirano K, Ordonio RL, Matsuoka M. 2017. Engineering the lodging resistance mechanism of post-Green Revolution rice to meet future demands. Proceedings of the Japan Academy, Series B;93(4):220-33.

Yadav S, Singh UM, Naik SM, Venkateshwarlu C, Ramayya PJ, Raman KA, Sandhu N, Kumar A. 2017. Molecular mapping of QTLs associated with lodging resistance in dry direct-seeded rice (*Oryza sativa)* Front. Plant Sci. 8:1431. doi: 10.3389/fpls.2017.01431.

ICSCI 2022/T2/102

Heterotic studies in hybrids of rice (*Oryza sativa*. L)

Y. Chandra Mohan*[1], L. Krishna[1], T. Virender Jeet Singh[2] , Y. Sai Kylash[2] T. Kiran Babu[1] , N. R.G Varma[1] and P. Raghurami Reddy[1]

1 Institute of Rice Research, ARI, PJTSAU, Hyderabad-500030, Telangana, India

2 Department of Genetics and Plant Breeding, Research Scholars, Institute of Rice Research, ARI, PJTSAU, Hyderabad-500030, Telangana, India

Email: drycmohan@gmail.com

Introduction

Rice is one of the most important food crops in the world, especially in Asian countries. It is estimated that by 2035, global demand for rice will increase to 852 million tons; however, records show that annual yield growth was near to 1% in the past decade. Given the limited resources currently identified, along with various environmental constraints, such as pest, diseases and unfavorable farming conditions, demand for sustainable ways to increase rice production remains an enormous challenge (Gramaje 2020). Hybrid rice technology offers the most effective solution to enhance yield for sustainable rice cultivation. The technology revolutionized the rice farming through boosting the yield from 35 to 40 q/ha from straight varieties of rice to the tune of 65 to 70 q/ha in rice hybrids. Given its yield advantage and economic importance, several hybrids in rice have been commercialized in more than 40 countries, which has created a huge seed industry worldwide. Moreover, this venture also has great service opportunity and generates additional employment for the poorer. However, it has some limitations in generation of hybrids, seed production, and marginal heterosis. Success of the hybrid depends on their parental combination, adaptability, and allelic interactions, and hence, faces several problems like unstable male sterility (MS), non-abundancy in cytoplasmic diversity, inherited CMS load, low seed producibility in seed parent, poor grain and eating quality, lack of responsive parents for biotic and abiotic stresses, hybrid sterility, marginal heterosis in *indica* hybrids, etc. Keeping the importance of the aspect, present study was carried out to know the magnitude of heterosis obtained for grain yield in newly developed rice hybrids.

Methodology

The experiment was conducted at Institute of Rice Research, Agricultural Research Institute, Hyderabad, Telangana, India. During *rabi*, 2020-21, 18 hybrids were developed involving 5 stable CMS lines and 16 known restorers through barrier isolation following standard seed production package *viz*., staggered sowings, supplementary pollination, rogueing. The combinations were selected considering duration and grain type of parental lines. The 18 hybrids along with a hybrid check (US 314) and varietal check (JGL 24423) were grown in RBD with plot size of 8.48 m^2 each, spacing of 15 x 15 cm and three replications during *kharif*, 2021. The recommended agronomic and plant protection measures were adopted to raise good crop. The grain yield was recorded in all plots after uniform drying and expressed as kg/ha. The data was subjected to statistical analysis and standard heterosis was calculated. The head rice recovery and grain type was recorded as per the standard procedure (IRRI, 2013).

Results

Higher heterosis is the prime requirement for any of the hybrid breeding program. Standard heterosis or useful heterosis is very much required for success of any hybrid in the market. The analysis of variance clearly revealed the existence of significant variability among the hybrids. Mean grain yield ranged from 7712 kg/ha to 10973 kg/ha (Table 1 & Fig 1). Highest grain yield was recorded in RNRH 141 followed by RNRH 156, RNRH 186 and RNRH 98. Similarly, the range of standard heterosis was very wide among the hybrids studied. The standard heterosis over variety check, JGL 24423 depicts that all the hybrids have recorded positive heterosis values with a range of 0.77 to 42.29 %. Among 18 hybrids, eleven test hybrids recorded significant positive heterosis over variety check, JGL 24423. However, the standard heterosis over hybrid check, US 314 ranged from -15.10 to 19.88. Five hybrids showed significant positive heterosis for grain yield. Highest significant positive standard heterosis was recorded by RNRH 141 (19.88%) followed by RNRH 156 (13.02%), RNRH 186 (12.97%), RNRH 98 (12.81%), RNRH 99 (12.38%). Similarly, Chandra Mohan *et al.* (2022) and Virender *et al.* (2020) reported superior hybrids with significant positive standard heterosis. Head rice recovery is an important grain quality parameter which greatly influence the acceptability of the hybrid by miller and there by market demand for the product. The head rice recovery (%) of the all hybrids was good and above the acceptable limit of 55 with a range of 56.9 to 67.5. The highest HRR % was recorded in RNRH-99 (67.5) followed by RNRH-180 (66.7), RNRH-186 (66.7), RNRH-188 (66.7) and RNRH-189 (66.7). The lowest HRR % was recorded in variety check, JGL 24423 (56.9) followed by RNRH 170 (58.3). Among the test hybrids, nine hybrids had long slender grain whereas three with long bold and two with medium bold grain. Interestingly, four hybrids *viz.*, RNRH 95, RNRH 96, RNRH 97 and RNRH 141 had medium slender grain type which has more consumer preference and hence farmer acceptance.

Table 1. Standard heterosis of rice hybrids for grain yield (kg/ha)

S. No.	Designation	Cross Combination	Mean grain yield (kg/ha)	Standard heterosis (%)		HRR %	Grain Type
				Over hybrid check, US 314	Over variety check, JGL 24423		
1	RNRH-68	CMS 59A x SN 336	8178	-10.65	6.05	60.0	LS
2	RNRH-95	JMS 18A x SN 194	8544	-6.65	10.79	60.3	MS
3	RNRH-96	JMS 18A x SN 196	8033	-12.24*	4.16	65.0	MS
4	RNRH-97	JMS 18A x SN 197	8138	-11.08	5.54	66.4	MS
5	RNRH-98	CMS 64A x SN 232	10325	12.81*	33.88**	65.3	LS
6	RNRH-99	CMS 64A x SN 233	10286	12.38*	33.38**	67.5	LS
7	RNRH-100	CMS 64A x SN 239	8892	-2.85	15.31*	64.2	LS
8	RNRH-116	CMS 52A x SN 480	8489	-7.24	10.09	63.0	LS
9	RNRH-141	JMS 18A x SN 923	10973	19.88**	42.29**	62.5	MS
10	RNRH-155	CMS 66A x SN 232	9556	4.41	23.92**	64.5	LB
11	RNRH-156	CMS 66A x SN 233	10345	13.02*	34.15**	65.0	LB
12	RNRH-168	CMS 59A x SN 1255	8875	-3.03	15.09*	64.2	LS
13	RNRH-170	CMS 59A x SN 1260	9151	-0.02	18.66*	58.3	MB
14	RNRH-179	CMS 59A x SN 1346	7771	-15.10*	0.77	63.1	LS
15	RNRH-180	CMS 59A x SN 1397	10178	11.20	31.98**	66.7	LS
16	RNRH-186	CMS 59A x SN 1407	10340	12.97*	34.07**	66.7	LB
17	RNRH-188	CMS 59A x SN 1418	9300	1.61	20.60**	66.7	MB
18	RNRH-189	CMS 59A x SN 1429	8296	-9.36	7.58	66.7	LS
19	US 314	Hybrid check	9153	0.00	18.69*	58.3	MS
20	JGL 24423	Variety Check	7712	-15.74*	0.00	56.9	LB
		Trial Mean	9155			64.0	
		CD (0.05)	1398			3.38	
		CV (%)	9.20			3.18	

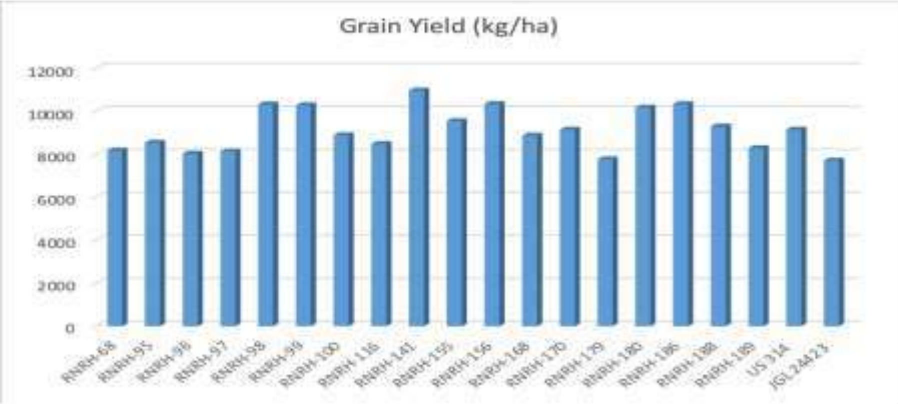


Fig 1. Mean performance of test hybrids and checks for grain yieldyield

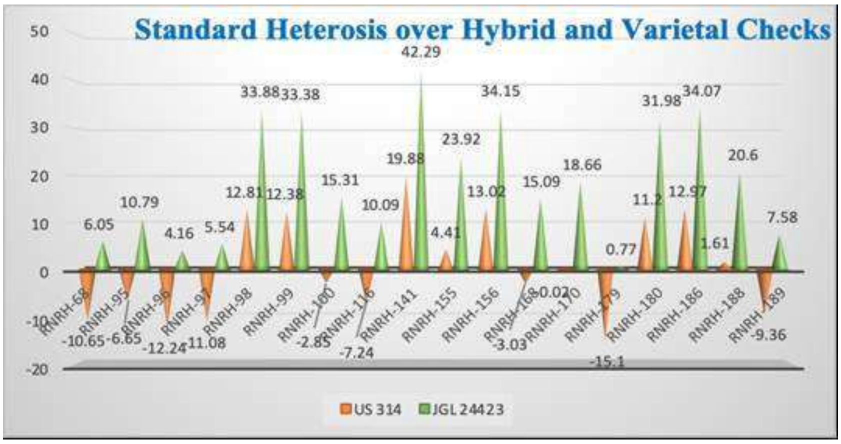


Fig 2. Standard heterosis over US-314 (hybrid) and JGL 24423 (varietal) check

Conclusion

This study concluded that among the test hybrids, RNRH-141 had recorded highest heterosis with medium slender grain and high HRR % and hence it could be promoted for multilocation testing and minikit trials to release for commercial cultivation. Similarly, in coarse grain segment, RNRH 156 was recorded significant heterosis over hybrid check with high HRR % and hence could be identified as potential hybrid.

References

Chandra Mohan, Y., Krishna, L., Virender Jeet Singh, T., Kiran Babu, T., Varma, N.R.G and Venkata Ramana. 2022. Genetic analysis of parental lines and identification of heterotic hybrid combinations in rice (*Oryza sativa*. L). *Oryza*, 59(1): 1-11.

Gramaje, L.V., Caguiat, J.D., Enriuez, J.O.S., Cruz, Q.D.D., Millas, R.A., Carampatana, J.E and Tabanao, D.A.A. 2020. Heterosis and combining ability analysis in CMS hybrid rice. *Euphytica*.216(14): 1-21.

IRRI 2013. Standard Evaluation System for Rice. 5th Edition. International Rice Research Institute, Manila, Philippines.

Virender Jeet Singh T, Damoder Raju CH, Chandra Mohan Y, Jagadeeshwar R, Balram M and Krishna L. 2020. Combining ability and heterosis studies for selecting elite parents and hybrids in rice (O*ryza sativa* L). *Journal of Rice Research*, 13(1): 18-32.

ICSCI 2022/T2/103

Effects of salinity stress on salinity adaptive mechanisms in guinea (*Megathyrsus maximus* Jacq.) germplasm

Seva Nayak Dheeravathu[1,4*], Reetu Verma[1], Mahendra Prasad[1], Rajkumar Thakur[3], Manish Kumar[3] and Vijay Kumar Yadav[1]
1 ICAR-Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh, India
[2]Southern Regional Research Station, ICAR-IGFRI, Dharwad-580005, India
[3]Central soil salinity Research Institute, Karnal, Haryana, India
[4]Indian Institute of Millets Research, Hyderabad, Telangana, India
**Present correspondence address: Seva Nayak Dheeravathu, Scientist (Senior Scale) ICAR-Indian Institute, of Millets Research (IIMR) Hyderabad, Telangana, India.*
Email: sevanayak2005@gmail.com

Introduction

Salinity is one of the rising problems causing tremendous crop yield and forage yield loss in many regions of the world, especially in arid and semiarid regions. In India, about 5.95M ha areas were affected by salinity. Five states viz. Haryana, Punjab, Rajasthan, Gujarat and Andhra Pradesh account for 48% of the country's total salt-affected soils (Mandal et al., 2010). The establishment of forage crop plants as one of the most important determinants of high yield is severely affected by saline irrigation water and soil salinity. Increasing salinity levels significantly decreased plant height, the number of tillers, relative water content (RWC), membrane stability index (MSI), K^+, Na^+ concentrations, green fodder yield, shoot and root length, shoot and root fresh and dry weights of Bajra Napier hybrids (Dheeravathu et al. 2021). Therefore, in the present investigation, eight selected lines (IG-01-189, IG-01-173, IG-01-125, IG-01-205, IG-01-93, IG-01-96, IG-01-221, IG-01-229) and 2 salt tolerant guinea grass were tested for their relative salt tolerance to increasing salinity levels in those combinations of salts which nearly exist in the natural salt-affected soils.

Methodology

The experiment was carried out under net house in pots at the Division of Crop Improvement, Indian Grassland and Fodder Research Institute, Jhansi, UP, India. A complete randomised block design (CRD) with three replications was followed to conduct the experiment. Four salinity levels i.e. 1.10, 4, 8, and 12dS/m, were used for the present study. A salinity of 1.10dS/m was considered as the control. Artificial saline soil conditions were created by adding a mixture of NaCl, Na_2SO_4, $MgCl_2$ and $CaSO_4$ (in a ratio 13:7:1:2) to pots to provide electrical conductivity of treated soils of 4, 8 and 12dS/m. Ten kg of artificial saline soil was filled in each pot. Two months old rooted slips of 10 guinea grass lines/ varieties were transplanted in plastic pots and irrigated with normal water. After 45 days of stress, antioxidant enzymes *viz*., *superoxide dismutase*, *catalase* and *peroxidase* sodium (Na^+) and potassium (K^+) concentrations in leaves were estimated. Field experiment using 2 varieties *viz*., BG-1 and DGG-1 was conducted at ICAR-CSSRI, Karnal in saline soils, ECe 6.40 and 7.60 dSm^{-1}; pH 7.6 and 7.9 at 0-15 and 15-30 cm soil depths, respectively. Standard protocols were usedfor antioxidant enzymes (Dheeravathu et al 2018) estimations and (Na^+) and potassium (K^+) concentrations in 1 g dry leaf, shoot, and root samples were determined by the flame photometer method of Jackson (1973). The study was conducted as a factorial experiment based on a completely random design with 3 replications. Microsoft Excel was used to analyse the data, and the correlation study was performed using XL STAT BASIC$^+$ at a 5% significance level.

Results

Antioxidant enzymes *viz.*, *Superoxide dismutase*, catalase and *peroxidase enzymes activities* increased with increasing salinity levels (4 to 12ECe dSm^{-1}) in the leaves. Large genotypic differences were detected regarding *superoxide dismutase,* catalase and *peroxidase enzymes* accumulation in leaves. Guinea grass was found to be moderately salt tolerant at 4-8 ECe (dSm^{-1}) (Fig-1). Among the eight lines, 6 performed better than salt tolerant check varieties. Lowest sodium, highest potassium concentrations and K^+/Na^+ ratio were recorded in BG-1 than DGG-1. The concentrations of potassium and K^+/Na^+ ratio was decreased with the increases in salinity in all the guinea grass germplasm and the highest decrease was observed at high level of salinity (12 ECe) (Antony et al 2021). Various studies have shown that plant increase N+ uptake under salt stress and K^+ accumulation is to counter the effect of N^+ taken up.BG-1 was found to be more salt tolerant than DGG-1 based on the K^+/Na^+ ratio(Table-1).

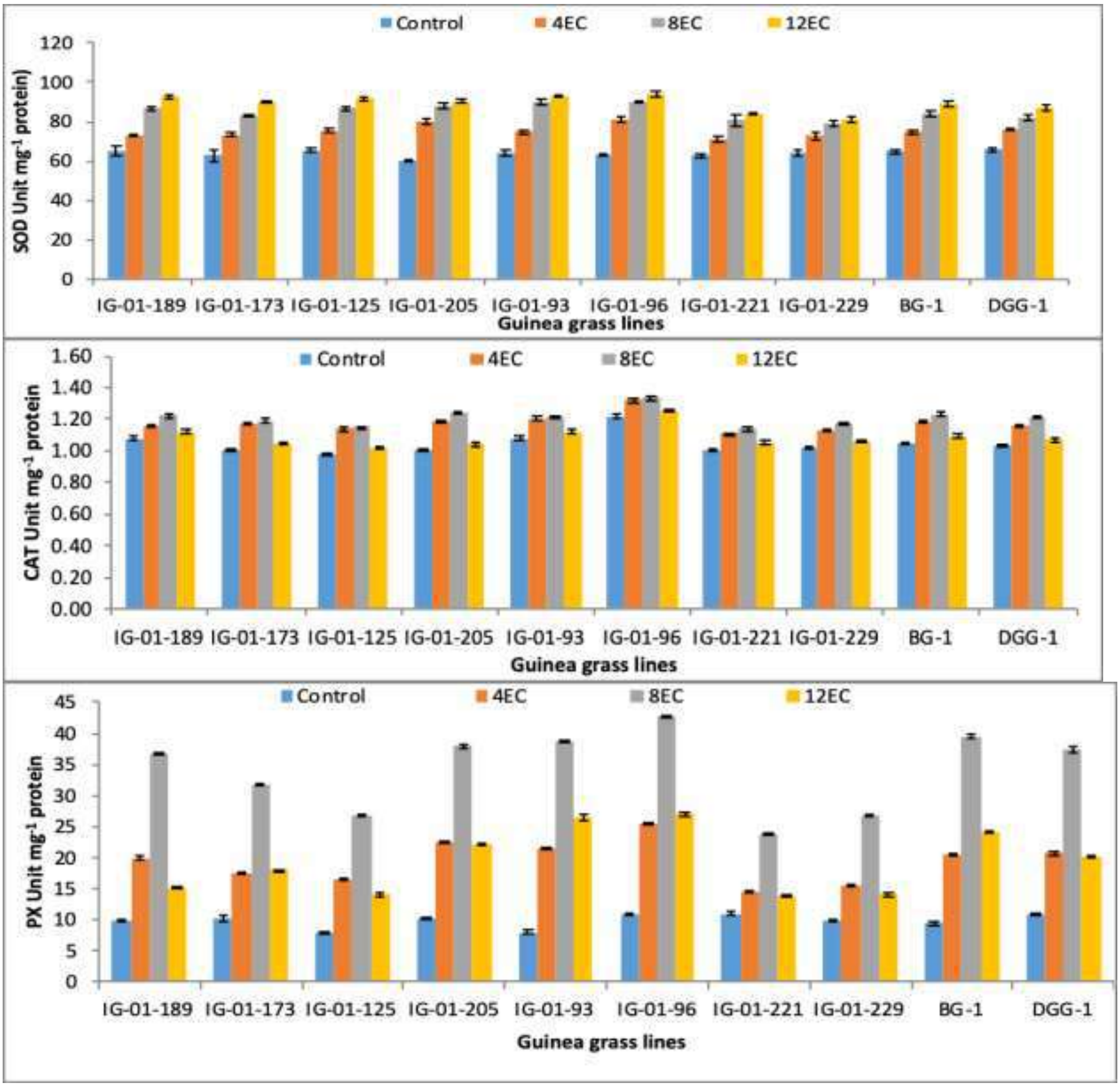


Fig.1: Effect of salinity on antioxidant enzymes (SOD, CAT and PX)

Table-1: Effect of salinity on K^+ and Na^+ concentration and K^+/Na^+ ratio

Caltivars	K^+	Na^+	K^+/Na^+
BG-1	1.1	1.45	0.76
DGG1	1.01	1.52	0.66

Conclusion

The current study indicated that increasing salinity levels affected the antioxidant enzymes and K^+/Na^+ ratio. BG-1 was found to be more salt tolerant than DGG-1 variety, based on antioxidant enzymes activities and K^+/Na^+ ratio. This variety may be selected for breeding programme for development of salt tolerant varieties' and increased fodder production and productivity in salinity-affected areas in arid and semi arid regions of India.

References

Dheeravathu SN, K Singh, PW Ramteke, Reetu, N Dikshit, M Prasad, D Deb, and TB Vadithe. 2021. Physiological responses of Bajra-Napier hybrids and a tri-specific hybrid to salinity stress.Tropical Grasslands-***Forrajes*** Tropicales. 9 (3): 337-347.

Antony E, AB Kawadikai, S Hullur, K Sridhar, S Nayak and VK Yadav.2021. Biomass repartitioning, tiller regeneration and salt secretion through leaf microhairs for salinity tolerance in guinea grass (Megathyrsus maximus Jacq.) Range management & Agroforestry 42 (2): 246-254.

Dheeravathu, SN, V. C. Tyagi., C. K. Gupta. and A Antony. 2018. Manual on Plant Stress Physiology.ICAR-Indian Grassland and Fodder ResearchInstitute, Jhansi. Stress assessment formulasand stress related terminology. pp. 1-87
Jackson, M.L. 1973.Soil chemical analysis.2nd Edn. Prentice Hall of India Private Limited, New Delhi, India.

MandaI, A.K., G Sharma, RC Singh, and JC. Dagar. 2010. Computerised database on salt affected soilsin India, Technical Bull etin: CSSRI/KamaJ/1/l010

ICSCI 2022/T2/104

Assessment of multiple tolerance indices to identify rice lines suitable for aerobic rice

Padmashree R[12], Kalyani M Barbadikar[1]*, Honnappa[12], Nakul Magar[1], Divya Balakrishnan[1], Lokesha R[2], Chanappa Gireesh[1], Anantha M. Siddaiah[1], Sheshu Madhav Maganti[1]

[1]ICAR-IIRR, Hyderabad 500030, [2]Departmentof Genetics and Plant Breeding UAS, Raichur 584104

Email: kalyani.mb@icar.gov.in

Introduction

Climate resilience is the most concentrated subject in the current scenario for rice improvement. The aerobic system of rice cultivation involving direct seeding with need-based irrigation in non-puddled soil is gaining ground with respect to water scarcity. The development of aerobic dry direct seeding adapted rice varieties is immensely needed and underlies the government policy of more crop per drop to double farmer income and livelihood with low input costs. Selection of lines suitable and stable under aerobic along with irrigated conditions without any yield penalty is one of the focus areas of the breeding program for resource use efficiency. In the present study, we have screened a panel of rice lines under aerobic i.e. limited water condition and irrigated conditions to identify ideal selection indices for selecting the best high-yielding and stable linesunder both the methods of rice cultivation. The deployment of selection indices here only pertains to find the differences in yield-related parameters under aerobic and irrigated conditions. We have used the selection indices that are commonly deployed to find the stress related indices under nutrient stress and normal conditions.

Methodology

The 118 rice lines including landraces, germplasm, mutant lines, popular varieties, introgression lines were grown under irrigated and aerobic conditions during *Kharif* 2019 for yield related traits, at ARS Dhadesugur, Raichur, Karnataka in augmented block design. Grain yield per plant was determined under irrigated and aerobic conditions and indicated as Yp and Ys respectively. The grain yield per plant from aerobic (YS) and irrigated condition (YP) was used to estimate stress indices. Analysis of variance, correlation, principal component analysis (PCA) was done using R studio (*version* 4.0.2) (https://cloud.r-project.org/package=augmented RCBD) using the R script. Stress tolerance indices were calculated using the following relationships Stress Tolerance Index - STI = YPYS/(YP)2, Tolerance Index- TOL = YP− YS, Stress Susceptibility Index- SSI = (1 − YS/YP)/ (1 − _YS/_YP), Yield Stability Index- YSI = YS/YP, Yield Reduction Ratio - YR = 1 − (YS/YP), Yield Index - YI = YS/_YS, Percent yield reduction- PYR = ((YP− YS)/YP) × 100 and GMP = (YP × Ys) 0.5.

Results

Analysis of variance showed highly significant differences for most of the indices of the lines (Table1). The mean sum of squares due to lines was significant for all the indices for grain yield under aerobic and irrigated conditions. To determine the most desirable criterion, the correlation coefficient between grain yield under irrigated and aerobic conditions were calculated. A positive significant correlation was observed between Yp and Ys (r = 0.537) suggesting that, indirect selection for an aerobic condition based on the results of normal condition will be efficient. Grain yield per plant had a significant positive correlation with STI, YI, MP and GMP under both irrigated and aerobic conditions, thereforethese indices are the most appropriate in screening high-yielding ricelines in both conditions. In the present study, grain yield and the YSI index exhibited significant positive correlation under aerobic conditions. PCA was performed to discern the per cent contribution of major components and indices towards the total variance using grain yield per plant under both conditions. The first two (PC1 and PC2) components were considered based on the eigen values that are greater than or equal to 1. Biplot analysis confirmed correlation analysis between studied criteria. The first component (PC1) explained 62.45% of the total variation and exhibited a high positive correlation with YI, YS, YSI, GMP, STI and MP, thus the variables belongingto the component one was named as yield potential components with aerobic adaption as explained by Fernandez (1992) group A and group C components as stable performing lines under aerobic and irrigated condition. The second component (PC2) explained 36.72% of the total variation and had the highest positive correlation with TOL, MP, STI, GMP, and SSI except for YRR and PYR (Figure1).

Table 1: Combined analysis of variance for grain yield under irrigated and aerobic conditions and stress tolerance indices for 118 rice lines

Source of variation	Mean sum of square											
	df	YP	YS	STI	TOL	YRR	SSI	YSI	YI	PYR	MP	GMP
Treatment	117	11.96 **	11.93 **	0.23 ns	10.47 **	0.05 ns	0.95 **	0.05 **	0.11 **	458.6 **	9.71 **	1680.52 **
Check	7	4.41 **	5.28 **	0.27 ns	13.32 **	0.14 ns	1.02 **	0.05 **	0.08 **	480.16 **	2.67 **	471.67 **
Test vs. Check	1	15.72 **	38.58 **	3.04 **	30.61 **	0.03 ns	3.75 **	0.35 **	0.99 **	1913.89 **	55.92 **	3363.2 **
Test lines	109	12.41 **	12.12 **	0.2 ns	10.11 **	0.04 ns	0.92 **	0.04 **	0.11 **	443.86 **	9.74 **	1742.71 **
Block	1	3.96 **	4.53 **	1.51 **	0.35 ns	0.09 ns	0.01 ns	0.02 **	0.06 *	0.94 ns	6.25 **	4.55 **
Residuals	7	0.05	0.16	0.12	0.39	0.05	0.0024	0.00037	0.01	0.48	0.03	0.15

*, ** Significant at 0.05 and 0.01 levels of probability, respectively; ns = not significant

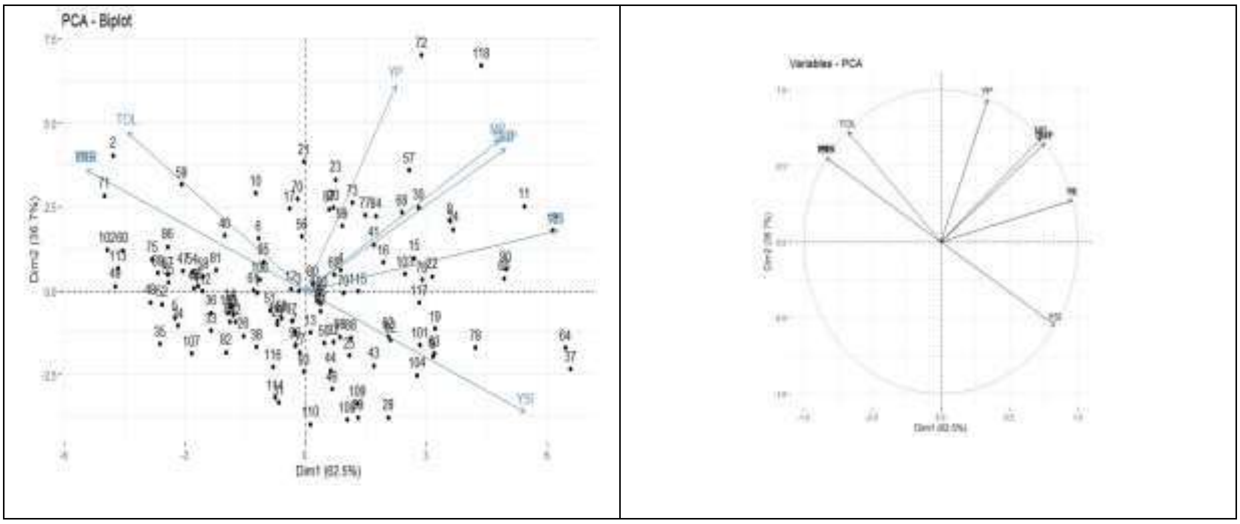


Fig.1: PCA-Biplot and variable plotfor stress tolerance indices under irrigated and aerobic conditions for 118 rice lines

Conclusion

In breeding programs, selection should be based on the tolerance indices calculated from the grain yield under both conditions to develop cultivars having aerobic tolerance (without any yield penalty). According to the results of multivariate analysis (correlation and PCA), STI, YI, MP and GMP exhibited a strong correlation with YP and YS. Therefore, they appear to be the most effective stress indices for the selection of lines with good yield potential under water limited and irrigated conditions. These indices serve as valuable selection criteria for the identification of aerobic-tolerant cultivars from both stress and normal conditions. These indices identified lines DB 5 (Swarna × *Oryza nivara* (IRGC 81848)), GNV-14-96-1 (BPT 5204 × Nerica line), JBB 631-1 ((Swarna*2/ IRGC 4105)

(RP 5405-JBB-631-1-1-1-1-1-1)), TI 124 (EMS induced mutant of BPT 5204), TI 36 (EMS induced mutant of BPT 5204), WB10 (Langphou), WB24 (Pat-Phou) and KR 209 (Wazuhophek × ISM) as promising lines for both environments. These lines are suitable because of low grain yield loss under aerobic conditions and can be further considered for cultivation.

References

Ehlers JD and Hall AE. 1998. Heat tolerance of contrasting cowpea lines in short and long days. Field Crops Research 55: 11–21.

Fernandez GCJ. 1992. Effective selection criteria for assessing plant stress tolerance. In: Kuo, CG, editor. Proceedings of the international symposium on adtheaptation of vegetables and other food crops in temperature and water stress; Chapter 25. Tainan, Taiwan: Shanhua: AVRDC Publication; p. 257–270.

ICSCI 2022/T2/105

Screening of drilled paddy genotypes against yellow stemborer, *Scirpophaga incertulas* (Walker) and leaffolder, *Cnaphalocrocis medinalis* (Guenee)

G.D. Hadiya, C.B. Damor, H.R. Adsul and M.B. Patel
Agricultural Research Station, Anand Agricultural University, Derol, Panchmahals(Gujarat)-389320
Email:hadiyagirish@aau.in

Introduction

One of the most significant staple food grain crops in the world is rice (*Oryza sativa* L.), which is the primary source of nutrition for two-thirds of Indians and 60% of the global population. (Ankita *et. al*., 2021). Farmers are switching to drilled paddy instead of transplanted paddy because they can save up to 25% on water use, 27% on diesel use as pumping energy is saved for field preparation, nursery raising, puddling, and less frequent irrigation water application, save 35 to 40 man days per ha and gain the advantages of earlier crop maturity by 7 to 10 days, which helps in the timely sowing of succeeding crops. (De Datta, 1986). The input requirements and the investment in direct seeded rice are much lower than in transplanted rice (Sunil *et al.*, 2002). More than 100 insect species, 20 of which are significant economically, attack on rice plants. Among these, yellow stem borer, *Scirpophaga incertulas* Walker and rice leaf folder, *Cnaphalocrocis medinalis* Guenee are the dominant and the most destructive insect-pest occurring throughout the country causing the yield loss of about 10-60 per cent (Chatterjee and Mondal Palash, 2014). The stem borer species attacking the rice crop, yellow stem borer, *Scirpophaga incertulas* Walker is considered as the serious and specific pest of irrigated and lowland rice that caused heavy yield loss (Singh *et al.*, 2005). The use of modern synthetic insecticides in crop pest control programmes around the world has resulted in thedisturbance of eco-bio-balance. However, host plant resistance is crucial in the ever-changing worldof pest management programmes. Considering the foregoing, an effort has been undertaken in the current study to screen rice genotypes against the yellow stem borer *Scirpophaga incertulas* (Walker) and the leaf folder *Cnaphalocrocis medinalis* (Guenee).

Methodology

Total 28 drilled paddy genotypes were evaluated against stem borer, *Scirpophaga incertulas* and leaf folder, *Cnaphalocrocis medinalis* in natural field conditions atAgriculturalResearch Station, Anand Agricultural University, Derol during *kharif,* 2021.The crop was raised by adopting standard agronomic practices. Three replications, 30 x 10 cm spacing and a randomized block design were used to set up the experiment. The gross plot sizewas4.0x 2.4m, whereas netplotsizewas4.0x 1.8m. Forrecordingtheobservationson the infestation of stem borer, 5 hills were selected randomly from each net plot at 15 days before harvesting. Observation on percent white ear infestation was recorded by counting the total number of panicles bearing tillers and total number of white ear head was calculated by using the following formula.

$$\text{Whiteears (\%) due to stemborer} = \frac{\text{Totalnumber ofwhite earhead}}{\text{Numberofpaniclebearingtillers}} \times 100$$

For recording the observations of the leaffolder incidence interms of number of damaged leaves by leaf folder, 5 hills were selected randomly from each net plot at the time of peak leaf folder infestation. Observation on percent leaf folder damage was recorded by counting the total number of leaves and number of damaged leaves was calculated by using the following formula.

$$\text{Percent leaffolder damage} = \frac{\text{Number of damaged leaves}}{\text{Totalnumberof leaves}} \times 100$$

Results

During *kharif* 2021 the stem borer and leaf folder infestation was low. The entries NWGD 1804 has recorded significantlylowest per cent white ears due to stem borer (2.61%) and it was *at par* with NWGD 1803, NWGD 1805, NWGD 1806, NWGD 1810, NWGD 1825, NVSR2305, NVSR2601, NVSR2842,NVSR2846,NVSR283,NVSR3031,NVSR3033,NVSR3313,NVSR3332,NVSR3347,N VSR3340andNVSR3488.Significantlyhigher white ears recorded in PURNA (6.44%). In case, leaf folder damage was very low (1.27 to 3.86%) in all the entries. NVSR 2837 and NVSR 3031 was registered significantly lowest leaf folder damage (1.27%), whereas higher leaf folder damage recorded in AAUDR 1 (3.86%).

Table1: Reaction of different entries against yellow stemborer and leaffolder

Sr. No.	Entries	Stem borer (% white ears)	Leaf folder (% leaf damage)
1	NWGD-1803	1.88(3.02)	1.34 (1.29)
2	NWGD-1804	1.76 (2.61)	1.51(1.80)
3	NWGD-1805	2.17 (4.22)	1.33 (1.28)
4	NWGD-1806	2.13 (4.04)	1.41 (1.49)
5	NWGD-1807	2.35 (5.01)	1.61 (2.09)
6	NWGD-1810	2.21 (4.39)	1.36 (1.35)
7	NWGD-1825	1.84 (2.87)	1.45 (1.59)
8	NVSR-2305	1.87 (3.01)	1.63 (2.16)
9	NVSR-2601	2.24 (4.51)	1.69 (2.34)
10	NVSR-2842	2.27 (1.65)	1.65 (2.23)
11	NVSR-2846	2.07 (3.80)	1.61 (2.08)
12	NVSR-2837	2.13 (4.04)	1.33 (1.27)
13	NVSR-3031	1.87 (3.01)	1.33 (1.27)
14	NVSR-3033	2.03 (3.61)	1.34 (1.31)
15	NVSR-3313	2.02 (3.58)	1.52 (1.82)
16	NVSR-3332	1.92 (3.20)	1.38 (1.39)
17	NVSR-3334	2.43 (5.39)	1.70 (2.40)
18	NVSR-3356	2.31 (4.85)	1.9 (3.1)
19	NVSR-3382	2.41 (5.30)	1.98 (3.44)
20	NVSR-3347	2.1 (3.9)	1.89 (3.08)
21	NVSR-3340	2.16 (4.17)	1.42 (1.50)
22	NVSR-3527	2.52 (5.83)	2.02 (3.60)
23	NVSR-3488	2.24 (4.51)	1.78 (2.66)
24	AAUDR-1 (C)	2.48 (5.66)	2.09 (3.86)
25	PURNA (C)	2.63 (6.44)	2.08 (3.83)
26	GR-8 (C)	2.55 (6.00)	1.99 (3.45)
27	GR-16 (C)	2.32 (4.89)	1.85 (2.94)
28	GR-5 (C)	2.54 (5.95)	1.86 (2.96)
S. Em. ±		0.18	0.17
C.D. at 5%		0.51	0.48
C.V. %		14.11	17.75

Conclustion

On the basis of present investigation, it can be concluded that those genotypes showed less damage against yellow stem borer and leaf folder, can be used as donor for varietal developmental programme against yellow stem borer and leaf folder in rice.

References

Ankita MG, Kashid NV, Jadhav, JD and Kamble, KM. 2021. Suitable drilled paddy varieties and sowing windows for drilled paddy in sub Mountain Zone of Pune district of Maharashtra. International Journal of Current Microbiology and Applied Sciences. 10(01): 485-490.

Chatterjee S and Mondal P. 2014. Management of rice yellow stem borer, *Scirpophaga incertulas* Walker using some biorational insecticides. Journal of Biopesticides.7(supp):143-147.

Dedatta, Sharma PK, Surajit K. 1986. Physical properties and processes of puddled rice soils. Advances in soil Science,139-178.

Singh RA, Singh RB, Singh G.2005. Drougt-induced shifting of stemborer species in shallow deep water rice. IRRN, 30(2):24.

Sunil K, Khajanji SN, Shrivastava GK, Tripathi, RS and Kumar S. 2002.Comparative study of different methods of sowing on morpho-physiological traits and economics of medium duration rice (*Oryza sativa*) inceptisols. Journal of Interacademician, 6 (2): 244–249.

ICSCI 2022/T2/106

Screening of rice (*Oryza sativa* L.) genotypes for submergence tolerance during germination and early growth stage

Varsha Rani[1] and Ekhlaque Ahmad[2]

[1] *Department of Crop Physiology, Birsa Agricultural University, Kanke, Ranchi, Jharkhand*

[2] *Department of Genetics and Plant Breeding, Birsa Agricultural University, Kanke, Ranchi, Jharkhand*

Email: bhardwajvarsha83@gmail.com

Introduction

Rice is the staple cereal crop of many regions of India where farmers are dependent on Rice based farming for food and income. Though rice is a semi aquatic plant which is capable of germination and coleoptile elongation under water logged condition, but submergence for longer duration of few weeks in semi deep and deep water areas causes failure of seed germination or death of germinated seed. Exploration of genetic diversity for water logging tolerance is required. Tolerance mechanism under submergence in rice includes faster coleoptiles elongation, formation of roots and leaves in stagnant water. Such genotypes have metabolic process linked to tolerance. When flooding occurs after direct seeding, the rice genotypes which are tolerant germinate faster, germination percentage is more and coleoptiles length is more as compared to sensitive genotypes.

Methodology

In the present laboratory experiment 23 rice genotypes received from ICAR-IIRR, Hyderabad were tested for submergence tolerance where 10 cm water depth was maintained in glass bottled and anaerobic condition was maintained by putting cap over the glass bottles.

Results

The germination percentage and coleoptiles elongation of all the genotypes was observed for 20 days. Out of 23 genotypes MAS 506, MAS 511 and MAS 521 were observed to have good coleoptiles length and around 15 days after submergence the white colored tubular structure of coleoptiles ruptured and turned green in color though the leaf could not expand fully into lamina and remained pin like tubular structure.

Conclusion

These observations depict submergence tolerance in the said genotypes while MAS 516 was observed to be poorest performing genotype with very low seed germination percentage and poor coleoptiles length.

ICSCI 2022/T2/107

Improving reproductive stage salt tolerance in *Saltol* rice through Marker Assisted Backcross Breeding (MABC) in *cv*. ADT 45

Premkumar A, S. Thirumeni, K. Paramasivam, S. Nadaradjan, J. Karthick and M. Tamizharasi

Department of Plant Breeding and Genetics, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal - 609603 Puducherry (U.T) India

Email: prembreeder2107@gmail.com

Introduction

Salinity is one of the major abiotic stresses, next to drought and submergence, limiting productivity worldwide. Conventional breeding method is more laborious and challenging to develop salt tolerant rice varieties due to genetic complexity of the trait and the performance of the genotypes varies from one environment to another environment. With the development of molecular marker technology, salt tolerant genes could be mapped on respective chromosomes. As a result, *Saltol,* a major QTL for vegetative stage salt tolerance, identified and fine mapped on chromosome 1 (at 11.35 Mb) from *Pokkali* was introgressed through Marker Assisted Backcrossing (MABC) in many mega varieties including ADT 45 in India and abroad. However, most of these introgressed lines do not outperform currently grown salt tolerant check varieties, owing to lack of tolerance at reproductive stage. QTL for reproductive stage salt tolerance *qSSISFH 8.1* ('R' *Saltol*) has been mapped on chromosome 8 (10.28 Mb) in CSR 27 (Qin *et al*. 2020 and Krishnamurthy *et al*. 2020). In the present study, an attempt was made to introgress this QTL (*qSSISFH 8.1*) into ADT 45 *Saltol* (possessing vegetative stage salt tolerant) to improve reproductive stage salinity tolerance.

Methodology

The QTL *qSSISFH 8.1* (*R Saltol*) from CSR 27 was introgressed into ADT 45 *Saltol* (KR 15010/IET 28039) through MABC. The marker tool kit consists of 'R' *Saltol* 1 (10.28 Mb) and RM 22739 (9.90 Mb) for foreground selection; RM 22692 (8.90 Mb) and RM 22739 (9.90 Mb) for recombinant selection at proximal and distal ends respectively. The true F_1s of ADT 45 *Saltol* x CSR 27 were identified using markers tightly linked to the target loci namely 'R' *Saltol* 1 and RM 22739 and positive plants (true) were backcrossed to recurrent parent (IET 28039) to develop BC_1F_1 generation. The same procedure was followed for the development of further backcross generations. Recombinant selection using RM 22692 and RM 22807 was done to minimize linkage drag and to obtain double recombinants. Since the recombinant markers were tightly linked to target loci only single recombinants at both ends were obtained. These single recombinants were backcrossed to recurrent parent IET 28039 to obtain double recombinants in BC_2F_1. The double recombinants obtained were selfed to fix homozygous recombinant in BC_2F_2 generation. These BC_2F_2 populations along with parents and checks (IR 29 as susceptible, FL 478 and CSR 27 as tolerant) were screened in hydroponic culture to confirm vegetative stage salt tolerance at an EC of 12 ds/m for a period of 14 days. The promising salt tolerant lines for vegetative stage were subjected to salt stress at an EC of 8 ds/m in pot culture for reproductive stage salt tolerance.

Results

The true F1s were identified using foreground Markers *viz*. 'R' *Saltol 1* and RM 22739. A total of 248 BC_1F_1 were generated and subjected to foreground selection to obtain 108 positive plants. These plants were screened to obtain double recombinants using RM 22692 and RM 22807 as shown in

Figure 1. Three single recombinants, two on the distal end and one on proximal end were obtained and no double recombinant was obtained. These single recombinants were backcrossed to IET 28039 to obtain double recombinants in BC_2F_1 generation. As a result, five double recombinants were obtained and selfed to produce homozygous recombinants (double). The homozygotes along with parents and checks (IR 29 susceptible, FL 478 and CSR 27 tolerant) were screened in hydroponic culture for vegetative stage salt tolerance at an EC of 12 ds/m for a period of 14 days. The tolerant lines identified for vegetative stage salt tolerance are being screened for reproductive stage tolerance. DUS characterization and background genome recovery using 50 K SNP chip are in progress and the promising salt tolerant introgression lines carryboth *Saltol* and *qSSISFH* QTL will be nominated subsequently.

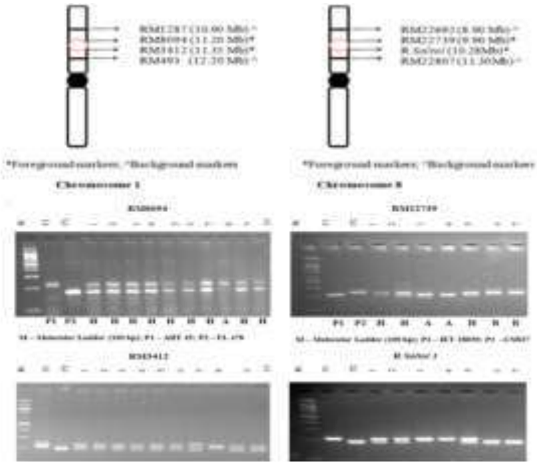


Fig.1. Gel profile showing foreground selections of BC2F2 generation of ADT *Saltol* x CSR27 cross

Conclusion

Thus, combination of QTLs for salt tolerance at both vegetative and reproductive stages can be precisely and rapidly introgressed into mega rice varieties through MABC in a shorter period of time.

References

Qin H, Li Y and Huang R. 2020. Advances and challenges in the Breeding of salt-tolerant rice. International Journal of Molecular Sciences. 21: 8385.

Krishnamurthy SL, Pundir P, Warraich AS, Rathor S, Lokeshkumar BM, Singh NK and Sharma PC. 2020. Introgressed *Saltol* QTL Lines Improves the Salinity Tolerance in Rice at Seedling Stage. Frontiers in Plant Science. 11:833.

ICSCI 2022/T2/108

Enhancing rice productivity under direct sown rice ecosystem

P. Arunachalam, M. Vengateswari and T. Ragavan
Krishi Vigyan Kendra, Tamil Nadu Agricultural University, Ramanathapuram – 623536, India
Email: arunachalp@gmail.com

Introduction

The Ramanathapuram district is known for its climatic vulnerability of dry-spells and high intensity of rainfall during cropping period. The annual average rainfall of this district is 827 mm of which 60 percent of rainfall received during North East Monsoon. The rice cultivation in Ramanathapuram district is encountered with numerous constrains namely uncertainty of rainfall led to intermittent drought / flood, poor physical condition of soil (lees infiltration), salinity of ground water, pre-monsoon dry sowing and rain-dependent intercultural operations limits timely operations of thinning and planting, weeding and fertilizer applications. With these constraints Ramanathapuram records with area under rice cultivation of 133847 ha, low average productivity of rice (2609 kg/ha) as compared to Tamil Nadu average productivity of 3380 kg/ha, (Season and Crop Report, 2020-21). The objective of this study aims to analyse the performance of climate resilient rice varieties, which is having characteristics of short duration with drought tolerance, slender rice with medium duration varieties and high market preference in the NICRA adopted villages by Krishi Vigyan Kendra (KVK) Ramanathapuram.

Methodology

Field demonstration to assess the performance of climate resilient varieties were conducted at farmers filed of NICRA adopted villages with their participation. The soil type of demonstration field is sandy clay loam with pH of 7.8 with low nitrogen, moderate to high phosphorus and potassium.The demonstrations of improved rice varieties at 68 farmers' holding of *Komboothi*,*Karukathi* and *Manjakollai* villages at Thirupulani block during 2021-22. The climate resilient rice varieties CO 53 (115 days), ADT 53 (115 days), TKM 13 (130 days), RNR 15048 (125 days) and VGD 1 were demonstrated under NICRA scheme by Krishi Vigyan Kendra, Ramanathapuram. Pre-monsoon direct sowing of rice was taken by the farmers from second fortnight of September 2021. The farmers followed the recommended packages of practices for their crop husbandry. The grain yield of rice from each demonstration has recorded variety wise at the time of harvesting. The range, mean of grain yield was analysed individual variety.

Results

Among the varieties demonstrated, the ADT 53 performed well under direct seeded condition with an average yield potential of 6459 kg/ha at *Majakollai* village and 6229 at *Karukathi* village (Table 1), followed by TKM 13, which yielded 5877 kg/ha at *Manjakollai* and at 5629 at *Komboothi* and CO 53 resulted 5647 kg/ha and 5363 kg/ha at *Manjakollai* and *Karukathi* respectively. The average yield of 5615 kg/ha at *Komboothi* and at 5403 at *Manjkollai* from short fine grain rice variety VGD 1 has realized. Whereas, the RNR 15048 was yielded 5363 kg/ha at *Komboothi*, 4838 kg/ha at *Karukathi* and 4753 kg/ha at *Manjakollai*. The top performance of 5651 kg/ha was realized at *Manjakollai* village among the villages wise performance followed by *Komboothi* (5531 kg/ha) and *Karukathi* (5128 kg/ha).On large scale testing the TKM 13 variety has recorded a overall mean grain yield of

5938 kg/ha in 159 locations which was 6.2 and 10.1 per cent increase over the check varieties CO (R) 49 (5592 kg/ha) and BPT 5204 (5390 kg/ha) respectively (Banumathy *et. al.* 2016). Both the varieties suited to direct seeded conditions and less prone to pest and diseases. The best performance in CO 53 was due to its drought tolerance in nature. Comparatively reduced yield in RNR 15048 is due to its photosensitivity and pest and disease incidence.

Table 1. Performance of rice varieties in NICRA adopted village demonstrations

S.No.	Village / Variety	No. of Demo	Grain Yield (kg/ha)		
			Minimum	**Maximum**	**Average**
I	***Manjakollai***	**22**	**4225**	**6639**	**5651**
1	TKM 13	6	5663	6639	5877
2	RNR 15048	4	4225	5095	4753
3	ADT 53	4	6175	6330	6459
4	CO 53	4	5525	5558	5647
5	VGD 1	4	5200	5249	5403
II	***Komboothi***	**28**	**4875**	**6947**	**5531**
1	TKM 13	14	5200	6947	5629
2	RNR 15048	5	2103	4631	5363
3	VGD 1	9	5038	5558	5615
III	***Karukathi***	**18**	**4225**	**6175**	**5128**
1	RNR 15048	13	4225	5095	4838
2	ADT 53	3	6013	6175	6229
3	CO 53	2	5363	5095	5363
	Overall	**68**	**4225**	**5730**	**4917**

Conclusion

The results of the demonstrations indicated that ADT 53 is found to be best adopted to the rainfed condition followed by TKM 13. The demonstrated varieties performed well under climatic constraint situations and yielded for its potentiality.

References

Banumathy S, R Saraswathi, A Sheeba, R Manimaran, E Sumathi, M Devanathan, G Manickam, GV Ramasubramanian, R Agila, T Jayaraj, and R Rajendran. 2016. Rice TKM 13: A high yielding medium duration fine grain variety. *Electronic Journal of Plant Breeding*, 7(3): 626-633

Season and Crop Report.2020-21. Department of Economics and Statistics, Government of Tamil Nadu, India.

ICSCI 2022/T2/109

Genetic variability studies for the identification of low phosphorus tolerant rice

Anantha M. S.*, D. Aleena, Honnappa, C. Gireesh, R. M. Sundaram, Senguttuvel P, Ch. Raveendra, V. Swaty, L. V. Subbarao, Abdul Fiyaz R, Aravind Kumar J, Ladha Laxmi, C N Neeraja, Santosha Rathod, R Mahender Kumar, Brajendra

ICAR – Indian Institute of Rice Research (IIRR), Hyderabad, Telangana – 500030

Email: anugenes@gmail.com

Introduction

Rice cultivation is practiced in India from prehistoric period. Rice breeding programmes have made tremendous improvement in yield thereby feeding the growing population. Out of 44 M.ha., of rice area in India, considerably high production is obtained from irrigated ecology. Many of the popular rice varieties are susceptible to both biotic as well as abiotic stresses. Out of the sixteen essential nutrient requirements; Nintrogen (N), Phosphorous (P), potassium (K) and sulfur (S) are major nutrients for rice. Phosphorus (P) is a vital nutrient required for growth and development of rice plant (Cordell and White, 2011). The majority of soils in the rice producing areas is either P-deficient or possesses high P-fixing capacity. The problem of Phosphorous fixation is noticed in both acidic and alkaline soils and becomes unavailable for plant to uptake (Vance et al. 2003). India is the biggest importer of phosphorus-based fertilizers with a 90% depend on import (Swamy et al. 2019). Therefore, there is a pressing need for development of crop varieties which yield better under low Phosphorous condition. This will reduce the fertilizer consumption thereby reducing environmental pollution and also increases farmers' income. Genetic variability available in germplasm is vital for any breeding programmes. To overcome P crisis, development of P efficient rice genotypes adapted to low P conditions is cost effective and environmentally viable, hence the genetic improvement of the tolerance of rice plants to P-limiting soils is need of the hour for the development of rice in order to minimize the application of phosphatic fertilizers and to enhance the sustainable rice production. To study genetic variability for identification of low phosphorus tolerant landraces in rice

Methodology

Landraces consisting of 405 along with checks were evaluated under low soil phosphorous soil at ICAR IIRR Rajendranagar farm to identify tolerant entries. The entire set of entries was screened under low soil P and normal soil P plots and different stress indices were worked out. Based on stress indices calculated using grain yield under low Phosphorous condition and normal soil phosphorous condition, 29 promising entries were selected. These selected entries are screened continuously for two seasons in both normal and low phosphorous conditions. Various genetic parameters like GCV, PCV, and heritability were worked out using above data.

Results

Statistical studies of the agro-morphological data revealed high PCV and GCV values for trails like number of productive tillers per plant, panicle length, filled grains and total number of grains per panicle. Except for the panicle length and spikelet fertility, remaining all the traits showed moderate to high range of heritability coupled with genetic advance indicating the presence of fixable gene action which may suggest a reliable crop improvement through selection of these traits. Principal component analysis revealed plant height, filled grains, test weight, total number of grains, spikelet fertility and grain yield were contributing towards total variability.

Conclusion

The identified stress tolerant promising landraces with desirable plant height, good number of tillers and high grain yield can serve as valuable genetic resources to develop mapping population for low P tolerance in rice breeding programmes.

References

Cordell D, White S (2011) Peak phosphorus: clarifying the key issues of a vigorous debate about long-term phosphorus security. Sustainability 3:2027–2049

Vance CP, Uhde-Stone C, Allan DL (2003) Phosphorus acquisition and use: critical adaptations by plants for securing a nonrenewable resource. New Phytol 157:423–447

Swamy HKM, Anila M, Kale RR, Bhadana VP, Anantha MS, Brajendra P, Hajira SK, Balachiranjeevi CH, Prasanna BL, Pranathi K, Dilip T, Bhaskr S, Kumar AV, Kousik MBVN, Harika G, Swapnil K, Rekha G, Cheralu C, Shankar VG, Reddy NS, Kumar S, Balachnadran SM, Madhav MS, Kumar RM, Sundaram RM (2019) Phenotypic and molecular characterization of rice germplasm lines and identification of novel source for low soil phosphorus tolerance in rice. Euphytica 215:118. https:// doi.org/10.1007/s10681-019-2443-0

ICSCI 2022/T2/110

Effect of low soil phosphorus on pollen and spikelet fertility in *Oryza glaberrima* steud. genotypes

K. Niranjana[1&3], B. V. Varaprasad[3], D. Srinivasa chary[2], B. Muralidhar[1], C. A. Manoj[1], C. Gireesh[1], P. Senguttuvel[1], K. B. Kemparaju[1], K. Suneetha[1], Santosha Rathod[1], L. V. Subba Rao[1], Brajendra, R. M. Sundaram[1], Anantha M S[1]*

[1]*Department of Plant Breeding, ICAR – Indian Institute of Rice Research, Hyderabad*
[2]*Central Instrumentation Cell, PJTSAU, Hyderabad*
[3]*Department of Genetics and Plant Breeding, PJTSAU, Hyderabad*
*Email:*anugenes@gmail.com

Introduction

Sustainable agriculture for the future aims to maximize the output by minimizing the inputs like fertilizers. Rice production is constantly affected by threat of biotic and abiotic stresses, adverse effects of rapidly changing climate, nutrient-deficient soils, etc. Phosphorus (P) nutrition is of unequivocal importance for the production of rice crop. Low soil phosphorus (P) levels is a major factor limiting rice yields in many resource-poor farms worldwide, while P fertilizer inputs represent a large proportion of the cost of rice production in high-input farming systems (Lacy *et al.* 2006). It was reported that environmental stresses cause a decline in pollen production, pollen number on stigma, pollen viability and pollen germination or retardation in pollen tube growth and those are the contributory factors to spikelet sterility (Khan and Abdullah, 2003). Therefore, pollen quality plays an important role in male fertility of rice and pollen grains can be used as an indicator of plant health as well as a screening tool for cultivar selection. *Oryza glaberrima* Steud.was considered as a rich reservoir of genes for various biotic and abiotic stresses. The major objectives of the study are as follows (i) Study of pollen fertility among *Oryza glaberrima* genotypes under low Phosphorous condition(ii) Correlation between pollen fertility and spikelet fertility in *Oryza glaberrima accessions*

Methodology

The material comprises of 31 *Oryza glaberrima* accessions along with four *Oryza sativa* checks viz., low soil P tolerant checks (Rasi and Swarna) and low soil P sensitive checks (Improved Sambha Mahsuri and MTU 1010) and they were grown under low soil P plot (with available P <3.0 ppm) and also in a plot with normal soil P (with available P > 30 ppm) during the wet season (i.e., Kharif), 2019. Yield and yield attributing characters along with pollen fertility and spikelet fertility were recorded. Pollen samples were collected from both low soil P plot and normal soil P plot and evaluated for pollen fertility and spikelet fertility. Three different pollen samples containing spikelets were collected randomly from each entry. Pollen samples were collected from the panicles present on the primary tillers by avoiding the top 1/3rd and bottom 1/3rd part of the panicles in order to reduce errors. From each sample three independent microscopic fields, so totally nine independent fields were recorded for each entry. The 6-10 anthers from different spikelet were collected on a clean glass slide and crushed using 1% Iodine-Potassium Iodide solution (Rosamma *et al.* 2005). For spikelet fertility study, randomly selected 5 panicles from each entry were counted for fertile spikelets and sterile spikelets and spikelet fertility is calculated.

Results

Based on pollen fertility observations, pollen grains were classified as fertile, partial fertile and sterile. Each genotype expressed varying degrees of fertile pollens, partial fertile pollens and sterile pollens. Under low soil fertility condition, fully fertile pollen grain percentage among the genotypes ranged from 63.43% (EC 861797) and 86.11 % (EC 861815) with the mean value of 82.28%. Partial fertile pollen grain percentage under low soil P condition was ranged from 2.34 % (EC861787) to 16.87% (EC861797) with the mean value of 5.88%. Sterile Pollen grain percentage under low soil P condition was ranged between 7.91 (EC861805) and 16.22% (EC861797) with the mean value of 11.81%.Under low soil Phosphorus condition, the spikelet fertility ranged between 60.52 (EC 861801) and 90.27 % (Rasi) with the mean value of 78.28 % (Table 1). Among the *Oryza glaberrima* lines, highest spikelet fertility among *O. glabberima* was observed in the accession, EC 861791 (86.34%) followed by EC 861812 (86.29%) and lowest being observed in EC 861801(60.52%).

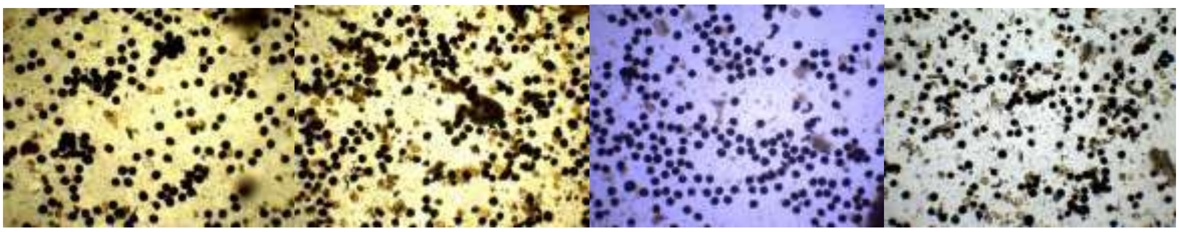
Correlation between pollen and spikelet fertility under low soil phosphorus condition.

Correlation between pollen fertility and spikelet fertility under low soil phosphorus condition was analysed. It is observed that under low soil phosphorus condition there exists a significant positive correlation between pollen and spikelet fertility. Results of correlation study under low soil P condition were given in Table 1.

Table 1: Correlation between pollen and spikelet fertility under low soil phosphorus condition.

Traits	Low P	
	Spikelet Fertility	Pollen Fertility
Spikelet Fertility	1.00	0.40*
Pollen Fertility	0.40*	1.00

* - significance at 5%   ns – non-significance at 5%



1) a. N. EC 861797 b. P_0. EC 861797 2) a. N.EC 861817 b. P_0.EC 861817

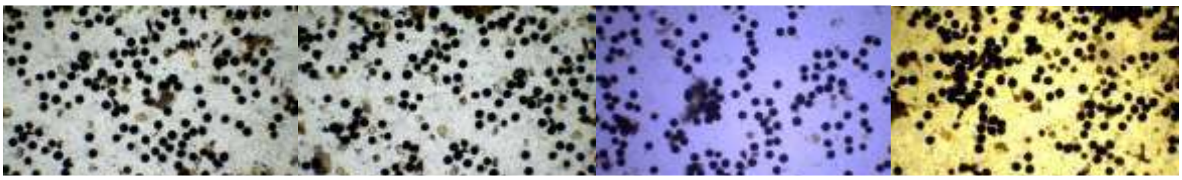


Fig. 1. Comparative microscopic fields of pollen grains from normal and low soil P

3) a. N. EC 861804 b. P_0. EC 861804 4) a. N. EC 861810 b. P_0. EC 861810

N – normal, $\mathbf{P_0}$ – low soil P pollen field.

Low soil phosphorus availability resulted in reduced pollen fertility in turn reduced spikelet fertility, ultimately greater yield losses under P-stress conditions in rice. Therefore, breeding for genotypes with efficient phosphorus utilization will overcome yield losses under phosphorus poor farming conditions. Breeding for genotypes with efficient phosphorus utilization will overcome yield losses under phosphorus poor farming conditions.

References

Lacy J., Batten G., Williams R., Beecher G., Kealey L., Lewin L., Humphreys L., Neeson R. and Ramsey B. 2006. In: Kealey LM, Clampett WS (eds) Production of quality rice in south eastern Australia. Rural Industries Research and Development Corporation, ACT. *Crop nutrition.*

Khan M.A. and Abdullah Z. 2003. Salinity induced changes in reproductive physiology of rice under dense soil conditions. *Environ Exp Bot*. **49**: 145-157.

Rosamma C.A. and Vijayakumar N.K. 2005.Maintainers and restorers for CMS lines of rice. *Journal of Tropical Agriculture*.**43**: 75–77.

ICSCI 2022/T2/111

Development of salinity and stagnant flooding tolerant rice varieties for low lying salt affected coastal saline soils

Manohara, K. K[1]., Yogini Shanbhag[2], Paramesha V[3] and Parveen Kumar[4]
ICAR-Central Coastal Agricultural Research Institute, Goa, 403 402
Email: manohar.gpb@gmail.com

Introduction

Coastal saline soils are usually monocropped with rice during the *Kharif* season. Rice productivity is low and unstable due to the prevalence of multiple abiotic stresses during the cropping season (Manohara and Singh, 2015). Salinity in combination with stagnant flooding affects rice productivity to a greater extent. Due to this, farmers still cultivate local landraces showing wider adaptability to different stresses prevailing in such areas. The local landraces though tolerant to salinity and stagnant flooding, are low yielders, usually prone to lodging because of their tall plant type (Manohara and Singh, 2015, Manohara et al 2019). Therefore, there is a need for the development of high yielding multiple stress tolerant rice varieties with tolerance to salinity and stagnant flooding. This would help in increasing the productivity under low lying coastal saline soils and also in increasing the sustainability of the coastal rice ecology.

Methodology

In the present study, we used six Recombinant Inbred Line Populations (RILs) derived from different parent combinations *viz*., Goa Dhan 1 x KS 19-2, Goa Dhan 1 x CSR 27, Goa Dhan 1 x Jaya, Jaya x CSR27, Goa Dhan 3 x Jaddu Batta and Karjat 3 x KS19-2, The experimental site chosen was a low lying paddy field prone to periodical flooding and water stagnation. Altogether 1221 lines from above six populations were planted in Augmented RCBD design to evaluate and select the superior lines in terms of grain yield, plant type, gain quality and tolerance to lodging. Thirty-one lines were selected and were multiplied during the *rabi* season 2021-22. During *kharif* 2022, 31 short listed lines were evaluated under saline and non-saline conditions along with five check varieties viz., Goa Dhan 1, Goa Dhan 2, Goa Dhan 3, Goa Dhan 4 & Jaya. Observations were recorded on yield and its attributing traits and combined analysis of variance was performed using R statistical package.

Results

Analysis of variance showed significant differences among the tested lines between stress and non-stress environments. Under non stress condition, grain yield ranged from 4.0 t/ha (Goa Dhan 2) to 7.8 t/ha (GD1/CSR27 RIL53). Top five entries with respect to grain yield under non stress condition are GD1/CSR27 RIL53 (7.80 t/ha) followed by GD1/CSR27 RIL11Goa (7.72 t/ha), GD1/Jaya RIL 22 (7.69 t/ha), GD1/CSR27 RIL178 (7.45 t/ha) and GD1/CSR27 RIL 88 (7.03). Grain yield under stress (coastal salinity condition) ranged from 1.46 t/ha (Jaya/CSR27 RIL117) to 4.32 t/ha (GD1/Jaya RIL74). Highest grain yield was recorded in GD1/Jaya RIL74 (4.32) followed by K3/KS19-2 RIL222 (4.16), GD1/CSR27 RIL109 (4.15), GD1/Jaya RIL66 (4.12) and Goa Dhan 3 (4.07). Three genotypes *viz*., GD1/CSR27 RIL178 (7.45 & 4.15 t/ha), GD1/Jaya RIL145 (6.61 & 4.07 t/ha) and GD1/CSR27 RIL 88 (7.03 & 3.97) showed superior performance in both stress and non-stress condition. Such genotypes with least difference in the mean grain yield between stress and non-stress condition may be considered for further testing and release as variety in the stress prone area.

Conclusion

Rice production in the low lying coastal saline soils is challenged by frequently occurring multiple abiotic stresses. With the changing climatic conditions, there has been rise in the sea level, resulting in frequent inundation of low lying paddy fields. In the present investigation, we identified three genotypes superior in terms of grain yield under salinity and normal condition. Such genotypes could be short listed for further testing in the multilocation trials and recommend as varieties to boost the productivity of rice in the low lying coastal areas.

References

Manohara, K. K., Bhosle, S. P. and Singh, N. P. 2019. Phenotypic diversity of rice landraces collected from Goa state for salinity and agro-morphological traits. *Agricultural Research*. 8(1):1-8. https://doi.org/10.1007/s40003-018-0354-2.

Manohara, K. K. and Singh, N. P. 2015.Genetic variability, correlation and path analysis in rice (*Oryzasativa* L.) under coastal salinity conditions of Goa.*Journal of the Indian Society of Coastal Agricultural Research*. 33(1): 34-39.

ICSCI 2022/T2/112

Phenotypic screening and introgression of anaerobic germination tolerance into the popular direct seeded rice variety, DRR Dhan 44

C. Gireesh[1*], Ch. Raveendra[1], M. S. Anantha[1], L. V. Subbarao[1], R. M. Sundaram[1], P. Senguttuvel[1], M. Prasanth[1], V. Swathy[1], Shruti[1], D. Aleena[1], V. Udaya[1], and T. Harisha[1]

[1] *ICAR – Indian Institute of Rice Research (IIRR), Hyderabad, Telangana - 500030*

Email: giri09@gmail.com

Introduction

Rice is staple food crop in India and grown in 43.5 million ha with total production of 124.5m.t. It is grown in irrigated, rainfed (lowland and upland) and flood prone ecosystems. Puddling and transplanting of rice seedling is main method of rice cultivation in irrigated ecology. It is reported that nearly 30% of water required for rice cultivation is utilized in puddling alone (Alam *et al*., 2020). The rice cultivation under standing water creates anaerobic condition and emits significant amount of methane gas causing global warming. In view of depleting water resources and shortage of labours for agriculture, alternate method of rice cultivation is imperative. This necessitates a shift in cultivation practice from transplanted to direct-seeded rice (DSR). The DSR method of rice cultivation will save water up to 35-54%, labour up to 11-66%, and reduces methane emission significantly (Chakraborty *et al*., 2017). Besides, the crop matures early by 7-10 days and also the cultivation is amenable for farm mechanization. In the changing climate, scarcity of labour and water, uncertainty of rainfall, the DSR is gaining popularity and replacing transplanting method of rice cultivation. Due to climate change, the heavy rains and flash flood are recurring soon after direct sowing, the field will be submerged in water leading to anaerobic condition (oxygen deficit) and cause failure of seed germination, subsequently crop failure. The rice has poor ability to germinate under water (anaerobic condition). Because of this reason, farmers are reluctant to practice DSR cultivation. The anaerobic germination tolerance (ability to germinate under water) is considered to be key for success and large-scale adoption of DSR cultivation in farmer's field. Based on this background, the present study was aimed with the following objectives: 1. Phenotypic screening of landraces and some identified donors and 2. Introgression of anaerobic germination tolerance into DRR Dhan 44

Methodology

A landrace from Myanmar, Khao Hlan On (KHO) possessing a major QTL, *qAG-9–2* (designated as AG1) for anaerobic germination was used as donor. A popular direct seeded rice variety, DRR Dhan 44 released from ICAR-IIRR was used as female parent for introgression of AG1 QTL. Landraces and some identified donors along with the parents (KHO and DRR Dhan 44) were initially screened under artificial anaerobic germination conditions at ICAR-Indian Institute of Rice Research (IIRR), Hyderabad. The seeds were sown in small cups and submerged in water with 10cm water level maintained above the soil surface. The observations like germination percentage (G%), seedling height (SH) and root length (RL) were observed at 10, 15 and 21 days after sowing (DAS). Hybridization was done between the parents and the true F_1 plants were confirmed by the tightly linked molecular marker, RM24161.

Results

The anaerobic germination tolerant donor KHO has showed 100 per cent germination under anaerobic conditions at 10 DAS while DRR Dhan 44 has showed no germination at 10 and 15 DAS. The shoot length of KHO was 5cm at 10 DAS, 17cm at 15 DAS and 26cm at 21 DAS. Whereas as the DRR

Dhan 44 showed sluggish growth of 5cm even after of 21 DAS with just 20% germination indicating DRR Dhan 44 is highly sensitive to anaerobic condition. The true F_1 plants which were confirmed by molecular marker RM24161 were backcrossed with DRR Dhan 44 to develop BC_1F_1. Foreground and background selection will be carried out at further backcross generations to develop the anaerobic germination tolerance version of the DRR Dhan 44 carrying the AG1 QTL.

Table. 1 Details of anaerobic germination results at 10, 15 and 21 days after sowing (DAS)

Genotype	10 DAS			15 DAS			21 DAS		
	G (%)	SH (cm)	RL (cm)	G (%)	SH (cm)	RL (cm)	G (%)	SH (cm)	RL (cm)
D14	60	1	0.5	60	4	2	70	12	5
D20	-	-	-	-	-	-	30	7	4
DRR Dhan 44	-	-	-	-	-	-	20	5	2
KHO	100	5	2	100	17	5	100	26	8.5

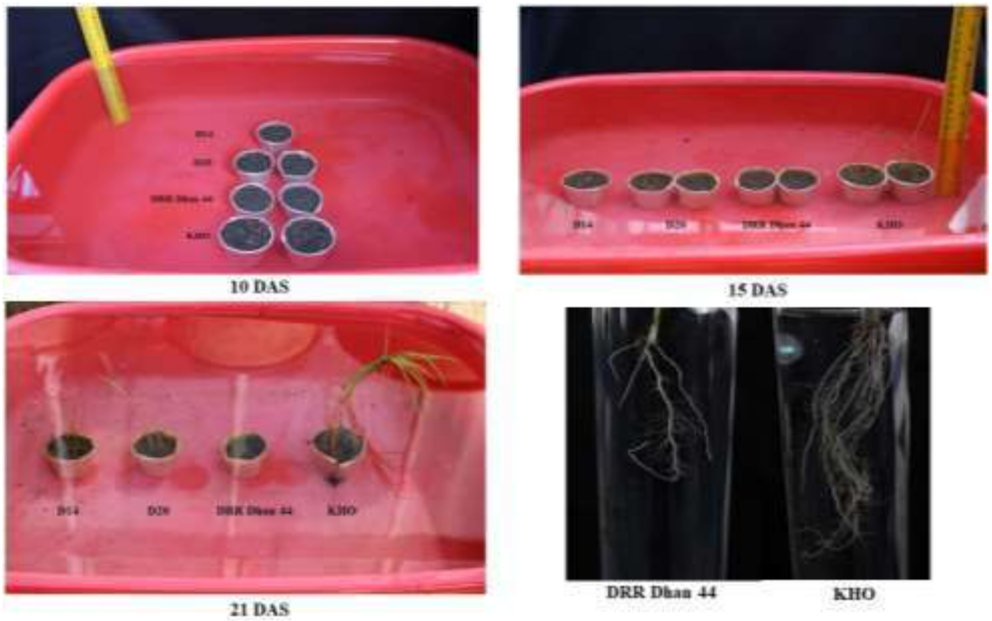


Fig. 1 Image showing the anaerobic germination tolerance of KHO at 10, 15 and 21 DAS

Conclusion

The experimental results have clearly shown that the KHO is highly tolerant to anaerobic germination and introgression of AG1 QTL into the direct seeded varieties mitigates the flooding effect and ensures uniform germination under the DSR conditions.

References

Alam MK, Bell RW, Hasanuzzaman M, Salahin N, Rashid MH, Akter N, Akhter S, Islam MS, Islam S, Naznin S, Anik MFA, Apu MMRB, Saif HB, Alam MJ and Khatun MF. 2020. Rice (*Oryza sativa* L.) Establishment Techniques and Their Implications for Soil Properties, Global Warming Potential Mitigation and Crop Yields. Agronomy, 10(6):888.

Chakraborty D, Ladha JK, Rana DS, Jat ML, Mahesh kumar G, Sudhir Yadav, Rao AN, Ramesha MS and Anitha Raman. 2017. A global analysis of alternative tillage and crop establishment practices for economically and environmentally efficient rice production. Scientific Reports,**7**, 9342.

ICSCI 2022/T2/113

Interrelationship studies among *OsPSTOL 1*geneintrogressed backcross inbred lines of rice (*Oryza sativa* L.)

Aananthi N[1] and R Anusha[2]
1Associate Professor (Plant Breeding &Genetics), Agricultural Research Station, TNAU, Kovilpatti -628501.
2 PG Scholar, Department of Plant Breeding and Genetics, AC &RI, Madurai -625104.

Introduction

Rice (*Oryza sativa*L.) is one of the most significant food crops grown in various agro-climatic conditions around the globe. With the largest area under rice(43.39 million hectares), a quarter of (22%, i.e. 104.3 million tonnes) of the world's rice is produced in India, with average productivity of 2.40 tonnes ha^{-1}.The FAO's forecast for global rice production in 2022 is 519.5 million tonnes. In addition 116 mt of rice will be needed by 2035 to feed the growing population (Emeric *et al.*,2019). The nutrient Phosphorus (P) plays an indispensable role required for all life forms and is one of the most regulated nutrients for plant growth and reproduction (Hou *et al*. 2020). A crucial macronutrient call ed P makes almost 0.2 percent of the dry plant matter Ramaekers *et al.* (2010).Rice (*Oryzasativa*) is very susceptible to Phosphorus deficiency. Around the world, 50 percent (20 million ha) of the rice-growing soils are P deficient. To meet the estimated output of crop growth application of exogenous P fertilizer is essential. The world P reserves are rapidly declining and may be nil by the year 2050. To feed the growing population improved varieties resistance and tolerance to various pests, diseases and nutrients to be developed. Thus, the research involved the introgression of phosphorus starvation tolerance into the lines from the resistant parent. Objectives: To screen the *OsPSTOL 1* introgressed lines (BC_3F_2), for phosphorous starvation tolerance and evaluation of its agronomic performance. To identify phosphorous starvation tolerance lines through molecular marker analysis.

Methodology

A total of 75 plants of five BC_3F_2 populationbelonging to Anna R4 x Samba Mahsuri Pup 1 cross was taken. Anna R4, a drought tolerant susceptible variety for phosphorus starvation and Samba Mahsuri Pup 1, a fine grain donor parent were analysed. The Methodology involves the gene profiling and molecular marker analysis. Biometrical observation was recorded for fifteen plants of each population. For days to 50% flowering, days to maturity, plant height, panicle length, the total number of tillers per plant and single plant yield

Gene profiling: The genotypic screening was carried out for the 75 plants to identify those plants containing the required phosphorus starvation tolerance *OsPSTOL1*gene. The DNA was isolated using the standard isolation methods.

Molecular marker analysis: The molecular markers analysis involves the use of foreground markers and background markers analysis analysing the presence of *OsPSTOL* 1 gene using foreground markers. A total of 80 polymorphic markers appropriately covering all 12 chromosomes were analyzed, and the polymorphic markers were used for the parental genome recovery. Background analysis was performed on plants that were screened positive for the *OsPSTOL 1* gene in the backcross population and that are homozygous for the recurrent parent. Scores were given to PCR amplicons, with "A" standing for the donor allele, "B" for the recipient allele, and "H" denoting the percentage of heterozygous background recovery.

Results

The interrelationship study among the various plants for ANNA R4 x Samba Mahsuri *Pup 1* , the trait single plant yield exhibited the highest, significant, and direct positive correlation with the number of tillers per plant (0.679). High positive and significant correlation between plant height (0.281) and days to maturity (0.280). The character days to fifty percent flowering (0.13) showed a positive but non-significant correlation with single plant yield.

Inter correlation among the various traits with yield

Days to maturity had a significant positive association (0.575) with days to 50% flowering of plants. Panicle length (cm) had positive significant association with yield through plant height (0.280). Total number of tillers per plant had a positive significant association with days to maturity (0.296), plant height (0.244), and days to fifty percent flowering (0.227). In the cross of Anna R4 x SMP, the single plant yield has the highest, significant, and direct positive association with the number of tillers per plant, and plant height. Thus, selecting these traits for yield improvement would be effective for crop improvement. The positive and significant correlation for the various characters *viz.*,the number of tillers per plant (Jeke *et al*., 2021), plant height (Nirubana *et al*.,2019) reported similar results for single plant yield. The intercorrelating traits *viz.*, total number of tillers per plant had a positive significant association seen through the days to maturity, plant height, and days to fifty percent flowering.

Genotypic correlations for various biometrical traits in Anna R 4 x Samba Mahsuri Pup 1 cross

	DFF	DTM	PH	PL	NT	SPY
DFF	1.000					
DTM	0.575**	1.000				
PH	0.147	0.118	1.000			
PL	-0.114	0.060	0.280*	1.000		
NT	0.227*	0.296**	0.244*	-0.103	1.000	
PT	0.196*	0.300**	0.247*	-0.099	0.934**	
FGP	-0.019	0.164	0.082	0.029	0.656**	
SF	-0.040	0.154	0.034	0.019	0.644**	
HGW	-0.100	0.027	-0.161	-0.113	-0.037	
SPY	0.113	0.280*	0.281*	0.006	0.679**	1.000

Conclusion

The traits *viz.*, the number of tillers per plant, plant height and days to maturity of the plants were directly correlated to the yield of the plant. Thus these traits, the total number of tillers per plant, influences the yield of a single plant.

References

Hou, Enqing, Dazhi Wen, Lifen Jiang, Xianzhen Luo, Yuanwen Kuang, Xiankai Lu, Chengrong Chen, Keanan T Allen, Xianjin He, and Xingzhao Huang. 2021. "Latitudinal patterns of terrestrial phosphorus limitation over the globe." *Ecology letters* 24 (7):1420-1431.

Jeke, Elias, Tenyson Mzengeza, Kang Kyung-HO, and Cornwel Imani. 2021. "Correlation and Path Coefficient Analysis of Yield and Component Traits of KAFACI doubled haploid Rice *(Oryza sativa* L) Genotypes in Malawi." *Int J Agriculture Technology* 1 (2):1-9.

Nirubana, V, C Vanniarajan, N Aananthi, S Banumathy, S Thiyageshwari, and J Ramalingam. 2019. "Genetic variability, cause and effect analysis for yield components and phosphorous content in rice (*Oryza sativa* L.) genotypes." *Electronic Journal of Plant Breeding* 10 (3):1011-1018.

Ratna, M, S Begum, A Husna, SR Dey, and MS Hossain. 2015. "Correlation and path coefficients analyses in basmati rice." *Bangladesh Journal of Agricultural Research* 40 (1):153-161.

Robinson, Berol L, and Leon Madansky. 1951. "Angular Correlation of the Gamma-Rays of Cs 134." *Physical Review* 84 (3):604.

Theme III

Resource (water, nutrients, energy, labor, etc.) use and conservation, in SCI (Natural Farming, Organic farming, Conservation Agricultur, etc.), climate resilience and ecosystem protection

Lightning talk **ICSCI 2022/T3/14**

A critical study on the present status and scope of natural farming in the state of Andhra Pradesh, India

B. Srishailam, Dr. V. Sailaja, Dr. S V Prasad
Department of Agricultural Extension Education, S V Agricultural College, Tirupati, Acharya N G Ranga Agricultural University, Andhra Pradesh.
E-mail- sribathini15@gmail.com

Introduction

The continuous and indiscriminate use of fertilizers and pesticides for cultivating crops has resulted in a negative impact on ecological, economic and existential aspects of agriculture. Also, the declining fertilizer crop response ratio has resulted in stagnated and reduced crop productivity. To increase the yield, farmers were buying the external inputs sold at a high price, which has pushed many farmers into the vicious cycle of poverty and it has also resulted in farmers' distress. Against this backdrop, globally several models have emerged as alternative options. Among many models, natural farming has recorded some successNatural farming is emerging as one of the sustainable farming practices worldwide. The cost of biological inputs per hectare in natural farming is lower than that of chemical inputs across all the crops grown (Galab *et. al*., 2019). This cost reduction is due to the use of on-farm available resources in the preparation of inputs. In Karnataka, a survey revealed that 85% of farmers reported improved income, 90% reported reduced production costs, 92% reported a reduced need for credit, 91% reported improved quality of produce and 78% reported improved yields (Khadse et al, 2018). To strengthen and sustain the natural farming and to make it a mass movement, the Government has introduced a Bhartiya Prakritik Krishi Paddhati (BPKP) as a sub-scheme of Paramparagat Krishi Vikas Yojana (PKVY) during 2020-21. Apart from BPKP, the Government of Andhra Pradesh, Department of Agriculture is implementing Andhra Pradesh Community managed Natural Farming (APCNF) Programme since 2016, through the Rythu Sadhikara Samstha (RySS), a not-for-profit organization established by the Government of Andhra Pradesh for promotion of Natural Farming in the state to minimize the cost of cultivation and the sustainability of farming. Therefore, to understand the status of natural farming in the state, a field study was undertaken.

Methodology

A total of 40 farmers who were practicing natural farming were selected purposefully from the Krishna district of Andhra Pradesh. Two villages namely Vadlamanu and Chinna Agiripalli were selected from Agiripalli blocks well as Akturu and Sheri Narasanna Palem villages were selected from the Unguturu block. Further, the data was also collected from 10 extensional professionals and 5 consumers from the state to elucidate their opinion on natural farming

Results and discussions

Villages profile of the study

The study reveals that 90.6 %, 97.4 %, 86.4 % and 29.9 % of farmers out of total farmers are practicing Natural Farming on 80.5 %, 60.4 %, 21.1 % and 23.8% of the total cultivable area in Vadlamanu, Chinna Agiripalli, Atkuru and S N Palem villages, respectively. It can be observed that Vadlamnu has the highest percent of land under natural farming and Chinna Agiripalli has the highest percent of natural farming farmers. The major crops grown under natural farming were Paddy and black gram and followed by mango and vegetables.

Area under natural farming in selected villages of Andhra Pradesh

The study revealed that the selected farmers of the district had an average total cultivable area of 3.2 acres with 2.4 acres under natural farming. Out of the selected villages, the farmers from Vadlamanu village have more area under natural farming, *i.e.*, 44.80 acres of land. The major factors that facilitated farmers in the adoption and practicing of natural farming were the training programs, demonstrations, village level meetings, SHG meetings with villages and other capacity building activities organized by RySS. The survey results show that the farmers of the selected village have been practicing natural farming in the last 6 years. But this differs from village to village and farmer to farmer, for example on average the farmers of Atkuru village started practicing natural farming in last 2 to 3 years.

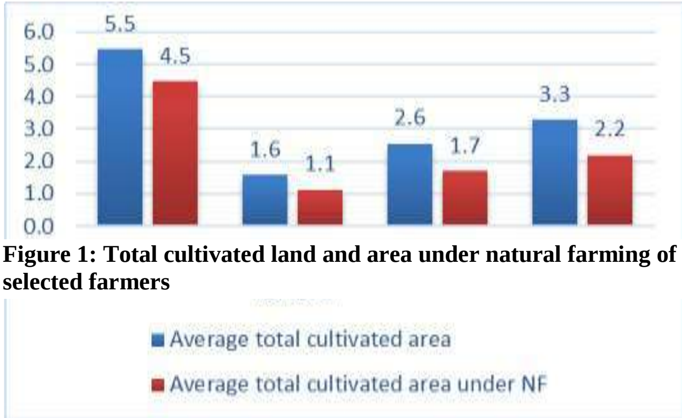


Figure 1: Total cultivated land and area under natural farming of selected farmers

Category of the selected farmers

The study shows that majority of farmers belong to the category of marginal farmers (50%) and small farmers (35%) followed by semi medium farmers (12%) and very few medium farmers (3%). As practicing on marginal and small area is easy, less labour intensive (and also does not require much time & place in the preparation of inputs for natural farming. This wider adoption was due to the influence of extension professionals from RySS (especially CRPs & ICRPs) and their motivation and training to adopt natural farming practices.

Practices adopted by natural farming farmers

Sr.	Adopted Practices	Vadlamanu (n=10)	Chinnaagiripalli (n=10)	Atkuru (n=10)	S N Palem (n=10)	Total (n=40)
1.	*Beejamruth*	08 (80.00)	10 (100.00)	10 (100.00)	10 (100.00)	38 (95.00)
2.	*Jeevamruth*	10 (100.00)	10 (100.00)	10 (100.00)	10 (100.00)	40 (100.00)
3.	*Ganjeevamruth*	10 (100.00)	08 (80.00)	10 (100.00)	10 (100.00)	38 (95.00)
4.	*Agniastra*	07 (70.00)	07 (70.00)	10 (100.00)	10 (100.00)	34 (85.00)
5.	*Bramhastra*	08 (80.00)	06 (60.00)	07 (70.00)	08 (80.00)	29 (72.50)
6.	*Neemastra*	09 (90.00)	09 (90.00)	09 (90.00)	10 (100.00)	37 (92.50)
7.	*Whapasa*	08 (80.00)	08 (80.00)	10 (0.00)	07 (70.00)	33 (82.50)
8.	*Acchadana*/mulching	09 (90.00)	10 (100.00)	10 (100.00)	10 (100.00)	38 (97.50)
9.	*Kashayams*	08 (80.00)	10 (100.00)	10 (100.00)	10 (100.00)	38 (95.00)
10	*Go-KruppaAmruth*	09 (90.00)	08 (80.00)	10 (100.00)	10 (100.00)	37 (92.50)

11.	Crop propagation	07 (70.00)	08 (80.00)	10 (100.00)	10 (100.00)	35 (87.50)
12.	No tillage	01 (10.00)	00 (00.00)	00 (00.00)	00 (00.00)	01 (02.50)
13.	Inter/mix/poly crops	07 (70.00)	06 (60.00)	06 (60.00)	10 (100.00)	29 (72.50)
14.	Use of local cultivar seeds	10 (100.00)	09 (90.00)	09 (90.00)	10 (100.00)	38 (95.00)

Experience of farmers in Agriculture and Natural Farming in Krishna district:

It was observed that natural farming was adopted in recent years by those farmers whose farming experience was more than 12 years. This may be because, over the years, farmers experienced low yield, health impacts, soil quality deterioration and increased cost of cultivation which is why they wanted to attempt a more sustainable agriculture practice in their field. The majority of the farmers (83%) in the district have a moderate experience in natural farming, which likely reveals that natural farming has become prevalent in the recent past.

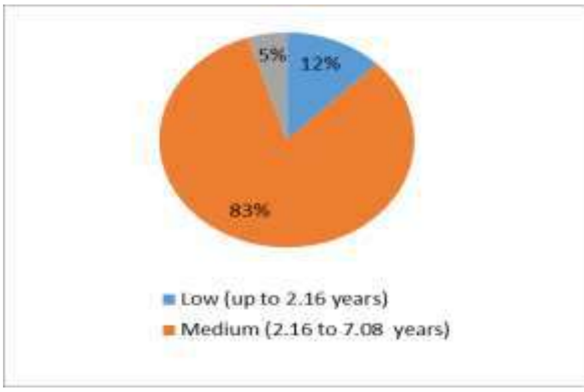


Figure2: Natural Farming experience of the selected farmers of Krishna district, Andhra Pradesh

Conclusion

The shift from chemical farming to natural farming has become realistic in Andhra Pradesh. The study also illustrates that there was a reinvigorated interest among the farmers in switching over to natural farming due to the benefits of less cost of cultivation (to a tune of 50%), increased soil organic content, enhanced soil water retention increased earthworms and microbes, increased micronutrients, resilience to droughts, *etc*. There is a need for concerted efforts to create markets and a separate single brand to enable farmers to sell their produces. Also, the study clearly indicated that farmers practicing natural farming mostly were marginal and small; hence, there is also an imperative need for creating good working models for big landholding farmers to follow natural farming. NF might help the country to move from the green revolution to an evergreen revolution, without deteriorating soil health, water, environment, while ensuring, farm productivity, profitability, social and economic security.

References

Galab, S., Reddy, P. P., Raju, D. S. R., Ravi, C., & Rajani, A. (2019). Impact Assessment of Zero Budget Natural Farming in Andhra Pradesh–Kharif 2018-19.

Khadse, A., Rosset, P. M., Morales, H., & Ferguson, B. G. (2018). Taking agroecology to scale: The zero-budget natural farming peasant movement in Karnataka, India. *The Journal of Peasant Studies*, *45*(1), 192-219.

Lightning talk **ICSCI 2022/T3/19**

Integration of millet crops in rice fallow ecology for system intensification

Triveni U[1*], Rani Y. S[2], Anuradha N[3] and Patro T. S. S. K[4]
Acharya N.G. Ranga Agricultural University, Agricultural Research Station,
Vizianagaram, Andhra Pradesh 535 001
E-mail: u.triveni@angrau.ac.in

Introduction

Increase in food grain production is essential for feeding the current global population. However, increase in crop area is not possible due to various issues like environmental concerns, urbanization, industrialization, salinization, etc. Hence crop intensification in the existing land area is the only option for increase in the food grain production in India. Rice fallow lands are low land rainfed rice growing areas remain fallow during winter season. These lands have enormous scope for crop intensification by integrating pulses and oil seeds. In India, 11.7 M. ha of rice fallow land is available across various states (Ali et al., 2014). Chhattisgarh has 35% (4.1 Mha) of rice fallow land and Odisha and Madhya Pradesh together have 15% (1.8 Mha). Southern states like Andhra Pradesh, Karnataka and Telangana collectively having 7.38 Mha rice fallow land (Gumma et al., 2016). Millet crops have a greater scope for crop intensification because of their shorter duration, low moisture requirement and biotic and abiotic stress tolerance. Moreover, Southern and Central India contributed most millet area and production in the country. Hence, introduction of short duration millet crops in the existing rice fallow lands would greatly contribute not only to increased millet grain production but also to increased nutritional security.

Methodology

An experiment was conducted during *rabi*, 2021-22 at Agricultural Research Station, Vizianagaram with an aim to test the feasibility of eight different millet crops for growing under rice fallow lands. The millet crops (sorghum, pearl millet, finger millet, foxtail millet, barnyard millet, brown top millet, kodo millet and little millet) tested in randomized block design with three replications. NPK nutrients were applied as per crop recommendations. A spacing of 22.5cm × 10cm was adopted for all the crops except pearl millet and sorghum, where 45cm × 10cm was used. Observations on growth and yield attributes and grain yield were collected at the time of maturity and data analysis was done by using ANOVA.

Results

Experiment conducted to evaluate the performance of different millet crops under rice-fallows revealed that all the millet crops adopted very well in rice fallow lands. However, the grain yield recorded with Sorghum was higher. Among other millets, the grain yield recorded with finger millet, pearl millet, foxtail millet and kodo millet were also higher next to sorghum. Per day productivity was highest with sorghum, but it was closely followed by pearl millet, finger millet and foxtail millet. Per day productivity of barnyard millet was higher than kodo millet due to its shorter duration. Lowest grain yield and per day productivity were recorded with little millet crop. Hence, little millet crop was not profitable to be grown under rice fallows. Because of the shorter duration and higher per day productivity, pearl millet and foxtail millet were found best with limited supplemental irrigation. With sufficient supplemental irrigation, sorghum, finger millet and kodo millet resulted in good economic yields.

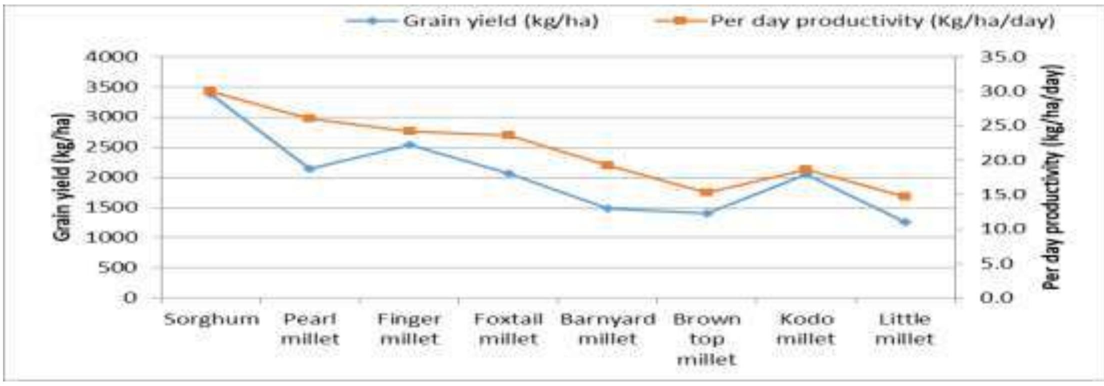


Fig.1. Grain yield and per day productivity of different millet crops under rice fallow condition

.

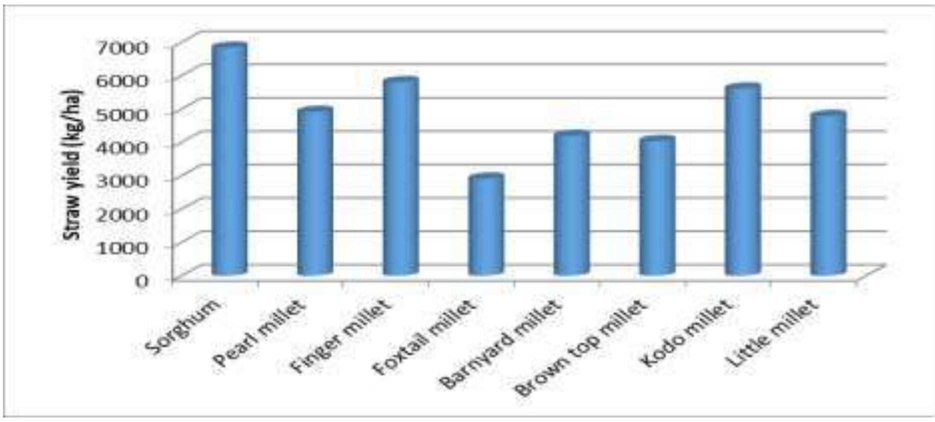


Fig.2. Variations among the straw yield of different millet crops under rice fallow condition

Nutritive values of millet fodder were far superior as compared to paddy straw (Chaudhry, 1998). Hence, millet fodder would be the ideal source of cattle feed. Among different millet crops tested under rice fallow situation, highest fodder yield was recorded with sorghum and it was closely followed by the fodder yields of finger millet and kodo millet (Fig.2). The longer growing period of these crops might be the reason for higher biomass accumulation as compared to the other millet crops

Conclusion

From this study it was concluded that sorghum and finger millet are good yielders under rice fallows provided with sufficient supplemental irrigation. Because of their shorter duration coupled with high productivity, Pearl millet and foxtail millet will be best suitable under limited supplemental irrigation.

References

Ali, M., Ghosh, P.K., Hazra, K.K. (2014). Resource conservation technologies in rice fallow. In: Ghosh et al (eds) Resource conservation technology in pulses. Scientific, Jodhpur, pp 83–89.

Gumma, M. K., Thenkabail, P.S., Teluguntla, P., Rao, M.N., Mohammed, I.A and Whitbread, A.M. (2016). Mapping rice fallow cropland areas for short-season grain legumes intensification in South Asia using MODIS 250 m time-series data. International Journal of Digital Earth, 9:10, 981-1003, DOI: 10.1080/17538947.2016.1168489

Lightning talk **ICSCI 2022/T3/21**

Impact of system of millets intensification and line transplanting on productivity of finger millets in southern Odisha

Suresh Kumar*[1], Prashant K Parida[2], M. Madhu[3], D.C. Sahoo[4]
[1]*Sr. Scientist, ICAR-Central Soil Salinity Research Institute, Karnal, Haryana-132001* [2]*Development Coordinator, M S Swaminathan Research Foundation, Biju Patnaik Tribal Agro-biodiversity Centre, Jeypore, Koraput District, Odisha-764002, Odisha, India.* [3]*Principal Scientist, ICAR- Indian Institute of Soil and Water Conservation, Dehradun, Uttarakhand-248195, India.*
[4]*Principal Scientist, ICAR- Indian Institute of Soil and Water Conservation, Research Centre, Koraput, Odisha-763002, India.*
E-mail: suresh.kumar10@icar.gov.in

Introduction

In the tribal areas of Odisha, millets make a substantial part of the diets and the cropping system with an area of around 125 thousand hectares (DES, 2022). With growing problem of land degradation and looming detrimental impact of climate change and variability, there is an emphasis on promoting millets to harness their multiple environmental and nutritional benefits. However, for expanding area under millets, the low productivity is one of the major concerns amongst other market related issues. To enhance the productivity of finger millets in southern Odisha, selected farmers were provided training on methods of sowing *viz.*, system of millets intensification (SMI) and line transplanting (LT). Additionally, the support of quality and improved inputs was also extended. Now, examining the effect of these interventions is a question of interest. For this end, the objective of present study is to assess the impact of improved methods sowing of finger millets on productivity in Southern Odisha. The findings will help in formulation of better package of practices for enhancing the productivity of finger millets in the region.

Methodology

From the project area *i.e.*, three districts of the southern Odisha namely, Koraput, Malkangiri and Rayagada, data from 70 farmers were collected following the simple random sampling, and 53 farmers were also investigated from adjacent control sites-areas with no intervention. As the beneficiary farmers were selected from the project area, which makes a typical case of non-random assignment of treatments, leading the issue of sample selection bias or endogeneity. To overcome this issue, a control function approach was used (Wooldridge, 2015) as given is equation 1.

$$Y_i = \beta_0 + \beta_1 X_i + \alpha D_i + \rho\ \widehat{(res)} + \epsilon_i \ldots\ldots\ldots \ (1)$$

Where, Y is yield of finger millet (kg ha-1); X is the vector of the socio-economic variable and inputs of the crop production; D is the dummy variable taking value of one if the farmers either adopted SMI or line transplanting (LT) for finger millets cultivation, and μ is the error term. β_0, β_1, α and ρ are the parameter to be estimated. Following the control function approach, the residual (res) from the probit model was used as additional explanatory variable in equation 1.

Results

From the estimates given in table 1, it can be stated that the adoption of SMI or LT has the potential of increasing the productivity of finger millets, which is precisely to the extent of 336 kg ha^{-1} and is statistically significant (P-value <0.01) at 1% level of significance. Further, adoption of improved varieties (KMR-204 and Arjun) also had a significantly positive effect on productivity to the extent of 499 kg ha^{-1} (P-value <0.01) as compared to the prevailing local varieties. Most interestingly, in the study areas, use of the INM and Bio-inputs had also helped in enhancing the productivity by 416.50 kg ha^{-1} as compared to farmers' practices of nutrient management. The productivity of farmers, who have been imparted training was significantly higher (P-value<0.05) to the extent of 151.46 kg ha^{-1} in comparison to farmers without proper training on crop management.

Table 1: Estimates of control function model: Impact of SMI and LT on the productivity of finger millets in Southern Odisha

Variable	Estimate	Robust Std. Error	P-value
Intercept	909.89***	299.98	0.002
Improved varieties (1 if yes; otherwise, zero)	499.33***	140.76	0.000
SMI or LT (1 if yes; otherwise, zero)	335.90***	58.77	0.003
Use of INM and bio-inputs (1 if yes; otherwise, zero)	416.50***	113.96	0.000
Labour (man-days)	−3.04	2.12	0.151
Expenditure on farm machine (INR per ha)	0.31***	0.10	0.002
Expenditure on Seeds (INR per ha)	−0.52	1.35	0.698
Socio-economic characteristic			
Sex (1 if male; otherwise, zero)	−80.63	96.66	0.404
Age (years)	−0.67	3.71	0.856
Family members (Nos)	35.16	21.69	0.105
Size of landholding (ha)	−156.51***	54.33	0.004
Livestock (Nos)	46.86***	14.56	0.001
Off-farm income (1 if yes; otherwise, zero)	203.19***	74.21	0.006
Education (schooling years)	3.70	10.82	0.732
Training (1 if yes; otherwise, zero)	151.46**	70.16	0.031
Residual (IV)	−179.79**	77.17	0.020
Dummy for districts			
District Dummy (base is Rayagada)			
Dummy for District (1 if Koraput; otherwise, zero)	34.06	76.20	0.655
Dummy for District (1 if Malkangiri; otherwise, zero)	81.95	107.90	0.448
Note: Adjusted R-squared: 0.73; F-stat (17, 105): 46.98***; Summary of variable is not shown due to paucity of space.			

Conclusion

Adoption of improved method of sowing (system millets intensification and line transplanting), along with improved varieties and better nutrient management have the potential of enhancing the productivity of the finger millets by 336, 499 and 417 $kgha^{-1}$, respectively. For adoption of such practices and their actual implementation in famers' fields, the training of farmers on better crop management practices is key factor for increasing the likelihoods of up-taking of these practices, and thereby enhancing productivity of finger millets in the region.

References

DES, 2022, Odisha Economic Suyvery-2020-21. Directorate of Economics and Statistics, Planning and Convergence Department, Government of Odisha.

Wooldridge, J. M. 2015. Control function methods in applied econometrics. Journal of Human Resources, *50*(2): 420-445.

Lightning talk **ICSCI 2022/T3/28**

System of chickpea intensification: an innovative approach to enhance productivity of irrigated chickpea

H. L. Sonboir[1] and Vivek Kumar Tripathi[2],
[1]Senior Scientist, [2]Professor Agronomy, Department of Agronomy
Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, 492012 India
E-mail: sonboir@rediffmail.com

Introduction

The greatest challenge to the agriculture in the years to come is to provide adequate food to burgeoning population in order to combat with hunger and malnutrition. In order to ensure self-sufficiency, the pulse requirement is projected at 39 million tonnes by the year 2050 which necessitates an annual growth rate of 2.2% (IIPR, 2015). Chickpea (*Cicer arietinum* L.) is the most important *rabi* season pulse crop grown in 11.2 million ha area in different parts of the country with productivity of 1036 kg ha^{-1} in 2020-21 (*agricoop.nic.in*). System of rice intensification has been reported with enhanced productivity of rice through creating favourable environment for exploitation of crop vigour. This has opened window to explore possibility of yield enhancement in other crops too. Therefore, in the similar fashion, a set of practices which promotes branching, number of pods per plant and yield of chickpea were designed and evaluated to explore possibility of yield enhancement and termed as System of Chickpea Intensification (SCI).

Methodology

If the growth and yield enhancing practices are allowed to express their full potential by providing favourable environment, the final production may be increased. Chickpea being a legume crop can meet out its own nitrogen requirement through biological nitrogen fixation in the root nodules. But sometimes, this characteristics of chickpea especially under high soil moisture condition exhibits negative effect as excessive vegetative growth resulting in poor pod set and ultimately lower yield. However, if the energy of this negative feature is managed properly, it would be boon to the crop and yield can be enhanced.

Components of SCI: The five components which were selected based on research findings and field observations, were applied altogether are as follows:

1. Wider spacing (50cm x20 cm): The wider spaced plants exhibit more horizontal growth and more branches compared to close spaced plants. The closely spaced plants exhibit upright growth with less branching and the pod setting on upper nodes of the plants.
2. Sowing of two seeds per hill: The hills having two plants support each other. The combined effect of two plants are vigorous and produce more branches, pods and untimely higher seed yield per hill compared to single plants.
3. Nipping: Nipping of top 3-4 leaves of chickpea plants increases secondary branches and pods per plant in timely sown crop.
4. Aeration and mechanical weeding: Chickpea roots are highly sensitive to high soil moisture condition and require aerobic condition. The mechanical weeding twice at 18-20 and 40-45 DAS keeps the field weed free and provides aeration in the root zone. The wider plant to plant spacing of 20 cm also make feasible the intra row mechanical weeding and aeration which is normally difficult in drilled crop.
5. Controlled irrigation: The higher soil moisture leads to more vegetative growth of chickpea but it is favourable for wider spaced plants. The moderate irrigation water of around 5.0 cm is applied at

sowing to ensure proper germination and at branching stage (35 DAS) to increase secondary branching and light irrigation of around 4.0 cm is applied at flower initiation stage (50-55 DAS) which enhanced the flowering duration.

The field experiments were conducted at Agriculture Instructional cum Research farm, IGKV Raipur (Chhattisgarh) during winter seasons of 2014-15, 2015-16, 2016-17 and 2017-18. The soil was clay in texture (*Vertisols*), neutral in soil reaction, normal in electrical conductivity, low in available nitrogen, medium in available phosphorus and high in potassium. The experiments were laid out in appropriate statistical design and number of replication to evaluate the performance of chickpea under different spacing, nipping frequency and time under timely as well as late sown condition. The test variety was JG 130 and two seeds were sown manually at a place. The chickpea crop was fertilized with recommended dose of fertilizer (20:50:30 kg $N:P_2O_5:K_2O$/ha) at basal. The package of practices was applied as per above components.

Results

Effect of number of seeds sown: It was observed that the hills having two plants produced 57.9, 63.0, 56.9 and 60.3% more branches, pods, grains and seed yield, respectively, compared to hills having single plant (Table 1). The more values of these parameters may be due to increased phosphorus solublization activity of chickpea roots through secreting organic acids.

Effect of spacing: The growth, yield attributes and yield were significantly influenced by spacing (Table 2). The number of and branches and pods plant^{-1} was higher under wider spacing of 60cmx20 cm which was at par with 50cm x20cm spacing and with significant difference to closer spacing. The increase in number of pods plant^{-1} was 37.6 and 34.3 % under wider spacing of 60cmx20cm and 50cmx20cm as compared to closure spacing of 30cmx20cm. Grain yield of chickpea was increased with increase in row spacing up to 50cmx20 cm with significant difference and thereafter, it decreased with further increase in spacing. The average increase in seed yield was 16.6 % with 50cmx20cm spacing as compared to closure spacing of 30cmx20cm.

Effect of nipping: The growth, yield attributes and yield were significantly influenced by nipping (Table 4). The number of pods plant^{-1} and seed yield were increased with one nipping and decreased with further increase in nipping level *i.e.* twice nipping, with significant difference. The increase in number of pods plant^{-1} was 11.8% and seed yield 7.6% under one nipping at 30 DAS as compared to no nipping. Regarding time of nipping, nipping at 30 DAS or 40 DAS recorded statistically similar seed yield.

Effect of sowing time: Timely sown chickpea in the month of November exhibited significantly higher number of pods plant^{-1}, number of seeds pod^{-1}, seed index and seed yield of chickpea, while late sown crop in the month of December showed decrease in number of pods plant^{-1}, seeds plant^{-1}, seed index and seed yield (Table 3). First week of November sowing exhibited significantly higher seed yield, straw yield and harvest index, statistically at par with third week of November sowing. December sown chickpea crop showed decrease in seed yield, straw yield and harvest index. The lower yield in late sown crop may be due heat stress during reproductive development.

Interaction effect of sowing time, spacing and nipping: The sowing time exhibited interaction effect with spacing and nipping on growth and yield of chickpea. Timely sown crop in the month of November produced more number of pods plant^{-1} and seed yield under spacing of 50cmx20 cm

Table 1: Performance of hills having different number of plants.

Plants/hill	Primary branches/ hill	Secondary branches/ hill	No. of pods/ hill	Number of grains/ hill	Grain yield, g/ hill
Single	2.8	20	58.6	84.1	17.92
Double	5.2	30.9	95.5	131.9	28.74
Per cent increase	85.7	54.5	63.0	56.9	60.3

Table 2: No. of pods/plant of chickpea as influenced by spacing.

Spacing	Number of pods/ plant		Seed yield, kg/ha	
	2014-15	2015-16	2014-15	2015-16
30cm x 20cm	68.0	64.3	2200	2149
40cm x 20cm	80.6	76.6	2430	2251
50cm x 20cm	91.2	86.6	2615	2455
60cm x 20cm	93.7	88.5	2331	2204
CD(p=0.05)	7.9	8.3	79	106

Table 3: Seed yield (kg/ha) of chickpea as influenced by interaction effect of sowing time and spacing

Treatments	30cm x 20cm		40cm x 20cm		50cm x 20 cm	
	2016	2017	2016	2017	2016	2017
November 1st week	2077	2787	2260	2801	2342	3079
November 3rd week	2159	2458	2428	2595	2460	2666
December 1st week	1834	2142	1855	2258	1794	1898
December 3rd week	1541	1718	1370	1529	1324	1524
CD (p=0.05)	Spacing at same sowing time				103	160
	Sowing time at same spacing				124	183

Table 4: Seed yield (kg/ha) of chickpea as influenced by interaction effect of sowing time and nipping

Treatments	No nipping		Nipping at 30 DAS		Nipping at 40 DAS	
	2016	2017	2016	2017	2016	2017
November 1st week	2119	2793	2262	2909	2299	2964
November 3rd week	2251	2476	2387	2569	2410	2673
December 1st week	1812	2081	1937	2148	1732	2069
December 3rd week	1501	1733	1386	1546	1347	1492
CD (p=0.05)	Nipping at same sowing time				60	120
	Sowing time at same nipping				104	161

spacing and it was recorded 29.8 to 31.7% more number of pods plant^{-1} and 11.0 to 11.5 % more seed yield as compared to closer spacing of 30cmx20cm. First week of December sowing exhibited more maximum seed yield under spacing of 40cmx20cm, which was statistically at par with 30cmx20cm spacing. The third week of December sowing recorded more seed yield under closer spacing of 30cmx20cm with significant difference. November sown chickpea recorded 15.3 to 21.2% increase in number of pods plant^{-1} and 4.8 to 7.5% seed yield due to nipping over no nipping. December first week sown chickpea did not exhibit any significant difference in number of pods plant^{-1} and seed yield while third week of December sowing recorded 7.0 to 8.2% decrease in number of pods plant^{-1} and 9.3 to 12.2 % seed yield due to nipping.

Conclusion

System of chickpea intensification is a new initiative towards enhancing productivity of irrigated chickpea. It has five components *viz*., wider spacing (50cmx20 cm), sowing of two seeds per hill, nipping at 30 DAS, aeration and mechanical weeding; and controlled irrigation and these has to be applied altogether. The combined effect of different components contributed nearly 40% increase in seed yield compared improved package of practices with saving of about 40% seed.

References

IIPR. 2015. Vision 2050. Indian Institute of pulse research (ICAR), Kanpur,

Lightning talk **ICSCI 2022/T3/37**

Comparative analysis of different nitrogen treatments on yield and its attributes in SRI and Conventional cultivations

B. Venkatanna, P.C. Latha, D. Srinivas, C. Chandrakala and R. Mahender Kumar*

ICAR - Indian Institute of Rice Research, Rajendranagar, Hyderabad - 500030

Email: kumarrm21364@gmail.com

Introduction

Rice is one of the most important food crops for half of the world’s population. India has the largest area (42.27m ha) and it is the second largest producer (105.24m t) of rice next to china.In Asia, more than two billion people are getting 60-70 per cent of their energy requirement from rice and its derived products.Rice production currently faces restraints like reducing the cultivable land of rice, decreasing table water(water is consumed at high amounts to produce rice),and other climate changes issues that are leading to decline in yields. Water being one of the most constraining factor for achieving increased rice grain production. Future predications on water scarcity limiting agricultural production have estimated that by 2025, about 15-20m ha of Asia’s rice fields will suffer from water shortage in the dry season especially since flood irrigated rice uses more than 45% of 90% of total freshwater used for agricultural purposes (Tuong and Bouman 2003). Conventional method has been the most important and common method of crop establishment practice under irrigated lowland rice which not only consumes more water but also causes wastage of water resulting in degradation of land. In the last few years to tackle this problem, many methods of cultivation have been evolving and one among them is System of Rice Intensification. This technique(SRI) has emerged as a water saving technology that has showed enhanced yield under controlled supply of water. SRI system has been documented to produce higher rice grain yields with less water and without the need for costly improved seeds or expensive chemical fertilisers. This additional rice will have to be produced on less land with less usage of water, labour and chemicals (Zheng et al., 2004). The combined use of organic and inorganic fertilizers help in maintaining yield stability and application to soil improves the physical, chemical and biological properties their by improving the nutrient availability in soils. Among nutrients, nitrogen is the most important limiting element in rice growth (Jayanthi et al.,2007).

Materials and Methods

The field experiments were carried out during kharif 2018 and 2019 at ICRISAT farm PatancheruIIRR, Rajendrangar, Hyderabad.Telanganastate, India. The farm is geographycially situated at an altitude of 17°.53’N latitude, 78°.27’E longitude, 545 m altitudeabove mean sea level on longitudes. According to Troll s climatic classification, it falls under semi tropics (SAT). The experimental soil was clay loam black soil in texture, alkaline in reaction (pH 6.90 - 7.42) with non-saline (EC 0.508 - 0.715 d/Sm^{-}1). The fertility status of the experimental soil was contained 0.875% -1.024 % high organic carbon 202-232 kg ha^{-1} available nitrogen.39-47 kg ha^{-1}of available Phosphorus.And 284-325kg ha^{-1}available K. The semi dwarf, high yielding rice variety Akshayadhan, having crop duration of 135days with yield potential of 5.5t ha^{-1}was grown in the grown experimental site. Micronutrients sufficient in Zn, Cu, Fe, Mn&B. The experiment was laid out in split plot design with two main plots consisting of two establishment methods of cultivation i.e., System of rice intensification(SRI) and normal transplanting(NTP) and sub plots comprising of four nitrogen management practices like control(T1), 100% organic(T2), 50% organic +

50% inorganic (T3) 100% inorganic(T4), sub plot treatments summing up to 12 treatment combinations and replicated thrice.

Results

In the present study the effect of different nitrogen treatments on yield and its attributes in System of Rice Intensification (SRI) and conventional methods were compared during the years 2018 and 2019 of kharif seasons. The yield attributes like plant height, number of tillers, panicle length and panicle grain, filled and unfilled grain percentage, 1000 grain weight, yield of grain and straw and harvest index were performed under both the methods. Among the nitrogen management practices 50% inorganic + 50% organic treatments (T3) showed better performance when compared to 100% inorganic (T4), followed by 100% organic (T2) and control (T1). The pooled analysis of grain was observed higher in T3 treatment (6.2 tons/ha), followed by T4 (6.1 tons/ha), T2 (6.0 tons/ha) and control T1(4.6 tons/ha) in SRI, while under conventional method also same trend was observed T3 (5.3 tons/ha), T4 (5.1 tons/ha), T2 (4.8 tons/ha) and T1 (4.1 tons/ha). Among the two-methods grain yield was observed to be higher in SRI when compared to conventional cultivation.

SRI compared to NTP, yield attributes like number of panicles per unit area and the grain weight were more in SRI, the number of grains per panicle was lower than in the conventional flood –irrigated crop. N3 Treatment significantly enhanced percentage of filled grains panicle length, 1000 seed weight in the order of N4>N2>N1. Grain yield was increased significantly by 18.3% under SRI over NTP. Among nitrogen treatments N3 enhanced 37.8% yield over N1 in both the years of pooled means.

Table 1. Effect of different nitrogen treatments on plant growth attributes in SRI and Conventional cultivations

Treatments	Grain yield(kg/ha^{-1})			Straw yield(kg/ha^{-1})			Harvestindex(%)		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
Meanvaluesofmaintreatments(M)									
M_1	5264	5266	5265	5884	5787	5836	47.0	47.4	47.2
M_2	4107	4228	4168	4936	4872	4904	45.1	46.3	45.7
S.Em±	21.3	32.9	17.7	38.1	13.7	12.4	0.27	0.24	0.08
C.D.5%	139.9	215	116.5	249.7	90.2	81.8	1.80	NS	0.57
Meanvaluesof subtreatments(N)									
N_1	3094	3189	3142	3928	3845	3887	43.9	45.3	44.6
N_2	4974	5002	4988	5689	5544	5617	46.4	47.3	46.8
N_3	5547	5554	5551	6119	6069	6094	47.5	47.8	47.6
N_4	5128	5242	5185	5904	5860	5882	46.4	47.1	46.7
S.Em±	53.6	40	25.7	91	99.8	61.7	0.51	0.49	0.25
C.D.5%	167.2	124.8	80.2	283	311	192	1.6	1.5	0.79
TxM	NS	NS	NS	NS	NS	NS	NS	NS	NS
TxM	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Effect of different nitrogen treatments on yield and its attributes in SRI and Conventional cultivations

Treatments	Plant height (cm)			No of tillers(m2)			Panicle length(cm)		
	2018	2019	2018	2018	2018	Pooled	2018	2019	Pooled
Meanvaluesofmaintreatments(M)									
M1-Systemof RiceIntensification (SRI)	105	106	106.1	396	411	403	27.1	27.2	27.1
M2-NormalTransplantation(NTP)	99	98	99.1	336	346	341	15.9	15.9	15.9
S.Em±	0.4	0.9	0.62	4.3	5.9	3.07	0.40	0.39	0.37
C.D.at5%	2.7	5.9	4.06	28.3	38.9	20.1	2.65	2.57	2.4
T1–Control	93	92	93.5	256	262	259.1	16.2	16.1	16.1
T_2-100%Organic	100	100	100.5	352	378	365.3	20	19.8	19.9
T_3-50%organic+ 50% inorganic	109	111	110.8	464	461	462.6	26.0	26.8	26.5
T4-100 %inorganic	106	105	105.8	392	413	402.6	23.7	23.5	23.6
S.Em±	0.7	0.7	0.56	9.2	10.8	8.6	0.5	0.39	0.28
C.D.at5%	2.2	2.3	1.76	28.6	33.7	27	1.7	1.2	0.87
TXM	NS	NS	NS	NS	NS	NS	NS	NS	0.28
MXT	NS	NS	NS	NS	NS	NS	NS	NS	0.87

References

Jayanthi, T., Gali, S.K., Chimmad, V.P and Angadi, V.V. 2007. Leaf colour chart based N management on yield, harvest index and partial factor productivity of rainfed rice. Karnataka Journal of Agricultural Sciences. 20(2): 405-406.

Tuong, T.P., and Bouman, B.A.M. 2003. Rice production in water scare environments. In L. W. Kijne, R. Barker and D. Molden, eds. Water productivity in agriculture: Limits and opportunities for improvement. The Comprehensive Assessment of Water Management in Agriculture Series.Wallingfort, UK, CABI Publishing. 1: 13- 42.

Zheng, J.G., Lu X.J., Jiang X.L and Tang Y.L. 2004. The System of Rice Intensification for superhigh yields of rice in Sichuan basin. In: T. Fischer *et al*. (ed.) New Directions for a Diverse Planet. *Proceedings of the 4th International Crop Science Congress*, 26 september–01 october, 2004. Brisbane, Australia.

Lightning talk **ICSCI 2022/T3/38**

Influence of different irrigation practices and establishment methods on yield and water productivity of basmati rice

Anuradha Saha [1] and Vijay Bharti [2]
All India Co-ordinated Rice Improvement Project Division of Plant Breeding and Genetics, *Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu Main Campus, Chatha, Jammu and Kashmir Union Territory, INDIA-180009*
E-mail: anuradha_agron@yahoo.co.in

Introduction

Every year demand for rice is increasing and it is estimated that the demand for rice will be 121.2 m tonnes in 2025 AD. A large quantity of water is required for rice cultivation and for 1 kg rice production, about 3,000–5,000 litres of water is required. In most countries, although a major portion of the water is lost through deep percolation, still use of water for irrigated rice cultivation is very high. Various methods are being used in reducing water use in rice production. One of the most tried methods is alternate wetting and drying (AWD) of paddy fields (Kepha *et al.* 2014). Similarly, saturated irrigation is another technique that increases water productivity in fully irrigated rice cultivation (Borrell, *et al.*, 1997). Traditionally, transplanting of rice under puddled condition was favored but stress on water resources due to climate change and competing demand for water from agricultural and non- agricultural sectors has forced us to rethink on alternate strategies such as system of rice intensification, dry direct seeded rice or broadcasting of seed. Hence, the present investigation was taken up to study the effect of different irrigation practices and establishment methods on yield attributes, yield and water productivity of basmati rice under sub tropical conditions of Jammu.

Methodology

A field experiment was conducted during the *kharif* seasons of 2016 and 2017 at Research Farm of SKUAST-J, Main Campus, Chatha, Jammu which is geographically situated at $32^0 40'$ North latitude and $74^0 58'$ East longitude with an altitude of 332 meters above mean sea level in the Shiwalik foothills of North-Western Himalayas. Soils were sandy clay loam in texture, medium in organic carbon (0.57%), available N (245.15 kg/ha), available P (14.35 kg/ha) and available K (146.31 kg/ha). The pH and EC of the soil was recorded as 8.03 and 0.21 dS/m, respectively.

The experiment was laid in split plot design comprising twelve treatments with three irrigation management practices viz. Flooding throughout crop growth (10 cm), Saturation maintenance (5 cm) and Alternate Wetting and Drying (with 5 cm / ha irrigation at 3 days after disappearance of ponded water) in main plots and four crop establishment methods viz. Direct Seeded Rice (line sowing) (DSR), Broadcasting, System of Rice Intensification (SRI) and Conventional Transplanted Rice (CTR) in sub plots replicated thrice. Irrigation treatments were isolated with buffer channels, so that water movement can be effectively controlled and managed. Seedlings were raised in nursery in accordance with establishment methods. Seedlings of 14 and 25 days were used for SRI and Conventional Transplanting of Rice, respectively. Marked ropes were used for square planting in the SRI method with 25 cm × 25 cm spacing. Similarly, 20 cm × 10 cm hill spacing in well puddled plots with 2-3 seedlings for CTR was done. The recommended dose of fertilizer for Basmati-370 rice as per package of practices in Jammu condition @ 30: 20: 10 kg N, P_2O_5 and K_2O ha^{-1}, respectively through Urea, DAP and Murate of Potash (MoP) was applied. Half the recommended dose of N and full dose of P and K were applied as basal and remaining N was applied in 2 equal splits at 30 and 60 DAS / DAT. All weed management practices were followed to keep the plots weed free. The data recorded for various parameters was statistically analyzed using "Analysis of variance test" and the comparison of treatment means was made by Least Significant difference (LSD) at P=0.05.

Results

Irrigation practices greatly influenced the yield and yield attributes of basmati rice. Among the three irrigation schedules, alternate application of water through AWD resulted in significant increase in yield attributes and yieldover saturation and continuous submergence methods, respectively (Table 1). Increased values of yield attributes and yield in AWD might be due to sufficient availability of nutrients during vegetative and reproductive phases which might be due to aeration and better root growth condition. These results confirm the findings of Chandrapala *et al*. (2010). Among the four crop establishment methods, SRI recorded significantly higher yield attribute parameters viz. panicles /m^2, number of filled grains / panicle and 1000 grain-weight (Table 1).

Table 1. Influence of irrigation practices and establishment methods on yield and water productivity of basmati rice (mean data of 2 years)

Treatments	Plant height (cm)	Panicles /m^2	No of filled grains / panicle	1,000 - grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Water productivity (kgm^{-3})
Irrigation practices								
Flooding	120.33	214.08	56.25	19.67	2.74	5.38	45.29	0.14
Saturation	127.42	227.42	62.33	20.08	2.96	5.98	43.97	0.20
Alternate wetting and drying (AWD)	144.67	232.25	68.25	20.56	3.04	5.99	45.04	0.23
SEm (±)	0.74	0.26	0.20	0.02	0.004	0.02	0.18	
CD (P=0.05)	2.99	1.04	0.81	0.06	0.02	0.01	0.74	
Establishment methods								
DSR (Line sowing)	124.44	219.22	60.33	19.90	2.63	5.22	44.40	0.19
Broadcasting	118.11	196.56	56.67	19.48	2.41	4.94	43.60	0.17
SRI*	144.00	244.11	68.11	20.76	3.42	6.79	45.75	0.24
CTR**	136.67	238.44	64.00	20.24	3.19	6.18	44.80	0.19
SEm (±)	0.72	0.67	0.18	0.02	0.003	0.01	0.17	
CD (P=0.05)	2.15	2.01	0.54	0.04	0.01	0.02	0.51	

*SRI-System of Rice Intensification ** CTR- Conventional Transplanting

The favourable conditions for growth of rice crops through SRI like optimum plant population, broader spacing, conoweeding were the cause of more resources to the plants which resulted in higher values of all these parameters. This might be cause of adequate availability of nutrients and early establishment in the SRI methods. Moreover, cono weeding also created aeration around rhizosphere of rice plants, which may serve as oxidizer catalyst to enhance the micro-organism activity and rapid disintegration of weed biomass and led to increased availability of nutrients to the crop whereas, broadcasting method showed significantly lowest values of all these parameters due to high population density of rice plants which resulted in intra-competition for sunlight, nutrients etc. As outcome growth components were reduced under broadcasting compared to SRI method. Duttarganvi *et al*. 2016 also reported similar findings. Likewise, among irrigation practices AWD showed highest water productivity over saturation and sub mergence. Crop establishment methods also greatly influenced the total water used wherein SRI recorded the highest water productivity

Conclusion

The results emanated from the study showed superiority of SRI in terms of establishment methods and alternate wetting and drying irrigation practice as alternative to flooding.

References

Borrell, A, A Garside and S Fukai, S.1997. Improving efficiency of water use for irrigated rice in a semi-arid tropical environment. Field Crops Research, 52 (3):231-248.Water Environment 9: 65–78.

Chandrapala, A G, M Yakadri , K R Mahender and G Bhupal Raj .2010. Productivity and economics of rice (*Oryza sativa* L.) – maize (*Zea mays* L.) as influenced by methods of crop establishment, Zn and S application in rice. Indian Journal of Agronomy, 55(3): 171–176 Agronomy 55(3): 171–176.

Chapagain T and E Yamaji .2010. The effects of irrigation method, age of seedling and spacing on crop performance, productivity and water-wise rice production in Japan. Paddy Water Environment,8: 81-90.

Duttarganvi Shantappa, R Mahender Kumar, BK Desai, BT Pujari, K Tirupataiah, BG Koppalkar, MR Umesh, MK Naik and KYella Reddy. 2016. Influence of establishment methods, irrigation water levels and weed management practices on growth and yield of rice (*Oryza sativa*). Indian Journal of Agronomy,61 (2): 174-178.

Kepha G, M OmwengaBancy and G Patrick .2014. Determination of the effect of the system of rice intensification on rice yields and water saving in new irrigation scheme. Kenya Journal of Water Resources and Protection, 6:895-901.

Lightning talk **ICSCI 2022/T3/50**

Sensor based irrigation water management in rice

[1]A. Suryakala, [2]G. Karuna Sagar and [3] R. Mahendar Kumar
[1&2]S. V. Agricultural college, Tirupati, Department of Agronomy, ANGRAU – 517502
[3]Indian Institute of Rice Research, Rajendranagar, Hyderabad – 500030
Email: adhikarisuryakala@gmail.com

Introduction

India has 18% of world population, having 4 per cent of world's fresh water, out of which 80 per cent is used in agriculture. Of this, 80 per cent water is consumed by just three crops - rice, wheat and sugarcane. Farmers in India are using 25 times the amount of water than that is needed to produce paddy. Improper irrigation methods and conventional flooding irrigation practice are the stated reasons for the high wastage of a scarce resource. As 4 billion people around the globe are currently affecting by the increasing threat of water scarcity, there is a need to replace the normal transplanted rice with sustainable crop establishment methods like system of rice intensification to achieve stable and increased rice yields with less irrigation water. Integration of the above sustainable crop cultivation practices with a potential water saving technology called alternate wetting and drying improves Nitrogen use efficiency and water productivity by reducing weed growth. The integration of an intelligent water-saving irrigation system called IoT (Internet of things) based water measuring sensors with different crop establishment methods under Alternate Wetting and Drying helps to monitor the water levels in the field. (Jinmao Li and Hu He, 2019) IoT is the web-based irrigation control system or programmed software connected to the mobile phone to remotely turn on the pumps when the water level in the field reaches a critical level. Using this technology, one can save the water and money on electricity or diesel for their pumps, reducing the various nitrogen losses and Green House Gas emissions from the rice fields (Steven Savage. 2018).

Methodology

This trial was conducted at Indian Institute of Rice Research, Rajendranagar, Hyderabad in *rabi* (RNR-15048) in 2021-2022 with the following treatments, Main plot: Methods of crop establishment - M_1: Normal Transplanted rice, M_2: System of Rice Intensification; Sub plot: Water management practices - I_1: Sensor based water management AWD with 5 cm depletion of water, I_2: Sensor based water management AWD with 10 cm depletion of water, I_3: Sensor based water management AWD with 15 cm depletion of water in Split plot Design with three replications. IoT based AWD sensors were fixed in each plot. In IoT based AWD two type of sensors were used i.e., bottom level and top level sensors. When water level reaches 5cm above ground level, top sensor will detect it and when water level reaches 5cm or 10cm below the ground level, bottom sensor will detect it. These sensors will send the data to the mobile phones through IoT gateway and IoT cloud platforms. We will receive the information about the water level in the field in the form of a text message with which one can switch on or off the motor.

Ex: Hi Suryakala, Water in the experiment plot IIRR-B4P7: I3-M1-MPSMS is less than 5cm below ground level. Please irrigate the plot as soon as possible – Switch on the motor.

Hi Suryakala, Water in the experiment plot IIRR-B4P7: I3-M2-MPSMS is less than 10cm below ground level. Please irrigate the plot as soon as possible – Switch on the motor.

A digital water metre was used to measure the amount of water used for each treatment. Using login credentials, one can see the IoT dashboard's data on irrigation water usage and weather conditions.

Fig. 1 Sensor in the field

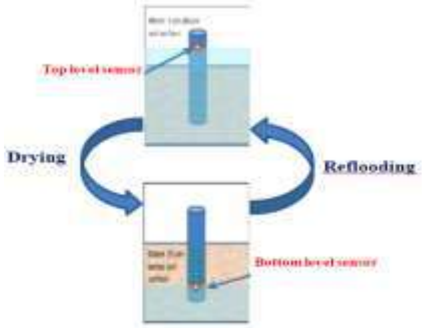


Fig. 2 AWD with sensors

Results

Moderate wetting and drying increases rice yield and reduces water use. AWD with 5cm to 10 cm depletion of water is considered to be safe as it saves water without compromising yield (Jindar *et al.*, 2018). AWD with 15cm depletion of water is not safe even though it saves water as it severely reduced the yield of paddy. Among all treatments sensor based AWD with 5cm depletion recorded higher yield (15.1%) compared to transplanted rice with less amount of irrigation water utilized.

Table: Mean applied irrigation water and yield of rice as influenced by establishment methods and irrigation regimes during *rabi* 2021-2022.

Treatments	Total Applied water (mm)	Yield (q/ha)
Establishment methods		
M_1 – Normal transplanting	1023	38.2
M_2 – SRI	912	42.8
Irrigation regimes		
I_1 – AWD at 5cm depletion	855	45.0
I_2 – AWD at 10cm depletion	752	44.2
I_3 – AWD at 15cm depletion	708	36.5

Total mean amount of irrigation water applied is higher in convention flooded rice compared to SRI cultivation method. Similar results were observed with Suryana *et al.*, 2020. No effective rainfall observed during the cropping season (Fig 3.)

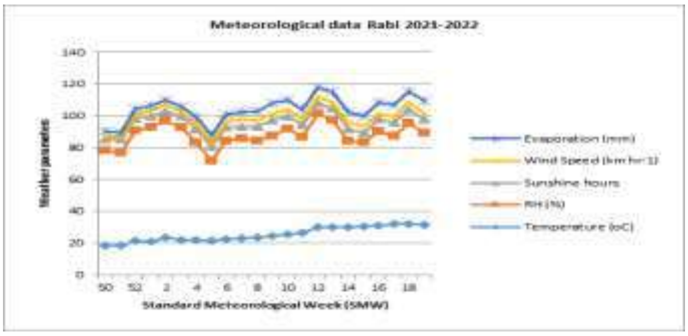


Fig 3. Meteorological data recorded at Rajendranagar, Hyderabad

Conclusion

From this study, it could be concluded that sensor based AWD with 5 cm to 10 cm depletion of water in SRI rice will reduce the irrigation water usage and enhances the yield of rice.

References

Jinmao Li and Hu He. 2019. Design of rice intelligent water-saving irrigation system based on agricultural internet of things. Journal of Physics: Conf. Series - 1176.

Steven Savage. 2018. AT&T, The Internet of Things (IoT), and Sustainable Farming. https://www.forbes.com.

Suryana, Y., Yogiswara and Supriono. 2020. Water level control system in rice fields with the SRI (System Rice Intensification) model based on IoT (Internet of Things). Food and Agricultural Sciences: Polije Proceedings Series, 3(1): 188–191.

Jindar, M.K., Praveen Rao, V., Ramulu, V., Avil Kumar, K. and Uma Devi, M. 2018. Alternate Wetting and Drying-A Climate Smart Water Management Practice in Rice. Pub. No. 106/BC/PJTSAU/2018, University Press, PJTSAU, Hyderabad, Telangana State, India.

Lightning talk **ICSCI 2022/T3/54**

Weed management in direct-seeded rice (*Oryza sativa* L.) sown by different methods for sustainable rice production under northwestern Indian conditions

B S Dhillon[1] and R M Kumar[2]

[1]*Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana- 141004*
[2]*Indian Institute of Rice Research, Hyderabad- 500030*
E-mail: bsdhillon@pau.edu, dhillonbs1@gmail.com

Introduction

The conventional system of rice production i.e. manual transplanting of rice in puddled fields is water and energy intensive, thereby, leading to increased pumping cost and water scarcity (Dhillon and Mangat, 2018). Repeated puddling destroys soil structure and creates shallow hard pan, affecting the performance of rice as well as succeeding wheat crop; also make the conditions favorable for the emission of methane (Bhardwaj and Sidana, 2019). In order to devise a solution for aforesaid problems, direct seeding of rice (DSR) was recommended, which claims to reduce water footprints by 10-20% and labour requirements by 80% besides increasing water recharging (Anonymous, 2021). Direct seeding of rice on beds in another intervention to further reduce the water footprints and improve overall resource use efficiency while maintaining optimum yields. Although a lot of studies on weed management in flat sown DSR has been undertaken but studies on weed management in bed sown DSR are quite meager. Hence, present studies were planned to evaluate weed management options in direct seeded rice established by different methods.

Methodology

A field experiment was conducted at the research farm of Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana located at 30° 54’ N and 75° 48’ E and 247.0 m above mean sea level with subtropical climatic conditions during summer (*Kharif*) 2021. The field trial was laid out in split plot design with five crop establishment methods {S_1: Broadcasting of seeds; S_2: Line sowing of seeds (20 cm row spacing sown in solid row); S_3: Line sowing in *Tar Vattar* f.b. 1st irrigation at 21 DAS (Soil mulch DSR); S_4: Raised bed sowing (4 rows on 1 mt wide bed); S_5: Raised bed sowing (2 rows on 67.5 wide bed)} in main plots; and four weed management treatments {W_1: Manual weeding (20, 30 and 40 DAS); W_2: Mechanical Weeding at 20 and 30 DAS; W_3: Pre-emergence (pendimethalin 0.75 kg ha^{-1}) + manual weeding (30 and 40 DAS); W_4: Pre- (pendimethalin 0.75 kg ha^{-1}) + post-emergence (Bispyribac sodium 25 g/ha)}in sub plots replicated thrice. Crop was raised as per the recommendations of Punjab Agricultural University given in the package of practice for *kharif* crops (Annonymous, 2021). For estimating grain yield, a net area of 10.0 m^2 was harvested from each plot and then threshed, sun dried, winnowed, cleaned, and weighed on an electronic balance. For valid comparison of different treatments, moisture in grains was estimated using a digital moisture meter (Kett's RICETER J Handheld grain moisture meter). Grain yield was adjusted at 14% moisture and expressed as q ha^{-1}. The weight of straw from each net plot was also recorded three days after harvest for estimation of straw yield, which was expressed as q ha^{-1}. B: C was worked out as net returns divided by the cost of cultivation under particular treatment. Data were subjected to analysis of variance (ANOVA) using the Proc GLM procedure of SAS software (SAS 9.3.). Least significant difference (LSD) at 5% level of probability was computed to compare the statistical significance of different treatments.

Results

Data in Table 1 reveal that line sowing (dry and *Tar wattar*) recorded the highest grain yield, which was statistically similar to both raised bed sowing methods (0.675 m bed and 1.0 m bed) but broadcasting was significantly inferior to all these methods. Similar trend was observed for straw yield. The superiority of line sowing and bed sowing over broadcasting can be explained in light of better yield attributes such as EBT/m^2 and panicle weight along with significantly lower sterility percent. Also the higher dry matter accumulation by weeds was a reason for lower yield of broadcasted crop (Table 1).

Table 1: Influence of different treatments on plant emergence, yield attributes, yield and DMA by weeds

Treatments	Plant population / m^2 at 20 DAS	EBT/ m^2	Panicle weight (g)	Sterility (%)	Grain yield (t/ha)	Straw yield (t/ha)	Irrigation water applied (cm)	DMA by weeds at PI stage (g/m^2)	B:C
Sowing methods									
S_1: Broadcasting	56.1	339.3	1.73	27.7	3.39	5.59	114.0	82.7	1.28
S_2: Line sowing (dry)	57.8	426.7	1.96	26.6	4.02	5.38	114.0	58.2	1.55
S_3: Line sowing (*Tar wattar)*	51.2	406.7	2.04	24.5	4.02	4.23	102.0	47.9	1.56
S_4: Raised bed (1.0 m)	52.4	386.7	1.98	24.0	3.94	4.26	95.0	55.4	1.45
S_5: Raised bed (0.675 cm)	50.0	366.7	2.01	23.9	3.68	3.77	104.0	59.2	1.28
LSD (p=0.05)	**NS**	**32.0**	**0.11**	**2.3**	**0.35**	**0.83**	**-**	**12.9**	
Weed management options									
W_1: Manual weeding	53.5	354.7	1.83	25.1	3.52	4.52	105.8	89.8	1.03
W_2: Mechanical Weeding	53.4	387.7	1.77	29.3	3.04	4.00	105.8	86.4	0.97
W_3: Pre-emergence + manual weeding	53.4	380.8	2.03	24.0	4.12	4.55	105.8	37.1	1.65
W_4: Pre- + post-emergence herbicides	53.7	417.6	2.14	22.9	4.56	5.50	105.8	29.5	2.04
LSD (p=0.05)	**NS**	**26.8**	**0.08**	**2.2**	**0.20**	**0.53**	**-**	**14.6**	

Data also brings out that the least irrigation water was applied to the crop sown on wide beds of 1.0 m (95 cm), which was followed by *tar wattar* line sowing (102 cm) f.b. bed sowing on 0.675 m wide beds (104 cm), thereby indicating the overall superiority of bed sowing (1.0 m wide bed). Among weed control options, pre-emergence application of pendimethalin 0.75 kg ha^{-1} f.b. post-emergence application (20 DAS) of Bispyribac sodium 25 g/ha recorded better yield attributes, yield and B:C due to significant reduction in dry matter accumulation by weeds. Former treatment was followed by pre-emergence + 2 manual weedings at 30 and 40 DAS. Although DMA by weeds was similar in manual weeding (at 20, 30, 40 DAS) and mechanical weeding (at 20 and 30 DAS) but mechanically weeded plots recorded the least grain yield than all other treatments due to the reason that lot of plants were uprooted during mechanical weeding in broadcasted plots in particular and in all plots in general.

Conclusion

All sowing methods except broadcasting, gave similar grain yield on account of similar dry matter accumulation by weeds but sowing on raised beds (4 rows on 1.0 m wide bed) was found better as it saved 16.7 and 6.7 % irrigation water over line sowing method (dry) and (*tar wattar*), respectively. Among weed management options, pre-emergence application of pendimethalin 0.75 kg ha^{-1} f.b. post-emergence application (20 DAS) of Bispyribac sodium 25 g/ha was found promising with B:C of 2.04.

References

Anonymous. 2022. *Package and practices for Kharif crops*, Punjab Agricultural University, Ludhiana

Bhardwaj S, Sidana BK. 2019. Ground water depletion and role of direct seeded rice in water saving: A move towards sustainable agriculture of Punjab. *Economics Affairs*, 64:19-28.

Dhillon, BS and Mangat, GS 2018. Direct Seeded Rice In Punjab: Opportunities and Challenges. *In. Technology for Rice Production*. Technical papers of National seminar on "Sustaibale Rice Production Technology for Increasing the Farmers' Income" held during January 20-21, 2018 at Indra Gandhi Krishi Vishav vidyalaya, Raipur (Chhatisgarh). *Pp* 535-38

Lightning talk **ICSCI 2022/T3/245**

Long-term evaluation of System of Rice Intensification – Yield, nutrients uptake, use efficiency and soil properties

K. Surekha, B. Venkatanna, R. Mahender Kumar, P. C. Latha, Ch. Padmavathi and N. Soma Sekhar
ICAR-Indian Institute of Rice Research, Hyderabad-500030, Telangana, India
Email: surekhakuchi@gmail.com

Introduction

Rice is the most important staple food crop and System of rice intensification (SRI), originated in Madagascar during 1980s represents an integrated and ecologically sound approach to irrigated rice cultivation. The six principles followed in SRI play important role in nutrients uptake and translocation thereby resulting in higher yields. The larger canopies and well-developed root system in SRI may lead to efficient and more effective N, P and K uptake than conventional system (Uphoff, 2005). A long-term field experiment was evaluated for a period of five years (2012-13 to 2016-17) to understand the response of rice crop under SRI over a period of 5 years in terms of grain yield, nutrients uptake, use efficiency and soil properties.

Methodology

The field experiment was conducted in five *kharif* (wet) and five *rabi* (dry) seasons during 2012-13 to 2016-17 at the Indian Institute of Rice Research- Ramachandrapuram farm in ICRISAT campus in sandy clay loam soil. The soil was slightly alkaline (pH 8.2), non-saline (EC- 0.47 dS/m) with high organic carbon (1.07%) content. Available N was medium (291kg/ha); available P was high (38 kg/ha) and available K was also high (507 kg/ha).

The experiment was laid in a split-plot design with nutrient treatments as sub plots (control, 100% organics, 25%+75%, 50%+50%, 75%+25% of organics and inorganics, respectively and 100% inorganics) and methods of crop establishment (SRI and normal transplanting, NTP) as main-plot treatments in three replications with Varadhan as test variety. The organics used were FYM and vermi-compost in equal combinations based on N equivalent basis. Inorganic nutrient sources were: urea, single super phosphate and muriate of potash. The recommended dose of fertilisers (RDF) is: 100-40-40 kg NPK/ha during *kharif* and 120-40-40 kg NPK/ha during *rabi*. At harvest, grain and straw yields were recorded after each season. Grain, straw and soil samples were collected and were analysed for N, P and K. Plant nutrient uptake was calculated and nutrient use efficiency was calculated using grain yield and total nutrient uptake. Soils were analysed for important properties like pH, EC, Organic carbon, available NPK status and enzyme activity.

Nutrients uptake and use efficiency: The major nutrients (NPK) uptake was high in SRI than NTP that followed the grain yield trend. Except control and 25%inorganics+75% organics, other treatments recorded almost similar uptake. Total NPK uptake varied from 90-119; 10-12.5 and 117-136 kg/ha during kharif and 93-111; 9.3-12.5 and 118-130 kg/ha during rabi in SRI, respectively. In case of NTP, NPK uptake ranged from 86-102; 8-10 and 104-126 kg/ha during kharif and 90-95; 8.1-9.6 and 104-113 kg/ha during rabi, respectively. Out of 10 crop seasons, N and P translocation to grain was higher in 8 seasons in SRI and K translocation was slightly higher with NTP in most (7) of the seasons.

Nutrients (NPK) use efficiency (kg grain/kg nutrient uptake) was high under SRI compared to NTP with mean values of 52.5 and 56.1 under SRI for N and 49.4 and 50.7 under NTP in kharif and rabi, respectively. Similarly, PUE was 520 and 530 (SRI) and 518 and 515 (NTP); KUE was 44 and 46 (SRI) and 41 and 44 (NTP) in kharif and rabi, respectively. NUE was marginally higher in rabi compared to kharif. Improved NUE along with higher yield in SRI compared to NTP was also reported by Mboyerwa et al. (2022).

Soil nutrient status and enzyme activity after harvest: Soil available nutrients measured after harvest of each season indicated improvement in organic carbon, available N and K in SRI without much variation in available P values. Complete organics recorded higher values of organic carbon content than inorganics by 7-42% across the 10 seasons. In case of enzyme activity, SRI recorded higher activity of glucosidase, phosphatase, arylsulfatase and dehydrogenase than NTP. Among the nutrient treatments, higher values were recorded with 100% organics followed by 75% organics+25% inorganics.

Results

Grain and straw Yields: SRI method recorded significantly higher grain yield in all years and in all seasons than NTP (Table 1). The yield increase in *kharif* ranged from 11-31% with more increase in *rabi* with a range of 12-36%. Control recorded the lowest yield in both systems. Pooled over 5 years, the mean yield difference is 22 % in kharif and 23% in rabi. Control plots without any fertilisers recorded the lowest yields in all seasons in both systems.

Among the nutrient treatments, though initially inorganic source dominated with higher grain yield, organics recorded on par yields with inorganics in the later years of study. Straw yield followed the similar trend as that of grain yield.

Conclusion

From the present study, it can be concluded that SRI resulted in higher yield and nutrient uptake with marginally higher nutrient use efficiency. Soil organic carbon, available N and K and enzyme activities were higher in SRI compared to NTP. With regard to nutrient sources, organics combined with SRI resulted in higher yield and improved soil properties throughout the experiment.

References

Mboyerwa PA, K Kibret, P Mtakwa and A Aschalew. 2022. Rice Yield and Nitrogen Use Efficiency with System of Rice Intensification and Conventional Management Practices in Mkindo Irrigation Scheme, Tanzania. Frontiers in Sustainable Food Systems. 6:802267. doi: 10.3389/fsufs.2022.802267

Uphoff N. 2005. Possible explanations for the productivity gains achieved with the System of Rice Intensification (SRI). *In* Transitions in Agriculture for enhancing Water Productivity. Proceedings of an International Symposium held in Killikulam, Tamil Nadu, India during 23-25, September 2003.

Lightning talk **ICSCI 2022/T3/246**

Effect of different spacing's on traditional finger millet [*Eleusine coracana* (L.) Gaertan.] varieties under guli method of cultivation

Devakumar, N., Boraiah.B., Naveesh.Y.B. and Lakshmipathi, R.N.
Research Institute on Organic Farming (RIOF), UAS, GKVK, Bengaluru, Karnataka-560065

A field experiment was conducted at Research Institute on Organic Farming (RIOF), UAS, GKVK, Bengaluru, on sandy loam soil. The experiment consisted of two factors *i,e* varieties and spacing's with combination of twelve treatments laid out in factorial randomized complete block design with three replications. Treatments consisted of three traditional varieties (V_1 –Sharavathi, V_2 - Jaglur local and V3-Unde) with four different spacing (S_1 =30 cm × 30 cm, S_2= 45 cm × 45 cm, S_3=30 cm × 10 cm, S_4= 45 cm ×10 cm).Guli method of ragi cultivation with jagalur local variety and 30 cm X 10 cm spacing recorded significantly higher grain and straw yield (34.09 q $ha^{-1}$and 72.75 q ha^{-1}) followed by Unde ragi and 45 cm X 10 cm spacing (33.62 q $ha^{-1}$and 65.52q ha^{-1}) respectively. Higher grain yield was attributed to increased growth and yield parameters such as, number of tillers $plant^{-1}$ (35.61), number of leaves $plant^{-1}$(78.96), total dry matter production (81.90 g $plant^{-1}$), number of productive tillers (34.30), grain yield $plant^{-1}$(168.02 g $plant^{-1}$) and thousand grain weight (3.64 g). Similarly, higher straw yield was attributed to higher plant height (108.50 cm), number of leaves $plant^{-1}$ (78.96) and total dry matter production (81.90 g $plant^{-1}$). Whereas, higher net returns (Rs 44789) and B:C ratio (2.20) was recorded in Jaglur local variety with spacing of 30 cm × 10 cm and farm yard manure applied at recommended N equivalent level under guli method of planting owing to its higher grain and straw yield saving the other cost of production.

Key words: Guli ragi, Traditional varieties, Spacing, Yield

Lightning talk **ICSCI 2022/T3/85**

Mitigation of greenhouse gas emissions with DSR and SRI

M.B.B. Prasad Babu[1], R. Mahenderkumar[1], P.C. Latha[1], Brajendra[1], J.V.N.S. Prasad[2] and G. Pratibha[2]

[1]ICAR-IIRR, Rajendranagar, Hyderabad, Telangana State, 500 030, India

[2]ICAR-CRIDA, Santoshnagar, Hyderabad, Telangana State, 500 059, India

Email: mbb.prasadbabu@icar.gov.in

Introduction

Rice (*Oryza sativa*) is one of the most important cereal crops of world which helps sustain two thirds of the world's population. It is the most important food crop in India, cultivated in 43.66 million hectares with a production of 118.87 million tons (MOAFW, 2021). Conventionally, rice crop is grown under submerged conditions and needs about 3,000–5,000 L of water to produce 1 kg of grain (Bouman et al. 2002). Hence, rice fields are considered to be one of the major sources of CH_4 emission which is produced in soil during microbial decomposition of organic matter under anaerobic conditions. Indian rice fields emit 3.37 mt of methane out of which, 1.84 mt is the contribution of irrigated rice fields (Bhatia et al. 2013). In addition to methane, as it receives very high quantities of N fertilizers, another GHG gas, nitrous oxide too is emitted during denitrification and nitrification. The present investigation was taken up to study the impact of different rice establishment methods Conventional transplanted (TPR), System of Rice Intensification (SRI), Direct Sown Rice (DSR) and Alternate Wetting and Drying (AWD) on methane and nitrous oxide emissions from rice.

Methodology

Four different planting methods (Conventional transplanted with continuous flooding – TPR (Flooded), System of Rice Intensification with irrigation at 5 cm depletion of ponded water (DOPD) – SRI (5 cm DOPD), Direct sown rice (Wet) with irrigation at 5 cm DOPD – DSR (5 cm DOPD) and Alternate Wetting and Drying – AWD (10 cm DOPD) were tested in a field experiment under RBD with five in *rabi* 2021, at research farm, IIRR, Rajendranagar, India. Gas samples were collected periodically and analysed for greenhouse gases *viz*., methane and nitrous oxide on Gas Chromatograph (GC) fitted with a flame ionization detector (FID) and an electron capture detector (ECD).

Results

Emission of Methane and Nitrous Oxide Greenhouse gas (Methane and nitrous oxide) emissions during the crop growth period were significantly impacted by the different rice establishment techniques. The seasonal integrated flux (SIF) for methane was the highest in conventional transplanted (TPR) method (22.36 kg ha^{-1}) followed by SRI (15.55 kg ha^{-1}), DSR (14.21 kg ha^{-1}) and AWD (12.65 kg ha^{-1}) methods with irrigation at 5 cm and 10 cm depletion of ponded water. Methane emissions decreased by more than 40 per cent in SRI and by 49 and 54 per cent in DSR and AWD respectively as compared to TPR. The higher methane emissions under conventional TPR method were due to the depletion of oxygen under submerged condition leading to conducive anaerobic or reduced atmosphere throughout the crop growth season. The seasonal integrated fluxes of N_2O-N were the least in TPR (0.675 kg ha^{-1}) as compared to SRI (0.861 kg ha^{-1}) and DSR and AWD methods (0.901 and 0.989 kg ha^{-1}). N_2O-N emissions were higher by 28 per cent in SRI and 33 and 47 per cent in DSR and AWD, respectively over TPR.

Table 1. Integrated seasonal flux of methane and nitrous oxide (*Rabi* 2021)

Treament	Methane ($kgha^{-1}$)	Nitrous oxide ($kgha^{-1}$)
Transplanted	22.36	0.675
SRI (5 cm DOPD)	15.55	0.861
DSR (5 cm DOPD)	14.21	0.901
AWD (10 cm DOPD)	12.65	0.989

Carbon Equivalent Emissions and Carbon Efficiency Ratio Carbon Equivalent Emissions (CEE) significantly varied with different establishment techniques. The CEE was the highest under TPR (207 kg C ha^{-1}) followed by SRI (176 kg C ha^{-1}). The lowest CEE values were observed under DSR and AWD methods (170 & 167 kg C ha^{-1}). The highest CEE in TPR was due to higher methane emissions during the entire crop growth period. The Carbon Efficiency Ratio (CER), an index of efficiency of a treatment which is a ratio of carbon (C), fixed in grain per unit of C emitted from soil. CER was the lowest in TPR method (11.7) and highest in (15.2) DSR. A low CER in TPR shows that more C is emitted and less C fixed where as in case of SRI and DSR the C emitted was significantly reduced as compared to the carbon fixed. The CER of conventional method was 23 per cent lower than DSR method, which shows that the latter is more efficient as it causes less emission in comparison to TPR.

Global Warming Potential The GWP varied significantly with the crop establishment methods. DSR and AWD methods lowered the GWP due to lower methane emissions as compared to the conventional TPR method. The highest GWP was recorded by TPR with 760 kg CO_2 eq. ha^{-1} which reduced to 645 kg CO_2 eq. ha^{-1} in SRI and further to 624 and 611 kg CO_2 eq. ha^{-1} in DSR and AWD respectively. SRI lowered the GWP by 15 per cent while DSR and AWD methods by 18 – 20% over TPR.

Conclusion

It is concluded from the results of the present study that direct sown rice can help in significant reduction (30 – 40%) of methane and nitrous oxide emissions as compared to conventional transplanted rice grown under continuous flooding.

References

MOAFW, Agricultural Statistics at a Glance (2021). Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India. *https://eands.dacnet.nic.in.* Accessed 16 Nov 2022.

Bouman BAM, Hengsdijk H, Hardy B, Bindraban PS, Tuong TP, Ladha JK (2002) In water-wise rice production. In: Proceedings of the International workshop on water-wise rice production, 8–11 April 2002, Los Banos. International Rice Research Institute, Los Banos

Bhatia A, Jain N, Pathak H (2013) Methane and nitrous oxide emissions from Indian rice paddies, agricultural soils and crop residue burning in 2007. Greenhouse Gas Sci Technol 3(3):196–211.

Lightning talk **ICSCI 2022/T3/110**

Direct-seeding of rice: an alternative option for profit maximization and resource conservation

Malay K. Bhowmick*, Panneerselvam Peramaiyan, Virender Kumar and Sudhanshu Singh
IRRI-South Asia Regional Centre, Varanasi 221106, Uttar Pradesh, India
E-mail: m.bhowmick@irri.org

Introduction

Rice (*Oryza sativa* L.) is the major food staple for over three-fourths of the Indians and nearly half of the world's population. The productivity, profitability, and sustainability of rice-based systems are in jeopardy due to impending challenges, particularly in Southeast Asia, such as degrading natural resource base, intensifying monsoon aberrations and climatic vulnerabilities, extreme weather events, emerging water scarcity, increasing cultivation costs, imbalanced input use, expanding labor shortages, rising labor wages, diminishing profit margins, etc. Farmers are constantly confronted with these challenges that hinder their ability to increase rice production and their income levels. Accordingly, worldwide rice production must be sustained to fulfill the escalating food demand of the expanding population while utilizing less resources, even in unfavorable climates and fragile ecosystems, and leaving reduced environmental footprints (Kumar *et al.*, 2017). Since the conventional rice transplanting requires huge quantum of labour, irrigation water, energy, and capital, it would not augur well in the near future (Kumar and Ladha, 2011, Pathak *et al*., 2011). The rising costs of labour and energy in India is making the puddled transplanted rice (PTR) less profitable proposition. Puddled transplanting method of rice cultivation not only deteriorates the soil physical properties, it also adversely affects the establishment and performance of succeeding upland crops. More significant emission of greenhouse gasses (GHGs) in PTR is another concern, considering its further impact on climate change. New ideas and innovations in rice cultivation are critically needed to meet increasing food demand and improve the livelihood, nutrition, and income of smallholder farmers and their families while addressing the growing shortages of labor, water, and energy, and increasing production costs (Kumar *et al*., 2017). This calls for switching from the conventional (capital-, energy-, labor- and water-intensive) puddled transplanted rice (PTR) to other alternatives that increase rice-based system productivity and profitability along with resource conservation. Compared with the PTR, direct-seeded rice (DSR) has been proving to be a more resource-efficient, climate-resilient, economically viable, and environmentally promising alternative option.

Direct-seeded rice production systems

Rice is grown in a variety of topographies, ecosystems, and environments, broadly through either transplanted or direct-seeded method of crop establishment (Pathak *et al*., 2011, Kraehmer *et al*., 2015). Direct seeding of rice is a method of crop establishment by sowing the seeds directly in the main field with raising the seedlings in the nursery and transplanting them in the main field (Farooq *et al.*,2011). The DSR can be done by (i) dry-seeding (dry-DSR), (ii) wet-seeding (wet-DSR), and (iii) water-seeding (water-DSR). In dry-DSR, dry seeds are broadcasted, drilled, or dibbled on dry (unsaturated) soils under rainfed upland conditions. Dry-DSR can also be grown in irrigated areas with precise water control as aerobic rice. In certain states, farmers can cultivate dry-DSR with the onset of monsoon and convert it to irrigated lowland rice after releasing the assured canal water in the system. Wet-DSR (drum-seeding) is mainly followed to address the labour scarcity, especially in eastern and southern states of India along with other countries like Malaysia, Philippines, Sri Lanka, Thailand, Vietnam etc(Bhowmick *et al*., 2016), whereas water-seeding is in practice to tackle the weedy rice infestations, mostly in United States

Emerging risks and challenges in DSR systems

A number of studies have highlighted certain risks and concerns about direct seeding because of early flooding, poor germination under anaerobic conditions, uneven crop stand (due to improper seeding depth or inundation after sowing or sub-optimal management practices), soil sickness, severe weed problem with greater yield reduction or even complete crop failure (due to inadequate and delayed weed management), evolution of herbicide resistance in weeds (due to exclusive reliance on herbicides), evolution of weedy rice and volunteer rice, shift in weed flora, crop susceptibility to lodging etc. (Kaur and Singh, 2017). These risks associated with DSR limit its widescale and accelerated adoption. Moreover, intense weed problems with complex and diverse weed flora, limited availability of cost-effective herbicides for timely managing these difficult-to-control weeds including weedy rice, lack of DSR-specific suitable cultivars or genotypes, poor capacity and affordability of the smallhoder farmers to bear and take the risks of newer technologies, lack of sufficient economic incentives to the farmers, and inadequate awareness and knowledge of farmers on the precise and mechanized DSR are the major challenges in scaling the DSR. To overcome these issues, a holistic approach is required from seed sowing to seed harvest.

Prospects and opportunities of DSR

Increasing water scarcity due to climate change and competition from urbanization is making the traditional method of rice production (PTR) unsustainable in the long run. Due to the uncertain monsoon, farmers often remain in a dilemma that leads to risk-averse input management, making them unable to capitalize even on the normal (non-stress) year. Dearth of labour availability or higher labour wages in recentl years and as also experienced during the COVID-19 pandemic causes a substantial delay in conventional transplanting. This compels the farmers to adopt and explore alternative crop establishment method at scale and across landscapes. As the cost of irrigation water and labour are likely to rise despite their limited availability in future, DSR appears to be an attractive alternative option (Sagwal *et al*., 2021). DSR resolves labor bottlenecks and drudgery by eliminating seedling uprooting and transplanting operations. Besides, DSR offers both mitigation of climate change (through reduction of GHG emissions) and adaptation to its effects (water shortages and variable monsoon conditions). Estimates reveal that DSR can save cost (20-30%), irrigation water (20-50%) and labor (30-40%), and reduce methane emissions (20-50%) and overall global warming potential (20-30%) as compared to the PTR. In addition, DSR provides faster and easier seeding, greater drought tolerance, improved fertilizer use efficiency, earlier crop maturity (7-15 days), higher or similar yields, lower costs of production (~120 USD ha^{-1}) and increased profits (90-120 USD ha^{-1}) with more energy-saving opportunities, better soil physical conditions for the next crop, improved system productivity (either comparable or bit higher in rice and 1.0-3.0 q ha^{-1} gain in wheat) with less environmental footprints, and greater resilience to climatic variations (Sagwal *et al*., 2021).

Interventions and innovations in DSR

Proper land selection with good land preparation (including precise levelling), sowing attributes (seed invigoration, optimized seed rate and seeding depth, *vattar* sowing, right spacing, timely sowing), integrated weed management (stale seed bed, soil/dust mulching, weed-competitive cultivars, use of pre-emergence herbicides, need-based use of post-emergence herbicide in integration with manual or mechanical weeding at 3-4 weeks after sowing, etc.), precision nutrient management (site-specific nutrient management, including micronutrients, especially zinc, boron and/or iron), precise water management (particularly during crop emergence and establishment phases), and integrated pest and disease management practices are the major interventions for achieving higher productivity and maximizing profit with DSR. Soil/dust mulching is a novel agro-technique to better control weeds, sow earlier (a few weeks before the start of monsoon) under tar-wattar/vattar (optimum soil moisture) conditions with reduced irrigation and conserve soil moisture in dry-DSR conditions (Malik *et al*., 2015; Micro-irrigation, particularly surface or sub-surface drip irrigation systems after early establishment of dry-DSR crop, is a modern water-saving technology that restricts soil evaporation and deep percolation, and thereby suppresses weed infestation as well (Shekhawat *et al.*, 2020; Rao, 2021). Rice genotypes that are tolerant to anaerobic germination (AG) are promising for the spread of DSR in rainfed lowland areas (Singh 2021). Another innovative strategy for precision DSR is the use of weed-competitive cultivars (inbreds or hybrids) coupled with their better bet agronomy (Singh, 2021). Rice genotypes that are herbicide-tolerant (HT) have the potential to improve the crop performance, reduce the risks of herbicide-resistant weedy rice development, and facilitate wider adoption of DSR. New herbicides (low dosage, high efficacy) with differential modes of action and their combinations (mixed and/or sequential applications) can provide for broad-spectrum control of diverse weed flora. Use of drones can help in seeding, herbicide spraying, crop health monitoring, detecting nutrient deficiencies, etc.

Conclusion

Appropriate rice genotypes (weed-competitive, high-yielding, AG-tolerant, herbicide-tolerant, less water requiring inbreds/hybrids of short- to medium-duration group) along with robust crop establishment methods, conforming management practices and scale-appropriate mechanization are very much critical to the success of direct seeding practices in order to save the resources (labour, water, and energy) which are becoming increasingly scarce and costlier. Mechanized DSR would have more employment opportunities for youth through service provision business models. Being knowledge-intensive technology for climate-resilience, resource conservation, sustainable intensification and profit maximization, it requires awareness creation, skill improvement and capacity building of different stakeholders for the target-oriented field-specific promotion and dissemination of the precise and mechanized DSR with a complete package of best management practices, besides ensuring availability of suitable herbicides, quality seeding machines (with precise seed-metering mechanism), and improved rice genotypes specific for DSR cultivation across different ecologies and landscapes.

References

Bhowmick, M.K., Duary, B., Bhattacharyya, P. and Dhara, M.C. (2016). Drum seeding technology: A viable option for resource-poor farmers toward profitable rice production in West Bengal. In: Mondal, B., Sarkar, D., Mukhopadhyay, S.D., Ghosh, S., Roy, B.C. and Chowdhury, S. (eds), *Family Farming: Challenges and Opportunities*, Renu Publishers, Mohan Garden, New Delhi, India, pp. 125-130.

Farooq, M., Siddique, K.H.M., Rehman, H., Aziz, T., Dong-Jin, Lee and Wahid, A. (2011). Rice direct seeding: Experiences, challenges and opportunities. *Soil & Tillage Research*, vol. 111, 87-98.

Kaur, J. and Singh, A. (2017). Direct seeded rice: Prospects, problems/constraints and researchable issues in India. *Curr. Agric. Res. J.*, vol. 5, 13-22.

Kraehmer, H., Jabran, K., Mennan, H. and Chauhan, B.S. (2015). Global distribution of rice weeds - A review. *Crop Protection*, vol. 80, 73-86.

Pathak, H., Tewari, A.N., Sankhyan, S., Dubey, D.S., Mina, U., Singh, V.K. and Jain, N. (2011). Direct-seeded rice: Potential, performance and problems - A review. *Curr. Adv. Agric. Sci.*, vol. 3, 77-88.

Shekhawat, K., Rathore, S.S. and Chauhan, B.S. (2020). Weed management in dry direct-seeded rice: A review on challenges and opportunities for sustainable rice production.

Kumar, V. and Ladha, J.K. (2011). Direct seeding of rice: Recent developments and future research needs. *Adv. Agron.*, vol. 111, 297-413.

Kumar, V., Opeña, J., Valencia, K., Thi, H.L., Son, N.H., Donayre, D.K., Janiya, J. and Johnson, D.E. (2017). Rice weed management in Southeast Asia. In: Rao, A.N. and Matsumoto, H. (Eds.), *Weed management in rice in the Asian-Pacific region*, Asian-Pacific Weed Science Society (APWSS); The Weed Science Society of Japan, Japan and Indian Society of Weed Science, India, pp. 282-307.

Panneerselvam, P., Kumar, V., Banik, N.C., Kumar, V., Parida, N., Wasim, I., Das, A., Pattnaik, S., Roul, P.K., Sarangi, D.R., Sagwal, P.K., Craufurd, P., Balwinder-Singh, Yadav, A., Malik, R.K., Singh, Sudhanshu and McDonald, A.J. (2020). Transforming labor requirement, crop yield, and profitability with precision dry-direct seeding of rice and integrated weed management in Eastern India. *Field Crops Research*, vol. 259, 107961.

Pathak, H., Tewari, A.N., Sankhyan, S., Dubey, D.S., Mina, U., Singh, V.K. and Jain, N. (2011). Direct-seeded rice: Potential, performance and problems - A review. *Curr. Adv. Agric. Sci.*, vol. 3, 77-88.

Rao, V.P. (2021). Sustainable food systems: Water challenges and transformation technologies. *Presidential Address*, Fifth International Agronomy Congress on "Agri-Innovations to Combat Food and Nutrition Challenges", November 23-27, 2021, Org. by the Indian Society of Agronomy, New Delhi at PJTSAU, Hyderabad, Telangana, India, 24 p.

Sagwal, P., Kumar, V., Bhowmick, M.K., Peramaiyan, P., Kumar, Ashok and Singh, Sudhanshu (2021). Mechanized direct-seeded rice: A way forward towards sustainable rice-based systems. *Abstracts*, XV Agricultural Science Congress on Energy and Agriculture: Challenges in 21st Century, November 13-16, 2021, Org. by National Academy of Agricultural Sciences (NAAS) at Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India, pp. 315.

Shekhawat, K., Rathore, S.S. and Chauhan, B.S. (2020). Weed management in dry direct-seeded rice: A review on challenges and opportunities for sustainable rice production. *Agronomy*, vol. 10, 1264.

Singh, Sudhanshu (2021). Agronomic innovations for tapping potential of improved rice genotypes. In: *Lead Papers*, Fifth International Agronomy Congress on "Agri-Innovations to Combat Food and Nutrition Challenges", November 23-27, 2021, Org. by the Indian Society of Agronomy, New Delhi at PJTSAU, Hyderabad, Telangana, India, pp. 67-70.

Lightning talk **ICSCI 2022/T3/86**

Carbon credits for reducing methane emissions from rice cultivation using the system of rice intensification (SRI)

Vassily Carantino[1] and James Hastwell[2]
CarbonFarm Technology
vassily@carbonfarm.tech

Introduction

Rice production is responsible for 12% of all anthropogenic methane and uses 28% of the world's freshwater resources. Sustainable practices, such as those promoted by the System of Rice Intensification methodology (SRI), can cut these emissions by 48%, reduce water use by 30%, while increasing yields. But adoption is too slow and farmer training programs are constrained by limited philanthropic fundings. Carbon credits could be an excellent way to finance these trainings and offer financial incentives for farmers. But today, they rely on manual audits, which are expensive and unreliable. As a result, this financing option is rarely used.

Methodology

CarbonFarm has successfully established and tested a remote-sensing approach to detect changes in water management practices in rice paddies, and estimate the related reduction in methane emissions. They are looking for potential partners to pilot this approach at scale in India, with the ambition to democratize the access to rice-based carbon credits for farmers and cooperatives, via satellite.

Results & Conclusion

Remote sensing could play a role to replace these manual audits, and democratize the access to rice-based carbon credits.

Lightning talk **ICSCI 2022/T3/111**

Putting the green revolution in its historical place: documenting the shift of attention from external inputs back to careful crop husbandry

Dominic Glover
Institute of Development Studies at the University of Sussex, Brighton BN1 9RE, United Kingdom
E-mail: D.Glover@ids.ac.uk

Introduction

The attention given to careful crop management practices within the System of Rice Intensification (SRI) (and related Systems of Crop Intensification (SCI)) represents a revival of scientific attention to field agronomy relative to crop breeding and external inputs. Field agronomy was somewhat sidelined during the Green Revolution (GR), when attention was directed towards scientific plant breeding and external inputs, such as mineral fertilisers, pesticides and other crop protection chemicals. The focus of attention on careful crop establishment and husbandry was common in agronomic research and extension before the GR, and has revived during the past two to three decades.

Methodology

The paper will present historical evidence from scientific journals to show that agronomic researchers used to focus more attention during the pre-GR era on farm and crop management practices such as nursery raising, planting density, water management and internal inputs, and that renewed attention has again been given in the post-GR period to agro-ecological and 'low external input' practices (exemplified in the paper by SRI and SCI)—representing a revival of interest among agronomic scientists and extensionists in these farm management practices.

Results

Evidence from scientific journals demonstrates that agronomic researchers and extensionists used to devote considerable attention to topics such as nursery raising, planting density, weed control, water management and soil care during the first half of the 20th century. During the GR, as is well known, attention switched decisively to scientific plant breeding and external inputs, including mineral fertilisers, irrigation and crop protection chemicals. In the post-GR period, there has been renewed attention to agro-ecological concerns, exemplified by SRI and SCI.

Conclusion

The GR may be placed firmly in its historical context as a completed historical episode, during which the focus of attention was given to scientifically improved crop cultivars and external inputs. However, rather than a radical novelty, the attention now being given to careful crop and field management within SRI and SCI should be understood as reflecting a revival of concerns that used to preoccupy scientists in the pre-GR era.

Lightning talk **ICSCI 2022/T3/60**

Iron coated seed - an effective water seeding technique for increased productivity in direct seeded rice in puddled soil condition

Mahender Kumar. R.[1]*, Kazumichi Sashi[2]., Soumya Saha[1]., Srinivas. D[1], Sreedevi. B[1]., Mangal Deep Tuti[1], Aarti Singh[1], Sandhyarani. A[1]., Vijaya Kumar. S[1]., Arun. M.N[1] and Venkatanna.B[1]

[1]*ICAR-Indian Institute of Rice Research, Hyderabad, Telangana, India – 500030.*
[2]*JFE-Steel Corporation.*
Email: seenu290@gmail.com

Introduction

Rice is a staple food in Asia and has been planted traditionally by labor-intensive transplanting, which includes raising seedlings, pulling, bundling, and transporting them to the fields. While transplanting is mechanized in some countries, mechanization has not gained popularity in many Asian countries, with seedlings mostly planted by hand. Direct seeding, or seeding directly into the fields without transplanting, offers many advantages, including requiring less labor at a time when many farming populations are aging, and with younger, more educated generations are seeking urban jobs. To overcome this, refine direct seeding practices and technologies become promising, which can contribute to preserving resources and environmental sustainability. Seed treatment of soaking, incubation, and drying increases the germination rate of rice even at low temperatures or under anoxia and that the treatment is effective not only in Japonica but also in Indica cultivars (Yamauchi, 2002; Mori et al., 2012). Andoh and Kobata (2002) reported that seeds that had been soaked and then dried have increased a-amylase activity and a high germination rate.

In many parts of Asia, farmers have developed a direct seeding method called “wet seeding” in which pre-germinated seeds are broadcast-seeded in damp or well-puddled soil. While faster and requiring less labor than transplanting, wet seeding often requires fields to be drained first, to ensure that seeds anchor on the ground rather than float away in the water. Unfortunately, draining is a waste of water, nutrients, and fertile soil clay minerals, and also stimulates the growth of weeds and weedy rice growth. An innovative direct seeding method has been successfully developed in Japan, which uses seeds coated with iron powder. This raises the density of the seeds, allowing them to be sown directly in flooded paddies, eliminating the need for forced drainage as well as reducing problems with weeds. This new seeding method is called “water seeding”, which has been little practiced in Asia before. Coating seeds with iron powder also reduces the occurrence of seed-borne diseases and minimizes incidences of birds eating the seeds. Hence, an experiment was initiated to assess the impact of the seed coating on crop establishment and productivity of the DSR system.

Methodology

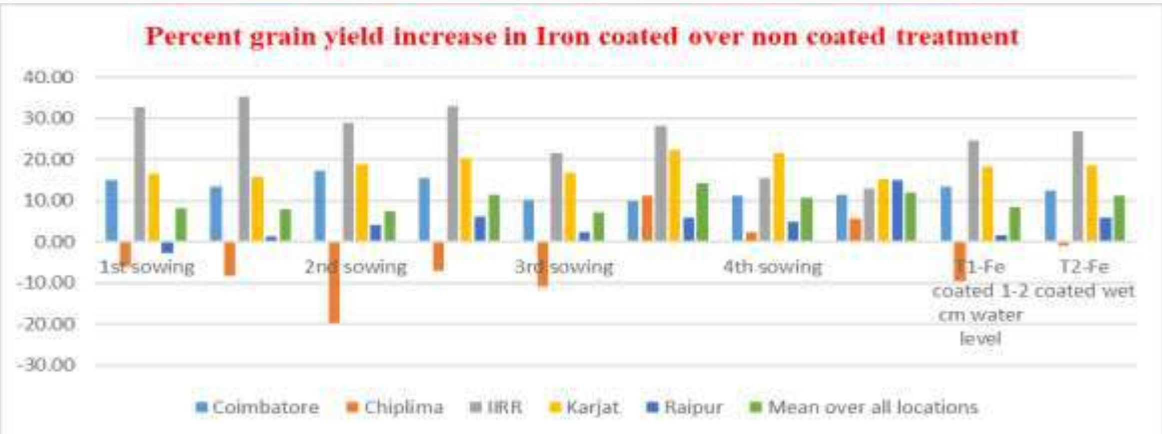
The AICRIP trial was conducted after two years (2016 & 2017) of station trial at ICAR-IIRR. The field trial was initiated to study effect of Fe-coating on growth and yield parameters of rice at five locations Chiplima, Coimbatore, Karjat, IIRR and Raipur for two years (2018 & 2019) with 4 date of sowings with one week interval as main plots and five establishment methods(T_1- Iron coated seed, seed rate 25 kg/ha, broadcasting in 1-2cm water level condition (Direct sowing) T_2- Iron coated seed, seed rate 25 kg/ha, broadcasting in wet Condition (Direct sowing) T_3 – Un-coated seed, seed rate 25 kg/ha, broadcasting in 1-2cm water level condition (Direct sowing) T_4 – Un-coated seed, seed rate 25 kg/ha, broadcasting in wet condition (Direct sowing) T_5 – Normal transplanting 21-25 days after sowing as subplots in 3 replications. Main plot was designed in four sowing dates with one-week interval to depict the anchorage and germination of iron coated seeds in the event of water lagging conditions under heavy rainfall situation, where there could be a chance for normal seed for dispersal in Broadcasting method. The germination of iron coated seed was significantly higher over uncoated seed in water logging condition due to heavy rainfall.

Results

The mean grain yield across all the 5 locations revealed that 1st date of sowing was the best time of sowing for all the locations resulting the highest yield of rice followed by 2nd, 3rd and 4th date of sowing. Iron coated treatments performed better than without coated treatments with a yield advantage of 7.10 to 11.18%. Iron coated seed with seed rate of 25 kg/ha and broadcasted in 1-2cm water level condition and iron coated wet seeding recorded higher grain yield (4.38 & 4.38 t/ha) than (4.05 & 3.94 t/ha) uncoated seeds (Pooled data of two years over five locations). There is an increase of 8.15 to 11.13% grain yield due to iron coating of seeds. The iron coating seed is promising over un coated seed in DSR broad casting method.

Table 1. **Percent Grain Yield Increase in Iron coated over non coated treatments**

Treatments		**Coimbatore**	**Chiplima**	**IIRR**	**Karjat**	**Raipur**	**Mean over all locations**
Main Plot	**Sub plots**						
1st sowing	T1	15.03	-5.93	32.77	16.61	-2.80	8.23
	T2	13.48	-8.21	35.20	15.82	1.42	7.94
2nd sowing	T1	17.30	-19.59	28.96	18.91	4.12	7.48
	T2	15.48	-6.96	32.94	20.26	6.16	11.55
3rd sowing	T1	10.32	-10.81	21.59	16.77	2.43	7.27
	T2	9.86	11.25	28.12	22.47	5.77	14.23
4th sowing	T1	11.24	2.44	15.41	21.51	4.90	10.80
	T2	11.46	5.65	13.10	15.24	15.10	11.99
T1-Fe coated 1-2 cm water level		13.55	-9.49	24.64	18.19	1.56	8.33
T2-Fe coated wet		12.54	-1.02	26.97	18.49	5.87	11.22



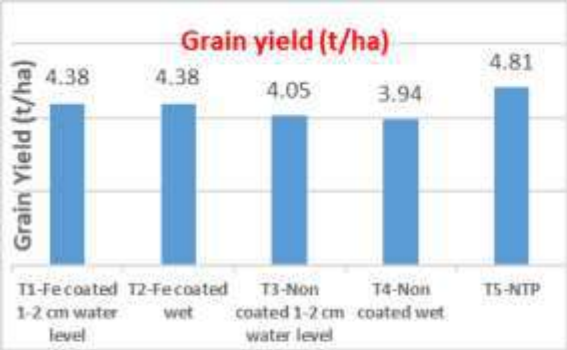


Fig 1. Pooled data of percent grain yield increase in Iron coated over non coated seed treatments

References

Andoh, H., and T. Kobata. 2002. Effect of seed hardening on the seedling emergence and a-amylase activity in the grains of wheat and rice sown in dry soil. (In Japanese, with English summary.) Jpn. J. Crop. Sci. 71:220–225.

Mori, S., H. Fujimoto, S. Watanabe, G. Ishioka, A. Okabe, M. Kamei. 2012. Physiological performance of iron-coated primed rice seeds under submerged conditions and the stimulation of coleoptile elongation in primed rice seeds under anoxia. Soil Sci. Plant Nutr. 58:469–478.

Yamauchi, M. 2002. Reducing floating rice seedlings in wet direct sowing by increasing specific gravity of seeds with iron powder coating. (In Japanese.) Jpn. J. Crop. Sci. 71(Suppl. 1):150–151.

Lightning talk **ICSCI 2022/T3/41**

System of Rice Intensification- a method for resource conservation and productivity enhancement in rice (*Oryza sativa. L.*) cultivars

Srinivas. D[1]*, Mahender Kumar. R.[1], Sreedevi. B[1]., Mangal Deep Tuti[1], Aarti Singh[1], SoumyaSaha[1]., Sudhakara T.M[1]., Thirupathi. I[2]., Sandhyarani. A[1]., Vijaya Kumar. S[1]., Arun. M.N[1] and Venkatanna.B[1].

[1]ICAR-Indian Institute of Rice Research, Hyderabad, Telangana, India – 500030.

[2]KVK-Bellampalli, PJTSAU.

Email: seenu290@gmail.com

Introduction

System of Rice Intensification (SRI) is best understood as an agronomic practice for small and marginal farmers to sustain with available or limited resources such as organic fertilizers, water and man power specially to sustain the productivity of the cultivars. In this context, the present experiment was conducted for continuous three years (six seasons) to evaluate suitable rice cultivars for SRI method of practice for their yield optimization, water productivity and potentiality of the method for the resource conservation.

Methodology

A total of 95 cultivars including hybrids, high yielding varieties and elite cultures (poor yields) were evaluated under System of Rice Intensification (SRI) method in comparison with normal transplanting method (NTP) during three Kharif and three Rabi seasons in F2 plot of Indian Institute of Rice Research farm located in ICRISAT, Hyderabad in sandy loam soils with pH 7.6, E.C. 0.26, Organic carbon 0.49% and with available NPK (kg ha^{-1})225: 42.5:323. Alternate wetting and drying method was followed for irrigation in SRI method up to panicle initiation stage where as in NTP saturation condition was maintained thorough out the crop period.

Table.1. Details of the methods of cultivation

S.No.	Practice	SRI method	Normal Transplanting
1	Nursery	Raised bed nursery	Flatbed nursery
2	Seedling age for transplanting	8-12 days	25-30 days
3	Seedlings	Single seedling is planted	Average of three seedlings are planted
4	Spacing	25 x 25 cm wider spacing	20 x 15 cm spacing
5	Weeding	4 times weeding by cono weeder	Hand and manual weeding at 20 and 35 DAT
6	Water management	Alternate wetting and drying irrigation up to panicle initiation stage	Saturation through the crop

Results

The SRI method found promising over NTP with higher yield parameters and yield with decreased days in crop maturity and inputs. Hybrids due to their heterotic potential viz; KRH2, DRRH3, PA6129, PA6444 & US312 were found promising with higher grain yield ranged from 6.02 to 7.66 t/ha over NTP with a grain yield increase ranged from 19.35% to 34.5%, with reduced water application. Among varieties, the percent grain increase was to the tune of 17.2% to 31.9% and the promising varieties identified were RP Bio 226, Akshayadhan, Vardhan, Sampada, IR 64 and Krishnahamsa, which matured early and reduced seed rate and water requirements to a greater extent (80% in seed and 30% in water input) with SRI method of cultivation .Among the elite and scented varieties (generally poor yields), the percent grain increase found in SRI over NTP ranged from 8.98% to 32.97% and promising elite cultures were Chittimuthyalu, Kasturi and Taroari basmati in terms of grain yield. It indicated that the elite and scented can be grown with the SRI method for enhancing the productivity and profitability of these cultivars. Mean over the three years, the percent grain increase was found higher in SRI over NTP i.e., 27.40% for hybrids, 22.93% for varieties and 20.0% for elite cultures (Fig .1). SRI practices create conditions for beneficial soil for microbes to prosper, saving irrigation water, and increasing grain yield (Subramaniam et.al, 2013).

The water productivity (kg grain produced per mm water applied) was significantly superior in SRI (7.08 kg/mm/ha) method over NTP (3.93 kg/mm/ha) in all the seasonsfor Hybrids, High yielding varieties and Elite and scented cultivars. Across the years, the water productivity ranged from 3.16 to 8.18 kg/mm/ha (Table-2), irrespective of cultivars, SRI method saved 32% of water input over NTP with increased output energy with of 24% higher grain yield, with reduced man power & input energy. Similar results of saving of about 40% of irrigation water and increase land productivity by about 46% while reducing the cost of cultivation by 23% over the conventional inundation method (Naranayamoorthy and Jothi, 2019). Further, most of the cultivars found promising and recorded higher grain yield with SRI method with reduced resources (seed, water & labour). Local and elite cultures yield can also be increased with adoption of SRI method.

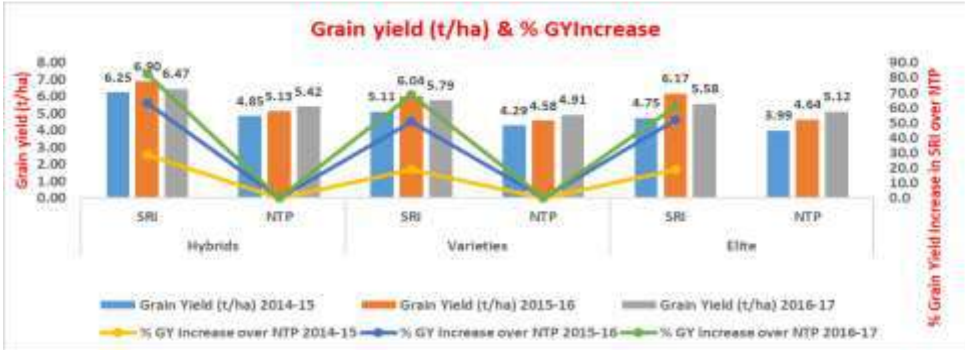


Fig 1: Grain Yield and % grain yield increase in SRI method over NTP

Table 1: Water productivity (kg grain/mm/ha)

Cultures		Water productivity (kg grain/mm/ha)			Mean
		1st Year	2nd Year	3rd Year	
Hybrids	SRI	7.45	8.18	7.91	7.85
	NTP	3.84	4.32	4.52	4.23
	CD(0.05)	0.22	0.17	0.31	
	CV(%)	2.94	2.48	4.01	
Varieties	SRI	6.1	7.17	7.09	6.79
	NTP	3.4	3.85	4.09	3.78
	CD(0.05)	0.16	0.24	0.29	
	CV(%)	3.35	6.76	5.93	
Elite	SRI	5.66	7.32	6.82	6.60
	NTP	3.16	3.9	4.27	3.78
	CD(0.05)	0.21	0.21	0.16	
	CV(%)	2.33	2.84	1.78	

Conclusion

The identified hybrids, cultivars and scented varieties could be promoted in SRI method for higher grain yield with lesser inputs especially seed and water in large scale.

References

Naranayamoorthy.A&Jothi. P. 2019. Water saving and productivity benefits of SRI: a study of tank, canal and groundwater irrigated settings in South India. Water Policy. 2019. 21 (1): 162–177.

Subramaniam Gopalakrishnan, R. Mahender Kumar, PagidiHumayun, V. Srinivas, B. RatnaKumari, R. Vijayabharathi, Amit Singh, K. Surekha, Ch. Padmavathi, N. Somashekar, P. Raghuveer Rao, P. C. Latha, L. V. Subba Rao, V. R. Babu, B. C. Viraktamath, V. Vinod Goud, N. Loganandhan, BikshamGujja, Om Rupela. 2013. Assessment of different methods of rice (Oryzasativa. L) cultivation affecting growth parameters, soil chemical, biological, and microbiological properties, water saving, and grain yield in rice–rice system. Paddy and Water Environment,2013. 12: 79-87.

ICSCI 2022/T3/01

Lessons learnt from the permanent manurial experiment on rice - rice cropping sequence of Cauvery delta zone of Tamil Nadu

Sathiya Bama, K [1], Sharmila Rahale, C[2] Raju, M[1] and Deepana, P [1]

[1]*Tamil Nadu Rice Research Institute, Aduthurai,* [2]*Dept. of Nanotechnology, TNAU, Coimbatore*

**E-mail:* kssoilscience@gmail.com

Introduction

Cauvery Delta Zone is the potential tract of rice cultivation in Tamil Nadu. Generally short duration rice varieties of 105-110 days are grown in '*kuruvai'* season while medium duration varieties (135-145 days) in '*Thaladi'* season. Thus rice-rice is the most common cropping sequence followed in the delta zone of Tamil Nadu. Though concise proven technologies are suggested by the University/ department of agriculture as blanket recommendation, farmers use their own input management particularly fertilizers application in accordance with their economic level. Therefore, it has been proposed to monitor the effect of farm chemicals, bio-fertilizers and organic manures on the changes in soil physico-chemical properties, fertility, rice productivity and nutrient uptake of rice-rice cropping sequence.

Methodology

With the above objectives, a permanent manurial experiment on rice-rice cropping sequence was started at Tamil Nadu Rice Research Institute, Aduthurai during June 1992 and so far 60 crop experiments had been conducted and in this paper the results of 30th year are discussed. The soil of the experimental site is fine, montmorillonitic, isohyperthermic, Udorthontic Chromusterts with heavy clay texture. This fixed plot experiment with 14 treatments was laid out in randomized block design with four replications. Fertilizers (organic and inorganic), bio-fertilizers, herbicide and soil amendments were applied as per the treatment. For treatments of T5, T6 and T7, green manure (GM) *Sesbania rostrata* was incorporated @ 6.25 t/ha for *kharif* rice while in *rabi* rice, FYM was applied. Phosphorus was skipped in T4 during *rabi* season. In the case of T11, only 75 % of the NPK was applied for *rabi* rice in order to assess the effect of reduced quantity of NPK. The experiment is continued for the 30th year with ADT 53 during 'kuruvai 2021' as 59th crop and ADT-46 in 'thaladi' as 60th crop.

Results

The effect of treatments on yield and soil analysis during 'kuruvai' is given in Table 1. Higher grain and straw yield was obtained under the treatment combining inorganic fertilizers of N:P:K @125:50:50 + GM @ 6.25 t/ha during Kuruvai (6285 and 8428 kg/ha). During 'Thaladi' also same trend of results was observed. After 30 years, the yields of 59th and 60th crop indicated that the treatment of NPK + GM + gypsum (T7) as the most productive with 78, 66, 62 and 58% higher yields over control (T13) and NPK + Gypsum (T10), NPK + GM + *Azospirillum* (T6) and NPK + GM, respectively. The results further showed that the combination of NPK + $ZnSO_4$ (T8) brought a significant increase in grain yield indicating the importance of $ZnSO_4$ application for rice grown in the heavy soils of Cauvery delta zone. Integrated use of organic and inorganic fertilizers can make important contribution for increasing and sustaining rice production. This was also evidenced by studies of Jayajothi and Nalliah Durairaj (2015) and Nayak *et al.* (2012).

Conclusion

During 'kuruvai' season, treatments receiving green manure @ 6.25 t/ha and gypsum @ 500 kg/ha with NPK (125:50:50) and in 'thaladi' season the treatments receiving FYM @ 12.5 t/ha and gypsum @ 500 kg/ha with NPK (150:60:60) consistently registered higher yields while improving the organic carbon content and available N, P and K nutrients in soil. There is a yield response to P and K application yield. Further, NPK +GM/FYM recorded higher non-labile carbon.

Table 1. Effect of nutrition treatments on yield and soil fertility of rice-rice cropping system in permanent plot study

Treatment	Kuruvai (2021)-ADT53	Thaladi (2021-22)-ADT46	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)	OC (g/kg soil)
NP	4581	4642	224	54.2	255	8.8
NK	4995	4931	235	46.2	245	8.6
NPK	5110	5132	224	52.8	316	8.4
STCR	5130	5174	224	51.2	281	8.4
NPK (no P - thaladi)	5171	4923	220	46.2	298	8.8
NPK+FYM	5493	5562	236	56.4	342	10.2
NPK +FYM+BGA	5561	5662	232	55.8	232	10.8
NPK +FYM+ Gypsum	6285	6632	244	60.2	346	10.8
NPK +$ZnSO_4$	5418	5405	226	47.2	290	9.6
NPK +Herbicide	5262	5182	228	51.3	299	8.2
NPK + Gypsum	5903	6035	236	52.4	290	9.5
NPK -75%	4995	5002	210	52.4	288	8.2
NPK + CCP	5305	5272	230	55.4	311	10.6
Absolute Control	3443	3135	185	38.6	260	7.7
CD (p=0.05)	402	415	25	8.5	32	1.52
Initial (1992)	-	-	231	30	228	5.7

References

Jeyajothi R and S Nalliah Durairaj. 2015. Influence of integrated nutrient management practices on yield and yield attributes, and economics of transplanted rice (*Oryza sativa*) in South Zone of Tamil Nadu. International Journal for Innovative Research in Science & Technology, 1(11): 462-467.

Nayak AK, B Gangwa, AK Shukla, SP Mazumdar, R Anjani Kumar Raja, Kumar Anil, PK Vinod Kumar Rai and Udit Mohan. 2012. Long-term effect of different integrated nutrient management on soil organic carbon and its fractions and sustainability of rice–wheat system in Indo Gangetic Plains of India. Field Crops Research, (127): 129–139.

ICSCI 2022/T3/02

Predicting rice yield for Cauvery delta zone of Tamil Nadu using statistical model

K. Sathiya Bama, S. Gayathri, M. Raju, V. Ambethgar
Tamil Nadu Rice Research Institute, Tamil Nadu Agricultural University, Tamil Nadu
E-mail: kssoilscience@gmail.com

Introduction

The traditional approach of forecasting crop yield involves sample surveys based on crop cutting experiments (CCE). These yield surveys being extensive, as plot yield data are being collected based on a stratified random sampling, also the production estimates are obtained much after the crop season is over (Ghosh *et al*., 2014). The crop responses to meteorological factors are mainly empirical relationship and yield forecast models are statistical. Therefore, weather parameters are obligatory to be incorporated in yield forecast models for its improvement. Rice is the major crop in the Cauvery delta of Tamil Nadu. The rice production and productivity is influenced by vagaries of weather condition. In this situation this study deal with the rice yield forecasting model using weather indices for Cauvery delta zone of Tamil Nadu through regression technique.

Methodology

The yield data of rice for a period of 1995-2021 was collected for the Cauvery Delta Zone districts *viz.*, Thanjavur, Thiruvarur, Trichy and Nagapattinam from reports available in the Department of Economics and Statistics, Government of Tamil Nadu. The daily data of weather parameters such as maximum and minimum temperature, morning and evening relative humidity and rainfall for the above mentioned period and districts was collected from Regional Meteorological Centre, India Meteorological Department, Chennai. Combination of weather variables for weather indices, thus generated are presented in Table 1.

Table 1: Weather indices used in models using composite weather variables

	Simple weather indices					**Weighted weather indices**				
	Tmax	**Tmin**	**Rainfall**	**RH I**	**RH II**	**Tmax**	**Tmin**	**Rainfall**	**RH I**	**RH II**
Tmax	Z10					Z11				
Tmin	Z120	Z20				Z121	Z21			
Rainfall	Z130	Z230	Z30			Z131	Z231	Z31		
RH I	Z140	Z240	Z340	Z40		Z141	Z241	Z341	Z41	
RH II	Z150	Z250	Z350	Z450	Z50	Z151	Z251	Z351	Z451	Z51

Statistical Package for Social Science (SPSS) computer software was used for the analysis of data with probability level of 0.05 to enter and 0.1 to remove the variables. The multiple linear stepwise regression analysis has been developed by assessment of coefficients of determination (R^2), standard Error (SE) of estimates values resulted from different weather variables.

Results

The rice yield forecast models for different district of Cauvery delta zone at mid-season stage (F2) and pre harvest stage (F3) are presented in the Table 2. The R^2 value for the predicted yield at mid-season stage ranged from 0.75 to 0.98 for districts. During 2021, Nagapattinam district registered higher R^2 value (0.98) indicating that the weather indices have more influence on crop yield. The lowest R^2value (0.75) was for Thanjavur district indicating that weather parameters do not have any influence on crop yield. Among the four districts, highest R^2 value was obtained in Nagapattinam which indicates the higher suitability of this statistical for this district followed by Tiruvarur, Trichy and Thanjavur.

Table 2. Crop yield forecast of *kharif rice* during 2021 for Cauvery Delta Zone - Tamil Nadu

District	Stage of the crop	Regression Equation	R^2
Thanjavur	Midseason (F2)	Y=5561.13(Z251*1.59+Z141*1.92)	0.75
	Pre-harvest (F3)	Y=3696.10+(Z51*23.72+Z31*5.82)	0.76
Trichy	Midseason (F2)	Y=5376.90+(TIME*62.94+Z141*3.41+Z140*-0.191+Z11*121.54)	0.80
	Pre-harvest (F3)	Y=1512.43+(TIME*119.15+0.48*Z231)	0.81
Tiruvarur	Midseason (F2)	Y=6059.47+(TIME*125.49+Z11*226.60+Z231*0.47+Z21*249.39)	0.89
	Pre-harvest (F3)	Y=9802.70+(TIME*27+Z11*245.29+Z231*0.44)	0.88
Nagapattinam	Midseason (F2)	Y= -14490.20+(TIME*117.46+ Z11*204.08+Z241*0.83+Z31*0.07)	0.91
	Pre-harvest (F3)	Y=-5875.43+(TIME*83.8847+Z141*1.70 +Z140*0.36+Z11*61.92+ Z341*0.68+Z240*0.08+Z31*-42.16+Z451* 0.27)	0.98

Conclusion

For development of *kharif* rice yield forecast methodology in four districts of Cauvery Delta Zone of Tamil Nadu under FASAL project, modified Fisher's technique have been used for developing statistical model was highly correlated in Nagapattinam district. For other three districts model has to be improved by including more number of sensitive weather parameters like bright sunshine hours, actual evapotranspiration, and remote sensing products.

References

Ghosh K, R Balasubramanian, S Bandopadhyay, N Chattopadhyay, KK Singh and LS Rathore. 2014. Development of crop yield forecast models under FASAL- a case study of kharif rice in West Bengal. Journal of Agrometeorology, 16(1): 1-8.

ICSCI 2022/T3/03

Soil test based fertilizer recommendation for targeted yield of rice in vertisol of South Gujarat

Darpana Patel[1], Gami, M.R.[2], Patel, P. B.[3] and Patel, J. M.[4]
Main Rice Research Centre, Soil & Water Management Research Unit, Navsari Agricultural University, Navsari-396450, Gujarat, India
E-mail: darpana_srs@yahoo.com

Introduction

Rice is most extensively cultivated food crop in India. The productivity of any crop depends upon various factors but use of inorganic fertilizer is important one as it is applied on the basis of state level fertilizer recommendations which may lead imbalance use and economic loss because the fertilizer requirement of a crop vary from field to field for the same crop on the same soil. The most appropriate, balanced and economic doses of fertilizers can be evolved on basis of soil test and crop response studies. Therefore, it is essential to protect the soil health by adopting balanced fertilization through soil testing and organic source as an INM approach. Among the different methods of fertilizer recommendation, yield targeting is appropriate as this concept not only indicate soil test fertilizer dose but also the level of yield that farmer can achieve if followed good agronomic practices. This concept strikes a balance between fertilizing the crop and soil. With this background, the present investigation was undertaken to develop a balanced fertilizer recommendation based on soil test values for desired yield targets of rice in vertisol of South Gujarat.

Methodology

The field experiments were conducted on rice during 2016-17 to 2017-18 at Main Rice Research Centre, Navsari Agricultural University, Navsari, Gujarat. The field experiment layout for rice comprised of three equal strips in which a fertility gradient was artificially created by applying graded dose (0%, 100% and 200% RDF) of N, P and K fertilizers so as to have a wide range in soil fertility. An exhaustive crop (sorghum) was grown on these three strips prior to rice to stabilize the soil system. After the harvest, the experiment was conducted with rice in the subsequent strips into 15 sub plots, 12 plot were randomly selected and treated with various levels of N, P and K. The remaining three plots in each fertility strip were kept as control. All the three strips were equally divided into three sub plots and FYM was applied at 0, 5.0 and 10.0 t ha^{-1} in randomly selected plots. Promising 12 treatments combinations of four levels of N (0, 50, 100 and 200 kg ha^{-1}), four levels of P_2O_5 (0, 30, 45 and 60 kg ha^{-1}) and three levels of K_2O (0, 30 and 60 kg ha^{-1}) along with three controls treatments were allotted to the sub plots. Using the data on rice yield, nutrient uptake, initial soil available nutrients and fertilizer dose applied, the basic parameters viz; nutrient requirement (kg q^{-1}), contribution of nutrients from soil (Cs), contribution of fertilizer nutrients in absence (Cfa) and presence (Cfp) of FYM, and contribution of nutrients from FYM were estimated as described by Ramamoorthy *et al.* (1967). These parameters were used in fertilizer adjustment equation for deriving fertilizer doses and soil test based fertilizer recommendations were prescribed in the form of ready reckoner for desired rice yield targets with NPK as well as with FYM.

Results

The range and mean values of rice yield and soil available nutrients of control and treated plots are presented in Table 1. The soil available N ranged from 113.07 to 139 with a mean 127.42 kg ha^{-1}, P ranged from 16.78 to 21.22 with a mean 19.34 kg ha^{-1} and K ranged from 277.47 to 303.40 kg ha^{-1} with a mean 293 kg ha^{-1}. The rice yield in control plots ranged from 4.13 to 78 q ha^{-1} and treated plots ranged from 6.89 to 88 q ha^{-1}. These results indicate that wide variability existed in the soil test value and seed yield of control and treated plots which is a prerequisite condition for calculating the basic parameters and fertilizer adjustment equations for calibrating the fertilizer doses for specified yield targets of rice crop.

The basic parameter *viz*., the nutrient requirement for producing one quintal of rice grain yield (kg q^{-1}), the per cent contribution of nutrient from soil (Cs), per cent contribution of fertilizer nutrients in absence of FYM (Cfa), contribution of fertilizer nutrient in presence of FYM (Cfp), and per cent contribution from (Cfym), have been calculated as described by Reddy *et al*., (1964) and Subba Rao and Shrivastava (1999) and presented in Table 2.

The nutrient requirements per quintal of rice grain were computed as 3.53, 0.54 and 3.07 kg N, P_2O_5 and K_2O, respectively. The contribution of soil available nutrient (Cs) was 40.12, 89.38 and 13.95 for N, P_2O_5 and K_2O percent, respectively. The contribution of nutrient from fertilizer in absence (Cfa) and presence (Cfp) of FYM were 137.86 and 164.49 for N, 9.76 and 91.55 for P_2O_5 and 125.22 and 323.57 for K_2O, respectively. Similarly, per cent contribution of N, P_2O_5 and K_2O from FYM (Cfym) were 0.07, 0.15 and 0.49, respectively. The data on Cs and Cfa or Cfp indicated that nutrient contribution from fertilizer source along with FYM were greater than that of in absence of FYM and from soil. The addition of FYM enhances microbial population and provides carbon which leads to higher availability and thereby higher contribution of nutrients to plants.

Table 1. Range and mean values of available nutrients in the soil and rice yield

Parameter	Range	Mean
Soil test value (kg ha^{-1})		
N	113.07-139.07	127.42
P	16.78-21.22	19.34
K	277.47-303.40	293.00
Rice yield (q ha^{-1})		
Control plots	4.13-78.00	44.47
Treated plots	6.89-88.00	53.97

Table 2. Nutrient requirement, percent contribution from soil, fertilizer and FYM for rice

Parameters	N	P	K
Nutrient requirement (kg q^{-1})	3.53	00.54	03.07
Contribution of soil available nutrients (%) C_s	40.12	89.38	13.96
Contribution of nutrients from fertilizers in absence of FYM (%) C_{fa}	137.86	9.76	125.22
Contribution of nutrients from fertilizers in presence of FYM (%) C_{fp}	164.49	91.55	323.57
Organic Efficiency (%)	0.07	0.15	0.49

Fertilizer prescription equation for desired yield target of rice

Soil test based fertilizer prescription equations for targeted yield of rice were formulated using the basic parameters. On the basis of these equations a ready reckoner was prepared for a range of soil test values and for rice grain yield targets of 45, 55, 65 and 75 q ha^{-1} (Table 3 and Table 4). Fertilizer N, P_2O_5 and K_2O requirements decreased with an increase in soil test values. For producing 45 q ha^{-1} of rice grain yield on clay soil, the fertilizer dose required for the average soil test value 270, 138, and 1649 kg N, P_2O_5 and K_2O, respectively were 32.22, 0 and 0 kg ha^{-1} of N, P_2O_5 and K_2O, respectively. However, in order to produce 55 and 65 q ha^{-1} rice with above soil test values, the fertilizer requirement would be 54.65 and 76 kg ha^{-1} of N, 0.0 and 0.0 kg ha^{-1} of P_2O_5 & K_2O, respectively along with application of FYM @ 5 t ha^{-1}.

Table 3. Soil test-based fertilizer prescription equation for target yield of rice

Without FYM	With FYM (5 t ha^{-1})	With FYM (10 t ha^{-1})
FN: 2.56*T - 0.29*STVN	FN: 2.14*T - 0.24*STVN-0.05 FYMN	FN: 1.98*T - 0.18*STVN-0.04 FYMN
FP_2O_5: 0.77*T – 1.28*STVP	FP_2O_5: 0.59*T - 0.98*STVP-0.08 FYMP	FP_2O_5: 0.50*T - 0.78*STVP-1.2 FYMP
FK_2O: 1.16*T - 0.11*STVK	FK_2O: 0.95*T - 0.10*STVK - 0.015 FYMK	FK_2O: 0.85*T - 0.09*STVK-0.018 FYMK

Note: FN, FP_2O_5 and FK_2O: fertilizer dose in N, P_2O_5 and K_2O kg ha^{-1}; T: Target yield (q ha^{-1}); STV: Soil test values of N, P_2O_5 and K_2O in $KMnO_4$-N, Olsen-P and NH_4OAc-K in kg ha^{-1}, respectively; FYM: t ha^{-1}

The foregoing results revealed that the soil test based fertilizer N, P and K adjustment equations for target yield of rice under efficient and balance fertilizer management to achieve a pre-decided yield targets. Further, STCR based fertilizer recommendations reduce cost of cultivation, increasing nutrients use efficiency, maintaining soil health and protect environment. The fertilizers may be calculated for lower/higher yields targets depending upon the inputs availability. The ready reckoner may be used by soil testing laboratories for fertilizer recommendations.

Table 4. Soil test based fertilizer recommendation (kg ha^{-1}) in clay soils of South Gujarat for targeted yield of *kharif* rice (Ready reckoner)

Soil test values	Fertilizer alone				With FYM 5 t ha^{-1}				With FYM 10 t ha^{-1}			
	Targeted yield (q ha^{-1})											
	45	55	65	75	45	55	65	75	45	55	65	75
N	N kg ha^{-1}											
100	72	94	115	136	70	91	113	134	68	89	110	132
150	60	81	103	124	58	79	100	122	55	77	98	120
200	48	69	91	112	45	67	88	110	43	65	86	107
250	35	57	78	100	33	55	76	98	31	52	74	95
300	23	45	66	88	21	42	64	85	19	40	62	83
350	11	33	54	75	9	30	52	73	7	28	49	71
400	0	20	42	63	0	18	40	61	0	16	37	59
P_2O_5	P_2O_5 kg ha^{-1}											
21	6	12	18	24	3	9	14	20	0	5	11	17
26	1	7	13	19	0	4	10	15	0	0	6	12
31	0	2	8	14	0	0	5	11	0	0	1	7
36	0	0	3	9	0	0	0	6	0	0	0	2
41	0	0	0	4	0	0	0	1	0	0	0	0
K_2O	K_2O kg ha^{-1}											
200	34	44	53	63	31	41	50	60	29	38	48	57
250	32	41	51	60	29	39	48	58	27	36	46	55
300	30	39	49	58	27	37	46	56	24	34	43	53
350	28	37	47	56	25	34	44	53	22	32	41	51
400	25	35	44	54	23	32	42	51	20	30	39	49
500	21	31	40	50	19	28	37	47	16	25	35	44
550	19	28	38	47	16	26	35	45	14	23	33	42

References

Ramamoorthy N, RL Narasimhan and RS Dinesh. 1967. Fertilizer application for specific yield targets of sonara 64. Indian Farming, 17: 43-45.

Reddy KCK, M Velayutham and GR Maruthi Sankar. 1964. Extension Bulletin of All India Co-ordinated Soil Test Crop Response Correlation Project, CRIDA, Hyderabad, pp. 621-642.

Subba Rao A and S Srivastava. 1999. An overview of fertilizer recommendations based on STCR fertilizer adjustment (targeted yield) equations. Fertilizer News, 44: 83-95.

ICSCI 2022/T3/04

Response of winter rice to INM triggered by zinc in nano form

***Poulomi Nandy and Sanjib Kumar Das**
Department of Agronomy, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia 741252, West Bengal, India
E-mail: p.nandy1993@gmail.com

Introduction

Rice is one of the most important staple foods for more than half of the world's population and influences the livelihoods and economies of several billion people. Integrated nutrient management (INM) is an approach of effective and efficient utilization of organic and inorganic sources of plant nutrients which is economically viable, socially acceptable and ecofriendly for sustaining and increasing crop production. Zinc is one of the most important micronutrients necessary for plant growth specially for rice grown under submerged condition. The study was made to standardize integrated nutrient management with nano zinc for better growth and yield of winter (*kharif)* rice in Inceptisol and also to improves Carantinooil biologiVcal properties.

Methodology

A field experiment was conducted to study the response of rice variety IET 4786 to integrated nutrient management triggered by nano zinc application during the *kharif* season of 2018 and 2019 at Kalyani (Nadia) in new alluvial zone of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India. The experiment was laid out in a randomized block design with 3 replications having 8 treatments viz. T_1: control ($N_0P_0K_0$), T_2 :100% RDN (recommended dose of nitrogen) through commercial chemical fertilizer, T_3: 75% RDN through commercial chemical fertilizer + 25% through FYM, T_4: 50% RDN through commercial chemical fertilizer + 50% through FYM, T_5 : $N_0P_0K_0$ + nano Zn spray @ 10 mg/ L, T_6 : 100% RDN through commercial chemical fertilizer + nano Zn spray @ 10 mg/ L, T_7 : 75% RDN through commercial chemical fertilizer + 25% through FYM + nano Zn spray @ 10 mg/ L, T_8 : 50% RDN through commercial chemical fertilizer + 50% through FYM + nano Zn spray @ 10 mg/ L. Two sprays of nano zinc with a dose of 10 mg L^{-1} each were given at two weeks after transplanting and five weeks after transplanting of rice seedlings.

Results

Application of nano zinc with INM significantly improved the growth & yield of winter rice (Table 1). Application of only nano zinc in the experiment increased the grain yield of rice by 17.59% over control. Foliar spray of nano zinc increased the rice yield by 9.76% and 8.82% in 75% RDN from chemical fertilizer + 25% RDN from FYM + nano zinc treated plot (5.06 t ha^{-1}) than 75% RDN from chemical fertilizer + 25% RDN from FYM (4.61 t ha^{-1}) and 100% RDN from chemical fertilizer treated plots (4.65 t ha^{-1}), respectively. A 8.24% and 5.99% increased dehydrogenase enzyme (Table 2) was estimated in 50% RDN from chemical fertilizer + 50% RDN from FYM + nano zinc treated plot (2.89 µg TPF/ g/ hr) and 75% RDN from chemical fertilizer + 25% RDN from FYM + nano zinc treated plot (2.83 µg TPF/ g/ hr), respectively than 100% RDN from chemical fertilizer + nano zinc treated plot (2.67 µg TPF/ g/ hr). Highest number of microbial population (bacteria, fungi and actinomycetes) was found in the treatments where equal proportion of inorganic and organic fertilizers was applied. The incorporation of organic manure enhanced the dehydrogenase activity because degradation of added material provides intra and extracellular enzymes and increase microbial activity in the soil (Patra *et al*., 2020).

Table 1: Grwoth, yield attributes and yield of rice as influenced by integrated nutrient management triggered by nano zinc application during *kharif* season

Treatment	Plant height (cm)	Tillers (m^{-2}) at harvest	Leaf area index at 60 DAS	No. of panicle m^{-2}	Filled grains/ panicle	Test Weight (g)	Grain yield (tha^{-1})	Straw yield ($t\ ha^{-1}$)	Harvest index
T1	89.4	253.83	3.03	239.4	93.43	17.19	3.41	4.13	0.45
T2	103.1	300.17	4.34	284.2	109.02	19.35	4.65	5.23	0.47
T3	101.0	290.00	4.35	281.4	110.63	19.47	4.61	5.41	0.46
T4	101.0	277.92	4.47	268.1	103.53	18.85	4.40	5.21	0.46
T5	94.0	266.58	3.53	253.9	96.50	18.17	4.01	4.51	0.47
T6	101.0	307.25	4.55	298.6	121.11	19.96	4.91	5.72	0.46
T7	104.3	310.67	4.71	300.3	119.73	19.19	5.06	5.85	0.46
T8	101.3	280.25	4.70	269.4	106.22	19.32	4.50	5.63	0.44
SEm (±)	2.032	6.045	0.094	6.698	3.201	0.543	0.097	0.106	0.004
CD (P=0.05)	6.224	18.512	0.288	20.51	9.803	N/A	0.297	0.324	0.013

Table 2: Dehydrogenase enzyme estimation and soil microbial population count after harvest of rice as influenced by integrated nutrient management triggered by nano zinc application during *kharif* season

Treatment	Dehydrogenase enzyme (µg TPF/ g/ hr)	Bacterial population (CFU ($1x\ 10^6$) g^{-1})	Fungal population (CFU ($1x\ 10^6$) g^{-1})	Actinomycetes population (CFU ($1x\ 10^6$) g^{-1})
T1	2.13	35.00	8.83	25.17
T2	2.60	38.33	9.67	27.67
T3	2.79	50.00	13.33	44.50
T4	2.83	50.33	14.17	43.17
T5	2.28	35.83	9.17	25.50
T6	2.67	39.50	9.67	27.33
T7	2.83	50.33	11.50	43.00
T8	2.89	51.83	13.83	45.00
SEm (±)	0.033	0.702	0.589	1.356
CD (P=0.05)	0.102	2.149	1.805	4.154

Conclusion

Therefore, from the above study it can be concluded that integration of both organic (25%) and inorganic fertilizers (75%) with addition of nano zinc spray significantly improved the growth parameters and yield attributing characters and yield of *winter* rice. Also it was found that application of nano zinc along with integrated treatments involving both inorganic fertilizers and organic sources had pronounced influence in improving soil biological properties.

References

Patra A, VK Sharma, TJ Purakayastha, M Barman, S Kumar, KA Chobhe, D Chakraborty, DJ Nath and AS Anil. 2020. Effect of long-term integrated nutrient management (INM) practices on soil nutrients availability and enzymatic activity under acidic Inceptisol of North-Eastern Region of India. Communications in Soil Science and Plant Analysis, 51(9): 1137-1149.

Raliya R and JC Tarafdar. 2013. ZnO nanoparticle biosynthesis and its effect on phosphorous-mobilizing enzyme secretion and gum contents in cluster bean (*Cyamopsis tetragonoloba* L.). Agricultural Research, 2: 48–57.

ICSCI 2022/T3/06

Yield and nutrient uptake of proso millet as influenced by times of sowing and nitrogen levels

Dimple. K. T, C. Nagamani, V. Chandrika, A. R. Nirmal kumar and G. Karuna Sagar
Department of Agronomy, S. V. Agricultural College, Tirupati, Andhra Pradesh, 517502, India
Email: karnamdimple@gmail.com

Introduction

Proso millet (*Panicum miliaceum* L.) is locally known as cheena, common millet, hog millet, broom corn, yellow hog, hershey and white millet. In India, proso millet is grown mostly in Southern India although it is cultivated in scattered localities in central and hilly tract of North India. It is a short duration crop sometimes used as contingency or insurance crop against a crop failure, due to unfavourable weather conditions or natural calamities. It also possesses special characters for adoption under adverse conditions such as drought, high temperature, low soil fertility and occurrence of disease and pests. It has very low water requirement and is well adapted to a range of climates, soils and elevations (Doggett, 1989). Time of sowing is one of the important non- monetary inputs provided to a crop which has a major impact in realizing higher yield. Favourable environmental conditions experienced with optimum time of sowing results in better performance of the crop. Hence, determination of optimum time of sowing is an important aspect in semi-arid regions during *kharif* with a short rainy season. Among the major nutrients, nitrogen plays an important role in increasing the productivity of a crop by improving the uptake of other nutrients available. Hence, the present study was conducted to find out the optimum time of sowing and nitrogen dose for higher yield and nutrient dynamics.

Methodology

A field trail was conducted during *kharif*, 2019 at dryland farm of S. V. Agricultural College farm Titupati, Acharya N G Ranga Agricultural University, Andhra Pradesh. The experiment was laid out in a split-plot design and replicated thrice. The soil of the experimental site was sandy loam in texture, neutral in soil reaction (7.3), low in organic content (0.46%) and available nitrogen (197.20 kg ha^{-1}), medium in available phosphorus (38.10 kg ha^{-1}) and available potassium (274.40 kg ha^{-1}). The experiment was laid out in a split-plot design and replicated thrice. The treatments include four sowing times allotted to main plots *viz.*, II FN of June (S_1), I FN of July (S_2), II FN of July (S_3) and I FN of August (S_4) and four nitrogen levels allotted to sub plots *viz.*, 0 kg N ha^{-1}(N_1), 20 kg N ha^{-1} (N_2), 40 kg N ha^{-1} (N_3) and 60 kg N ha^{-1} (N_4). The test variety of proso millet used was DHPM-2769 and the spacing adopted was 25 cm ×10 cm. Nitrogen was applied through urea as per the subplot treatments where 50 per cent was applied as basal and the remaining half was top dressed at 20 DAS. Phosphorus was applied @ 20 kg ha^{-1} common to all the plots as basal. The nutrient uptake at harvest (N, P and K) of proso millet were analysed by standard procedures.

Results

Times of sowing and nitrogen levels significantly influenced the grain, straw yield and uptake of nutrients (N, P and K). However, their interaction effect was not statistically traceable (Table 1). The higher grain, straw yield and uptake of nutrients was realized with II FN of June (S_1) sown crop which was significantly higher than that of I FN of July (S_2). Whereas the crop sown during I FN of August (S_4) resulted their lower values. These results were in line with the findings of Mubeena *et al*. (2019) and Nandini and Sridhara (2019). Significantly higher grain, straw yield and nutrient uptake were noticed with 60 kg N ha^{-1} (N_4) compared to other lower nitrogen levels tried. Lowest grain yield, straw yield and nutrient uptake were recorded with control (N_1). Similar results were obtained by Arshewar *et al*. (2018).

Table 1. Grain, straw yield and nutrient uptake of proso millet as influenced by time of sowing and nitrogen level

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Nitrogen uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Potassium uptake (kg ha^{-1})
Time of Sowing (S)					
S_1 - II FN of June	1239	2909	24.4	13.4	101.0
S_2 - I FN of July	1145	2688	22.5	12.1	98.0
S_3 - II FN of July	1052	2428	21.5	10.9	92.0
S_4 - I FN of August	745	2131	18.4	9.4	87.0
CD (P=0.05)	90	185	0.7	1.0	3.0
Nitrogen level (N)					
N_1 - Control	796	2058	16.6	9.1	84.0
N_2 - 20 kg N ha^{-1}	954	2448	21.0	10.6	92.0
N_3 - 40 kg N ha^{-1}	1127	2672	23.2	12.3	97.0
N_4 - 60 kg N ha^{-1}	1304	2977	26.0	13.8	104.0
CD (P=0.05)	107	211	1.7	1.3	4.0
Times of sowing (S) × Nitrogen levels (N)					
CD (P=0.05) N at S and S at N : NS					

Conclusion

From the present experiment, it can be concluded that proso millet sown during II FN of June (S_1) resulted in significantly higher grain yield, straw yield and nutrient uptake at harvest, with respect to N levels, crop provided with 60 kg ha^{-1} (N_4) resulted in superior grain yield, straw yield and nutrient uptake. Hence, it is concluded that the optimum time of sowing for proso millet is II fortnight of June with 60 kg N ha^{-1}.

References

Arshewar SP, PN Karanjikar, AS Dambale and MB Kawde. 2018. Effect of nitrogen and zinc levels on growth, yield and economics of pearlmillet (*Pennisetum glaucum* L.). International Journal of Bio-resource and Stress Management, 9(6): 729-732.

Doggett H. 1989. Small millets-A selective overview. Small millets in global agriculture, eds. Seetharam, A, Riley KW and G Harinarayana, 3-18. Janpath, New Delhi, India: Oxford and IBH Publ. CO. Pvt.Ltd.

Mubeena P, AS Halepyati and BM Chittapur. 2019. Effect of date of sowing and nutrient management on nutrient uptake and yield of foxtail millet (*Setaria italica* L.). International Journal of Bio-resource and Stress Management, 10(1): 092-095.

Nandini KM and S Sridhara. 2019. Performance of foxtail millet (*Setaria italic* L.) genotypes to sowing dates in Southern transition zone of Karnataka. Journal of Pharmacognosy and Phytochemistry, 8(1): 2109-2112.

ICSCI 2022/T3/07

Physiological ability of traditional rice landraces from Tamil Nadu on drought tolerance to ensure climate resilience and preservation of natural resources

S. Ashok[1], P. Chandrasekaran[2], R. Kuttimani[3], A. Senthil[4], C. Sarankumar, S. Sampath, P. Ilavarasi, M. Sala and M. Valarmathi

Department of Crop Physiology, Adhiparasakthi Agricultural College, Kalavai- 632 506, Tamil Nadu, India, [2] Department of Crop Physiology, Vanavarayar Institute of Agriculture, Pollachi-642 103, Tamil Nadu, India, [3]Department Crop Physiology

Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India

E-mail: ashok.tnau.ac.in@gmail.com

Introduction

Rice (*Oryza sativa* L.) is the foremost important food crop of the world and more so in Asia as it accounts for 90 and 92 per cent of world's area and production, respectively. Drought is the one of the important factors that limit the productivity of rice in the fragile environments of South India. The existing modern varieties of rice do not perform well under drought stress conditions. India is home to wide varieties of rice cultivars, land races and many lesser known varieties that have been under cultivation since ages by farmers as well as local entrepreneurs. In Tamil Nadu, there are many landraces available of which some of them have highly tolerant to environmental stresses, such as drought and heat, and are used by the people in that area traditionally. Although the yield capacity of traditional varieties is limited this is compensated by other appreciable characters such as high nutritional value, good cooking qualities including pleasurable aroma, and sufficient volume of cooked meal with less quantity of raw rice. Therefore, improvement of the heritage of traditional varieties of rice and rice landraces could well be the foundation for future research for authenticated results to future food needs. The aim of this work was to study the effects of drought stress on reproductive stage of popular traditional rice landraces to judge the performance of these rice varieties under drought stress. The study may be helpful for better understanding of drought tolerance and use of these popular landraces in future breeding programs.

Methodology

A pot culture experiment was conducted in the glass house of the Department of Crop Physiology, TNAU, Coimbatore during summer, 2019. The location is in North Eastern Agro-Climatic Zone of Tamil Nadu at 11.01°N latitude and 76.39°E longitude and at an altitude of 426.7 m above MSL. In this study, separate set of plants with three replications were maintained in pots. Chlorophyll content in leaves was estimated by using the method described by (Hiscox and Israelstam, 1979) and expressed in mg g^{-1} fresh weight. Catalase was estimated according to (Teranishi *et al.*, 1974) and expressed as µg of H_2O_2 reduced min^{-1} g^{-1} fresh weight.

Results

Chlorophyll is one of the most important components for photosynthesis in chloroplast. The photosynthetic pigment, total chlorophyll content (Table 1) was analysed and found that there was an increase of chlorophyll content from vegetative to reproductive stage but rapidly declined thereafter due to water stress induced degradation. Chlorophyll content of the plant tissue represents the photosynthetic capacity of the plant. Among the rice landraces, kuliyadichan recorded the lowest reduction in chlorophyll content due to drought over its control (19.15 %) followed by milagu sambha (23.53 %) and kallundai (29.32 %) under vegetative stage drought condition. Kuliyadichan registered higher total chlorophyll content under drought (2.28, 1.90 mg g^{-1}) at vegetative stage and reproductive stage, respectively compared to other rice genotypes. Drought-induced chlorophyll loss is mostly due to damage to chloroplasts caused by active oxygen species (Smirnoff, 1995), which are formed more often under abiotic stress conditions. The increased activity of the chlorophyll degrading enzyme chlorophyllase may also contribute to the decrease in chlorophyll content during drought stress. Chlorophyllase and peroxidase enzymes increased in response to extreme drought stress, lowering chlorophyll concentration (Abaaszadeh *et al.*, 2007). Furthermore, the decline in chlorophyll content during drought stress is influenced by the length and intensity of the drought (Zhang and Kirkham, 1996). Drought-induced chlorophyll depletion has long been thought to be a sign of pigment photo-oxidation and chlorophyll degradation. This was in corroboration with the results of the present study that recorded higher total chlorophyll content in landrace kuliyadichan.

In the present study, catalase activity (Table.2) was higher in kallundai and kothamalli sambha under drought given at vegetative stage. Moisture stress increased the catalase activity by 22.26 per cent at vegetative stage and 23.44 per cent at reproductive stage. Under drought stress, super-micro structures of chloroplasts and mitochondria in the leaves were damaged and catalase activity was negatively related to degree of damage of plasmalemma, mitochondria and chloroplast, but positively related to the indices of drought resistance (Wang *et al.*, 1995). Lum *et al.* (2014) discovered that moisture stressed plants have higher catalase activity than control plants. In addition, drought-tolerant variety have higher CAT, SOD, and POD activity than susceptible kinds, implying that the antioxidant system plays a key role in environmental stress tolerance. This outcome was consistent with the findings of the current investigation. Increase in CAT activity in response to drought stress suggests a prominent role for this enzyme in the protection of leaf tissue as well as root tissue against oxidative damage.

Table 1. Impact of drought stress on total chlorophyll content (mg g^{-1}) in rice genotypes under pot culture condition

Genotype	Vegetative stage stress			Reproductive stage stress		
	Control	**Stress**	**Mean**	**Control**	**Stress**	**Mean**
Rascadam	2.56	1.89	2.23	2.57	1.31	1.94
Kothamalli sambha	2.38	1.61	2.00	2.45	1.05	1.75
Kattu sambha	2.32	1.52	1.92	2.38	0.86	1.62
Kallundai	2.43	1.71	2.07	2.47	1.18	1.83
Kuliyadichan	2.79	2.27	2.53	2.84	1.88	2.36
Milagu sambha	2.66	2.04	2.35	2.69	1.52	2.11
Cochin sambha	1.91	0.83	1.37	2.05	0.44	1.25
Muttrina sannam	2.19	1.28	1.74	2.28	0.73	1.51
N 22	2.53	1.72	2.13	2.60	1.39	2.00
IR 64	2.30	1.09	1.70	2.42	1.02	1.72
Mean	2.41	1.60	2.00	2.48	1.14	1.81
	G	T	G x T	G	T	G x T
CD (0.05)	0.15	0.07	0.21	0.14	0.06	0.20

Table 2. Impact of drought stress on catalase activity (µg H_2O_2 reduced $min^{-1}g^{-1}$) in rice genotypes under pot culture condition

Genotype	Vegetative stage stress			Reproductive stage stress		
	Control	**Stress**	**Mean**	**Control**	**Stress**	**Mean**
Rascadam	4.74	7.50	6.12	4.87	7.69	6.28
Kothamalli sambha	3.94	4.71	4.33	4.01	5.13	4.57
Kattu sambha	3.61	4.34	3.98	3.72	5.03	4.38
Kallundai	5.57	7.21	6.39	5.64	7.89	6.77
Kuliyadichan	5.53	7.34	6.44	5.71	7.85	6.78
Milagu sambha	4.65	7.11	5.88	4.82	7.39	6.11

Cochin sambha	2.70	2.97	2.84	3.21	3.69	3.45
Muttrina sannam	2.15	2.59	2.37	3.42	3.99	3.71
N 22	4.32	6.62	5.47	5.14	7.75	6.45
IR 64	4.46	4.90	4.68	5.60	6.12	5.86
Mean	4.17	5.53	4.85	4.61	6.25	5.43
	G	T	G x T	G	T	G x T
CD (0.05)	0.38	0.17	0.54	0.42	0.19	0.59

Conclusion

Considering the above results of this experiment, it is concluded that rice landraces, being adapted to harsh environments, have inherent ability to withstand drought situation. And Rascadam, Kuliyadichan, kallundai performed better interms of physiological parameters like Chlorophyll content, RWC and Catalase activity which ultimately contributed for better tolerance compared to other landraces and check varieties taken for this study. Hence, the traits which are conferring better tolerance in these landraces may be studied further to unravel the actual mechanisms responsible for drought tolerance and to exploit these traits for crop improvement programme.

References

Abaaszadeh PA, H Sharifi, Lebaschi and F Moghadasi. 2007. Effect of drought stress on proline, soluble sugars, chlorophyll and RWC level in Melissa oggicinalis. Iran Journal of Medicinal Plants Research, 23(4): 504-513.

Hiscox J and G Israelstam. 1979. A method for the extraction of chlorophyll from leaf tissue without maceration. Canadian journal of botany, 57(12): 1332-1334.

Lum M, M Hanafi, Y Rafii and AJJAPS Akmar. 2014. Effect of drought stress on growth, proline and antioxidant enzyme activities of upland rice. The Journal of Animal & Plant Sciences, 24(5): 1487-1493.

Smirnoff, N. 1995. Environment and plant metabolism: flexibility and acclimation: BIOS Scientific publishers.

Teranishi YA, Tanaka, M Osumi and S Fukui. 1974. Catalase activities of hydrocarbon-utilizing Candida yeasts. Agricultural and Biological Chemistry, 38(6): 1213-1220.

Wang Z, B Quebedeaux and GW Stutte. 1995. Osmotic adjustment: effect of water stress on carbohydrates in leaves, stems and roots of apple. Functional Plant Biology, 22(5): 747-754.

Zhang J and M Kirkham. 1996. Enzymatic responses of the ascorbate-glutathione cycle to drought in sorghum and sunflower plants. Plant Science, 113(2): 139-147.

ICSCI 2022/T3/09

Effect of Integrated Foliar Nutrition on yield attributes of summer cowpea in Northern dry zone of Karnataka

Kavyashree C*., S. A. Biradar., V. S. Devaranavadagi and S. B. Kalaghatagi
Department of Agronomy, College of Agriculture, Vijayapur - 586101
University of Agricultural Sciences, Dharwad - 580005 (Karnataka), India
**E-mail: kavya1341997@gmail.com*

Introduction

Cowpea (*Vigna unguiculata* L. Walp) is one of the most important pulse crops native to Central Africa and belong to family Fabaceae. Cowpea is called as vegetable meat due to high content of protein in grain with better biological value on dry weight basis. Apart from this, cowpea forms excellent forage and it produces a heavy vegetative growth and covers the ground so well that it checks the soil erosion. It is usually grown as *kharif* crop, however can be grown as a *rabi*, spring or summer crop in different parts of the country. Initially fast growth helps in extensive root development and early establishment of crop in wake of drought like situation. It also has the excellent ability against soil erosion from rain water and being denoted as prominent cover crop.

Foliar fertilization is an economical way of supplementing the plant nutrients when they are in lack or unavailable in the soil. One advantage of foliar nutrition is that it often brings about immediate improvement in plant health and growth and eliminates problems like fixation and immobilization of nutrients. Hence, foliar nutrition is being recognized as an important method of fertilization in modern agriculture (Chaurasia *et al*., 2005). Foliar application is also less likely to result in ground water pollution. When nutrient supply to plants become a limiting factor due to soil properties, foliar spray helps in optimal supply of nutrients to plant (Naik *et al*., 2018).

Methodology

A field experiment was conducted during summer 2020-21 at Krishi Vignana Kendra farm, Vijayapur, Karnataka, on vertisol having pH 8.24 and EC 0.32 dS m^{-1}. The soil was medium in organic carbon content (0.51 %), low in available N (224 kg ha^{-1}) and high in available P_2O_5 (32 kg ha^{-1}), K_2O content (425 kg ha^{-1}). The experimental site was located at altitude of $16^0$49’ North and longitude of 75^0 43‘East with an altitude of 593.8 meters above mean sea level in the Northern Dry Zone of Karnataka (Zone 3). The cowpea variety used for this experiment was DC-15. The experiment was laid out in randomized complete block design with three replications. The experiment consisted of nine treatments *viz*., T_1: RPP, T_2: RPP + Vermiwash @ 10%, T_3: RPP + Cow urine @ 10%, T_4: RPP + Pulse magic @ 1%, T_5: RPP + 19:19:19 @ 1%, T_6: RPP + Urea @ 2%, T_7: RPP + 19:19:19 @ 1% + Vermiwash @ 10%, T_8: RPP + 19:19:19 @ 1% + Cow urine @ 10%, T_9: RPP + 19:19:19 @ 1% + Pulse magic @ 1% including the foliar application of different nutrients at flower initiation and peak flowering stage (two common sprays).

Results

In the present investigation, the yield attributes of summer cowpea recorded after harvesting were significantly influenced by integrated foliar nutrition treatments except for 100 seed weight. The treatment which received RPP + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% (T_7) at flower initiation stage and peak flowering stage registered significantly higher number of pods plant^{-1} (29.98) which was on par with RPP + 19:19:19 @ 1% + Cow urine @ 10% (T_8) and RPP + 19:19:19 @ 1% + Pulse magic @ 1% (T_9) recorded 27.73 and 26.67, respectively. Compare to foliar nutrition significantly the lower (18) number of pods were recorded in recommended Package of Practice (T_1). Similarly, higher pod length of (22.75 cm) were recorded with RPP + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% (T_7) with the influence of integrated foliar application at flower initiation and peak flowering stage, whereas significantly minimum pod length of 15.33 cm was recorded in recommended Package of Practice (T_1). Similarly, number of seeds pod^{-1} and pod weight per plant differed significantly with foliar nutrient application at flower initiation and peak flowering stage, whereas higher number of seeds pod^{-1} (18.78) and higher pod weight per plant (14.66 g plant^{-1}) was recorded with the treatment RPP + foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% (T_7) which was on par with treatments RPP + 19:19:19 @ 1% + Cow urine @ 10% (T_8) and RPP + 19:19:19 @ 1% + Pulse magic @ 1% (T_9) which were recorded. Whereas significantly lower number of seeds pod^{-1} of 11.67 and lower pod weight plant^{-1} of 10.58 g plant^{-1} was recorded in recommended Package of Practice (T_1). The higher yield attributes from the foliar application of nutrients over recommended Package of Practice may be due to increase in growth and physiological parameters as well as biomass per plant, as a result of increased absorption of foliar nutrients. All these favourable situations might have resulted in greater accumulation of carbohydrates, proteins and their translocation from source to the sink which in turn increased the higher number of pods as well as other yield attributing parameters. Similar results had also been reported by Ebrahim *et al.* (2011).

Table 1: Number of pods plant^{-1}, length of the pod and number of seeds pod^{-1}, 100 seed weight and pod weight plant^{-1} of cowpea as influenced by integrated foliar nutrition

Treatment	Number of pods plant^{-1}	Length of the pod (cm)	Number of seeds pod^{-1}	100 seed weight (g)	Pod weight plant^{-1} (g)
T_1: RPP (Recommended package of practice)	18.00	15.33	11.67	9.66	10.58
T_2: RPP + Vermiwash @ 10%	24.25	17.76	13.12	10.74	11.87
T_3: RPP + Cow urine @ 10%	23.33	17.25	12.56	10.41	11.25
T_4: RPP + Pulse magic @ 1%	21.50	16.36	12.13	10.17	11.07
T_5: RPP + 19:19:19 @ 1%	24.48	18.69	14.69	11.59	12.58
T_6: RPP + Urea @ 2%	24.00	18.25	14.25	11.57	12.21
T_7: RPP + 19:19:19 @ 1% + Vermiwash @ 10%	29.98	22.75	18.78	11.73	14.66
T_8: RPP + 19:19:19 @ 1% + Cow urine @ 10%	27.73	21.67	16.75	11.63	13.72
T_9: RPP + 19:19:19 @ 1% + Pulse magic @ 1%	26.67	21.23	15.33	11.84	13.35
CD (P=0.05)	5.35	4.04	3.54	NS	2.03

Conclusion

Based on the investigation results, it was concluded that growing of cowpea in summer with foliar spray of 19:19:19 @ 1% + Vermiwash @ 10% along with RPP (25:50:25 kg/ha $N:P_2O_5:K_2O$) was found superior over the other treatments which resulted in higher yield attributes which lead to increase the yield of summer cowpea.

References

Chaurasia SNS, KP Singh and Mathura Rai. 2005. Effect of foliar application of water soluble fertilizers on growth, yield, and quality of tomato (*Lycopersicon esculentum* L.). Sri Lankan Journal of Agricultural Sciences, 42: 66-70.

Ebrahim S, K Usha and B Singh. 2011. Pathogeneis related (PR) proteins in plant defence mechanism. Science against microbial pathogens: communicating current research and technological advances, 2: 1043-1054.

Naik SR, LP Anusha and SB Kumar. 2018. Review on foliar nutrition enhancing the growth and yield characters in blackgram. International Journal of Chemical Studies, 6(6): 2212-22

ICSCI 2022/T3/10

Influence of different weed management practices on yield and economics of *rabi* groundnut in telangana state

Charitha, N *[1], Madhavi, M[1], Pratibha, G[1] and Ramprakash, T[2]
[1]Department of Agronomy, [2]AICRP on Weed Management, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad-500030, Telangana, India
E-mail: charitha183@gmail.com

Introduction

Groundnut or peanut (*Arachis hypogaea* L.) is grown over 20 million hectares in the tropical and subtropical part of about one hundred countries in the world. The total annual world production amounts to about 25 million tons of unshelled nuts, 70% of which is contributed by India, China and U.S.A. (El Naim et al., 2010). They play an important role in the dietary requirements of resource poor women and children and haulms are used as livestock feed. The main problems limiting production of groundnut are poor cultural practices as well as inadequate weed management (EL Naim et al., 2010). The productivity of crops under irrigated condition is not stable due to various reasons. Among them weed infestation is considered to be one of the major problems. Yield loss due to weed infestation amounts to 80 percent in groundnut. So weed infestation is one of the major constraints that limit the productivity of groundnut (Divyamani et al., 2018). Critical period of crop weed competition is ranged between 40 to 60 days after sowing. Though, groundnut is a hardy crop, but it is highly susceptible to weed preponderance due to small canopy and slow initial growth. Generally, weeds are controlled by hand weeding, which is very expensive, laborious and shortage of labours. It is therefore important to find out suitable herbicides that will control the weeds economically and safely. Use of pre-and post-emergence herbicides mixtures offers an alternative viable option for effective and timely control of all categories of weeds in groundnut. Hence, there is a need to evaluate the pre-and post-emergence herbicide mixtures for obtaining broad spectrum weed control in *rabi* groundnut. Hence, the study was made with the objective to study the effect of integrated weed management involving herbicide and herbicide mixtures on weed control in groundnut, to study the impact of integrated weed management practices on the growth and yield of *rabi* groundnut and to find out the economical and efficient integrated weed management practice for *rabi* groundnut.

Methodology

The present experiment was carried out at College Farm, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, Telangana State. The experiment was planned in a randomized block design with three replications of 10 treatments; which included diclosulam 84% WDG 26 g ha^{-1} PE *fb* intercultivation at 20 DAS (T_1), imazethapyr 2% EC + pendimethalin 30% EC 960 g ha^{-1} PE *fb* intercultivation at 20 DAS (T_2), pyroxasulfone 85 % WDG 127.5 g ha^{-1} PE *fb* intercultivation at 20 DAS (T_3), propaquizofop 2.5% + imazethapyr 3.75% w/w ME 125 g ha^{-1} early PoE *fb* intercultivation at 40 DAS (T_4), imazethapyr 35% + imazomox 35% WG 70 g ha^{-1} early PoE *fb* intercultivation at 40 DAS (T_5), sodium acifluorfen 16.5% EC + clodinafop propargyl 8% EC 250 g ha^{-1} PoE *fb* intercultivation at 40 DAS (T_6), imazethapyr 10% SL 100 g ha^{-1} PoE *fb* intercultivation at 40 DAS (T_7), intercultivation (20 and 40 DAS) (T_8), intercultivation *fb* hand weeding (20 and 40 DAS) (Weed-free) (T_9) and Unweeded control (T_{10}). Groundnut crop (variety kadiri-9) was sown on 8th October 2020 at spacing of 30*10 cm using a seed rate of 300 kg ha^{-1}. Herbicides were applied using a Knap sack sprayer fitted with flat fan nozzle calibrated to deliver 500 litres of water per hectare. Cultural practices recommended for groundnut were adopted during the crop growth period. The crop was supplied with recommended fertilizer dose of fertilizers with 20 kg N, 40 kg P_2O_5 and 50 kg K_2O ha^{-1} through urea, single super phosphate and muriate of potash, respectively to all the plots as basal. Top dressing of 10kg of N was applied in form of urea at 25 DAS. Crop was harvested on 10th February 2021. The prices of the herbicides prevailed in local market during experimentation were considered for working out the cost of cultivation of Groundnut. The gross returns were calculated using the pod yield of groundnut and the market price of the produce at the time of marketing. The net returns per hectare were calculated by deducting the cost of cultivation per hectare from the gross returns per hectare.

Results

Pod yield

Among different weed management practices, the highest pod yield of groundnut was obtained with intercultivation *fb* hand weeding at 20 and 40 DAS (2743 kg ha^{-1}) which was however, statistically on par with diclosulam PE *fb* intercultivation at 20 DAS (2640 kg ha^{-1}) and imazethapyr + pendimethalin PE *fb* intercultivation at 20 DAS (2610 kg ha^{-1}). The higher pod yield in these treatments was due to minimum crop-weed competition and effective control of broad spectrum of weeds for a longer period in the initial stage of crop and provided congenial environment for growth and development. These results were in line with the findings of Sandil *et al.* (2015).

Economics

The weed management practices adopted should also be economically feasible for a farmer in order to reduce their input cost without sacrificing yields. The data with respect to gross returns, net returns and benefit cost ratio of groundnut are presented in Table 1 and Fig. 1. Among different weed management practices, maximum cost of cultivation was recorded with intercultivation *fb* handweeding 20 and 40 DAS (60,040 ₹ ha^{-1}) this was due to the higher cost incurred in cleaning of the infested area using power weeder and minimum cost of cultivatiom was recorded with unweeded control (46440 ₹ ha^{-1}). Weed management practices significantly influenced the gross returns of groundnut cultivation. The highest gross returns were recorded with intercultivation *fb* hand weeding at 20 and 40 DAS (1,44,686 ₹ ha^{-1}**).** Among the chemical weed management practices diclosulam PE *fb* intercultivation at 20 DAS **(**1,39,248 ₹ ha^{-1}**)** and imazethapyr + pendimethalin PE *fb* intercultivation at 20 DAS **(**1,37,698 ₹ ha^{-1}**)** were statistically on par with the intercultivation *fb* hand weeding at 20 and 40 DAS and were the best among the chemical treatments which was due to increased pod yield. The net returns of groundnut cultivation were significantly influenced by different weed management practices. The highest net returns were associated with diclosulam PE *fb* intercultivation at 20 DAS (87,208 ₹ ha^{-1}) which was statistically on par with imazethapyr + pendimethalin PE *fb* intercultivation at 20 DAS (84,698 ₹ ha^{-1}), intercultivation *fb* hand weeding at 20 and 40 DAS (84,646 ₹ ha^{-1}) and sodium acifluorfen + clodinafop propargyl PoE *fb* hand weeding at 40 DAS (77,420 ₹ ha^{-1}). This might be due to reduced cost involved under herbicidal treatments and increased pod yield as a result of effective control of weeds. These results are in confirmity with findings of Kumar *et al.* (2016) and Jinger *et al.* (2016). The benefit-cost ratio of groundnut cultivation was significantly influenced by different weed management practices. The highest benefit-cost ratio was recorded with diclosulam PE *fb* intercultivation at 20 DAS (2.68) which was followed by imazethapyr + pendimethalin PE *fb* intercultivation at 20 DAS (2.60), sodium acifluorfen + clodinafop propargyl PoE *fb* intercultivation at 40 DAS (2.50) and intercultivation *fb* hand weeding at 20 and 40 DAS (2.41). This might be due to reduced cost of cultivation and increased pod yield as a result of effective control of weeds.

Table 1. Yield and Economics as influenced by weed management practices in groundnut

Treatment		Pod yield (kg ha^{-1})	Cost of cultivation (₹)	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	Benefit-cost ratio
T_1	Diclosulam 84% WDG 26 g ha^{-1}PE *fb* intercultivation at 20 DAS	2640	52040	139248	87208	2.68
T_2	Imazethapyr 2% EC+ pendimethalin 30% EC 960 g ha^{-1} PE *fb* intercultivation at 20 DAS	2610	53000	137698	84698	2.60
T_3	Pyroxasulfone 85 % WDG 127.5 g ha^{-1} PE *fb* intercultivation at 20 DAS	2071	55990	109232	53242	1.95
T_4	Propaquizafop 2.5% + imazethapyr 3.75% ME 125 g ha^{-1} Early PoE *fb* intercultivation at 40 DAS	2161	52340	113985	61645	2.18
T_5	Imazethapyr 35% + imazamox 35% WG 70 g ha^{-1} Early PoE *fb* intercultivation at 40 DAS	1996	52240	105303	53063	2.02
T_6	Sodium acifluorfen 16.5% EC + clodinafop propargyl 8% EC 250 g ha^{-1}PoE *fb* intercultivation at 40 DAS	2449	51758	129178	77420	2.50
T_7	Imazethapyr 10% SL 100 g ha^{-1} PoE *fb* intercultivation at 40 DAS	1926	52320	101620	49300	1.94
T_8	Intercultivation (20 and 40 DAS)	2388	55240	125987	70747	2.28
T_9	Intercultivation *fb* hand weeding (20 and 40 DAS) (Weed free)	2743	60040	144686	84646	2.41
T_{10}	Unweeded control	1460	46440	77025	30585	1.66
	CD (P = 0.05)	269.7	-	**14228**	**14244**	-

Conclusion

Monetary returns play a key role, for adopting the refined agro techniques. In the present study the net returns recorded with application of either herbicide alone or intercultivation alone as well as integration of herbicides with intercultivatuion were comparable but pre-emergence application of diclosulam at 26 g ha^{-1} *fb* intercultivation at 20 DAS proved practically more convenient and economically best feasible integrated weed management practice for groundnut as it recorded the highest net returns comparable with other treatments. If intercultivation is not possible post-emergence application of sodium acifluorfen + clodinafop propargyl at 250 g ha^{-1} could be an alternative method for managing the weeds effectively and improving the productivity of *rabi* groundnut considering the present scarcity and high cost of labour.

References

Divyamani B, YR Ramu and D Subramanyam. 2018. Yield and nutrient uptake in rabi groundnut as influenced by different weed management practices. Journal of Pharmacognosy and Phytochemistry, 7(5): 3166-3168.

El Naim AM, MA Eldoma and AE Abdalla. 2010. Effect of weeding frequencies and plant density on vegetative growth characteristic of groundnut (*Arachis hypogaea* L.) in North Kordofan of Sudan. International Journal of Applied Biology and Pharmaceutical Technology, 1:1188-1193.

Jinger D, R Sharma and A Dass. 2016. Effect of sequential application of herbicides on weed control indices and productivity of rainy-season greengram (*Vigna radiata*) in North Indian plains. Indian Journal of Agronomy, 61(1): 112-114.

Kumar A, R Nandan, KK Sinha and D Ghosh. 2016. Integrated weed management in lentil (*Lens culinaris*) in calcareous alluvial soils of Bihar. Indian Journal of Agronomy, 61(1): 75-78.

Sandil MK, JK Sharma, P Sanodiya and A Pandey. 2015. Bio-efficacy on tank-mixed propaquizafop and imazethapyr against weeds in soybean. Indian Journal of Weed Science, 47(2): 158-162.

ICSCI 2022/T3/11

Influence of sowing date and nirogen level on nutrient uptake, fibre and protein content of browntop millet grain

Sai Kishore A*[1], Bhanu Rekha, K[1] Hussain, S A[1] and Madhavi, A[2]
[1]Department of Agronomy, [2]AICRP on STCR, ARI, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad-500030, Telangana, India
E-mail: saikishore361@gmail.com

Introduction

With the burgeoning population and dwindling natural resources, the need of the hour during 21st century is to meet the ever-growing food and fodder demand.Millets are nutritionally superior to cereals owing to their rich nutrient profile characterised by high dietary fibres, amino acids, polyphenols and other bioactive compounds (Amadou *et al.*2013).The role of millets in lowering rate of fat absorption, slow release of sugars (low glycemic index) and reduced risk of heart diseases, diabetes and high blood pressure is well documented and aptly termed as nutri-cereals (Banerjee and Maitra *et al*. 2020). They are climate resilient crops (Maitra *et al.*2020) and play vital role towards nutritional security (Behera, 2017). Among the minor millets, browntop millet (*Brachiaria /Panicum / Urochola ramosa*) is a versatile crop remarkable for early maturity and nutritious properties and has huge demand in the recent past. To tackle the threats of malnutrition and hidden hunger, inclusion of this nutrient rich crop like browntop millet in staple diet could be a better nutritional security option (Behera, 2017). It is a rich source of natural fibre (8.5%) due to which it serves as an excellent medicine for dealing life style diseases (Kering and Broderick, 2018). Variation in sowing time brings varied plant environment interaction, which determines the efficiency of inherent physiological processes and ultimately the crop yield. Determination of optimum nitrogen level plays an exceptional role in realizing the genetic yield potential of crops under particular geographical conditions. The information on agronomic practices with respect to ideal sowing date and nitrogen fertilisation in browntop millet is very meagre. Keeping these points in view the present investigation was planned with the objectives to identify the suitable sowing window and nitrogen dose for browntop millet, to study the effect of dates of sowing and nitrogen levels on growth, deviation in yield and nutrient uptake of browntop millet and to work out the economics.

Methodology

The experiment was carried out during *Kharif*, 2019 at College Farm, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad. The experimental site was geographically located at 17°19' 19.2" N Latitude, 78°24' 39.2" E Longitude at an altitude of 542.3 m above mean sea level. As per Troll's classification it falls under Southern Telangana Agro Climatic Zone. The experiment consisted of 16 treatment combinations formed by four sowing windows (June 15th, June 30th, June 15th and July 30th) and four N levels (0, 20, 40 and 60 kg ha^{-1}) and was laid out in Factorial randomized block design and replicated thrice. Crop was sown on different sowing windows as per treatments by adopting inter row spacing 30 cm and intra row spacing of 10 cm. Uniform dose of P_2O_5 (30 kg ha^{-1}) and K_2O (20 kg ha^{-1}) along with 50 % of N (as per treatment) was applied as basal and remaining 50 % N was applied at tillering in all experiment plots except in 0 kg N ha^{-1}.

Results

Nutrient uptake of grain

Among the dates of sowing, the total N, P and K uptake by grain was significantly higher with June 15th sowing (108.35, 23.17 and 26.75 kg ha^{-1}) over June 30th (86.54, 19.94 and 22.81 kg ha^{-1}), July 15th (73.06, 16.74 and 19.08 kg ha^{-1}) and July 30th (63.38, 13.63 and 14.70 kg ha^{-1}). Higher nutrient uptake in June 15th sown crop could be ascribed to the prolonged photoperiod that facilitated higher assimilatory surface that contributed and reflected in higher dry matter production as evident from the respective data at different crop growth stages, grain and straw yield at harvest coupled with higher N content. The findings corroborate with those of Mubeena *et al*., 2019.

With respect to nitrogen levels, the total N, P and K uptake by grain was significantly higher with the crop supplied with 60 kg N ha^{-1} (112.70, 22.80 and 35.39 kg ha^{-1}) over corresponding lower levels of 20 (78.56, 17.13 and 26.00 kg ha^{-1}) and no N (45.22, 13.77 and 15.73 kg ha^{-1}). However, 60 kg N ha^{-1} was at par with 40 kg ha^{-1} (98.77, 20.53 and 33.32 kg ha^{-1}). Nutrient uptake is the product of dry matter accumulation and nutrient content. Significantly higher dry matter accumulation at different crop growth stages, grain and straw yield coupled with nutrient content with D_1-June 15th and application of 60 and 40 kg ha^{-1} resulted in significantly higher nutrient uptake by crop. Further, increased nutrient uptake of N, P and K might be attributed to greater availability of nutrients to plant in different forms present in the soil and through applied fertilizer their contribution to growth coupled with improved cell permeability and better absorption. These findings are in agreement with those of Divyasree et al. (2018) .

Protein content (%) in grain

Among the dates of sowing, June 15th sown crop recorded higher crude protein (10.89 %) in comparison to June 30th (9.31 %), July 15th (8.43 %) and lowest was noticed in July 30th (7.85 %). Protein content is proportional to N content. Higher protein content recorded with June 15th sowing could be ascribed to the improved growth coupled with higher N content as evident from respective data. The findings are in line with those of Chouhan *et al*. (2015).

With respect to N level, application of 60 kg ha^{-1} recorded significantly higher protein content (11.37 %) in comparison with 40 (10.39 %), 20 kg N (8.91 %) and the lowest protein content was registered with N_1-0 kg ha^{-1} (5.81 %). Protein content is directly proportional to N content. Improved crude protein content in crop supplied with 40 kg N ha^{-1} was due to higher N content in grain. This was mainly attributed to higher availability and uptake of N that reflected in higher protein content. Apart from this N plays an important role in plant metabolism and is a constituent of amino acids (DNA and RNA), it transfers genetic transformation and regulates cellular metabolism of amino acids and protein that form structural units and biological catalyst of phosphorylated compounds which is involved in energy transformation. These findings are in confirmation with the results of Ayub *et al*. (2007) and Nandini *et al.* (2018) and Divyashree *et al.*, 2018.

Fibre content (%) in grain

Among different sowing dates, crop sown on D1-June 15th registered significantly higher fibre (9.50) in comparison with D_2-June 30th (8.28 %), D_3- July 15th (8.06 %) and lowest was noticed with D_4-July 30th (7.73 %). The reduced crude fibre content with delayed sowing could be due to the reduced nitrogen content. Similar results of lower fibre content in grain with delayed sowings were reported by Dapake *et al.,* 2017. It could be observed from the data that varying levels of nitrogen significantly influenced fibre content in grain of brown top millet. Application of 40 kg N ha^{-1} recorded significantly higher fibre content (10.70 %) over 60 (7.49 %), 20 kg N (8.50 %) and no N (7.71 %), respectively. The decrease in crude fibre content with increasing N level was mainly due to the rapid synthesis of carbohydrates which were converted into proteins and protoplasm and only a smaller portion was available for cell wall material and thus decrease pectin, cellulose and hemi cellulose content which are the major constituents of crude fibre (Ayub *et al.*, 2007, Nandini *et al.*, 2018).

Table 1. Protein, fibre and nutrient uptake in grain of browntop millet under varying sowing dates and nitrogen levels

Treatment	Protein content (%)	Fibre content (%)	N uptake (Kg ha^{-1})	P uptake (Kg ha^{-1})	K uptake (Kg ha^{-1})
D_1 - June 15th	10.89	9.50	108.35	23.17	26.75
D_2 - June 30th	9.31	8.28	86.54	19.94	22.81
D_3 - July 15th	8.43	8.06	73.06	16.74	19.08
D_4 - July 30th	7.85	7.73	63.38	13.63	14.70
CD (P=0.05)	0.49	0.73	5.43	3.01	3.46
N_1 - 0 kg ha^{-1}	5.81	7.71	45.22	13.77	15.73
N_2 - 20 kg ha^{-1}	8.91	8.50	78.56	17.13	26.00
N_3 - 40 kg ha^{-1}	10.39	10.70	98.77	20.53	33.32
N_4 - 60 kg ha^{-1}	11.37	7.49	112.70	22.28	35.39
SEm ±	0.17	0.25	4.88	1.04	1.20
CD (P=0.05)	0.49	0.73	14.43	3.01	3.46
SEm±	0.34	0.48	6.76	2.09	2.40
CD (P=0.05)	NS	0.50	NS	NS	NS

Conclusion

From the results of the experiment, it could be concluded that among sowing dates, June 15th and among N levels, 40 kg ha^{-1} is best for higher fibre and protein content in browntop millet grain in alfisols of Southern Telanagana Zone.

References

Amadou I, ME Gounga and GW Le. 2013. Millets: nutritional composition, some health benefits and processing - a review. Emirates Journal of Food and Agriculture, 25: 501-508.

Ayub M, NM Ather, A Tanveer, M Tahir and RMA Khan. 2007. Interactive effect of different nitrogen levels and seeding rates on fodder yield and quality of pearl millet. Pakistan Journal of Agricultural Sciences, 44(4): 592-596.

Banerjee P and S Maitra. The role of small millets as functional food to combat malnutrition in developing countries. Indian Journal of Natural Sciences, 10(60): 20412- 20417.

Behera MK. 2017. Assessment of the State of Millets Farming in India. MOJ Ecology and Environment Science, 2(1): 16–20. DOI: 10.15406/mojes.2017.02.00013.

Chouhan M, ND Kumar, N Gudadhe, VVK Singhal and R Hanwat. 2015. Productivity, quality, and nutrient uptake by summer pearl millet as influenced by transplanting dates and nitrogen levels. An International Quarterly Journal of Environmental Sciences, 6: 325-329.

Dapake PP, PM Chaudhari, SK Ghodke and MR Patil. 2017. Effect of sowing time and nutrient management on growth, yield and quality of pearl millet cv. dhanshakti under rainfed condition. Contemporary Research in India, 7(3): 2137-2237.

Divyashree U, Dinesh Kumar M and Ganapathi. 2018. Effect of different fertilizer levels on nutrient uptake and yield of little millet (*Panicum sumatrense* Roth ex Roem. & Schult). International journal of science and nature, 9(2): 201-205.

Kering MK and CK Broderick. 2018. Potassium and manganese fertilization and the effects on millet seed yield, seed quality, and forge potential of residual stalks. Agricultural Sciences, 9(7): 888-900.

Maitra S, P Sandipan, S Tanmoy, P Arunabha and P Biswajit. 2020. Agronomic Management of Foxtail millet (Setaria italic L.) in India or Production Sustainability: A Review. International Journal of Bioresource Science, 7(1): 11-16.

Mubeena P, AS Halepyati and BM Chittapur. 2019. Effect of date of sowing and nutrient management on nutrient uptake and yield of foxtail millet (*Setaria italica* L.). International Journal of Bio-resource and Stress Management, 10(1): 092-095.

Nandini KM, S Sridhara and Kiran Kumar. 2018. Effect of different levels of nitrogen on yield, yield components and quality parameters of foxtail millet (*Setaria italica* L.) genotypes in southern transition zone of Karnataka. International Journal of Chemical Studies, 6(6): 2025-2029.

ICSCI 2022/T3/12

Comparative evaluation of aqueous and solvent extracts of Brown algal seaweed, *Sargassum wightii* against rice leaf folder (*Cnaphalocrocis medinalis*)

S Balamurugan* and R Kannan
Department of Entomology, Faculty of Agriculture, Annamalai University, Annamalai nagar, 608002
Email: sbala512945@gmail.com & kaninsect@gmail.com*

Introduction

Rice leaf folder *Cnaphalocrocis medinalis* Guenee (Lepidoptera: Crambidae) has been categorized as a major pest of rice in many South Asian countries (Rizwan *et al*., 2021). The larvae fasten the longitudinal margins of the leaf together to make a leaf fold and being inside feed on the leaves by scrapping the chlorophyll. Chemical insecticides may cause insecticide resistance, pest resurgence, residual toxicity. Seaweeds as a natural resource are abundant in oceans and seas all over the world and have been shown to produce several secondary metabolites.

Methodology

Mass culturing of rice leaf folder

Adult moths were collected from the field were introduced (10 pairs) for oviposition on TN1 plants (20 to 25 days old) and covered with cylindrical mylar cages. The potted TN1 plants inhabit the adults for oviposition and the laid eggs were separated and retained for continued development after a 3-day pre-oviposition period. The neonates from this stock culture were utilized for the experiments (Javvaji *et al.*, 2021).

Poison food bioassay

The fresh rice leaves were cut into pieces of about 5 cm in length and soaked in 1% Tween 20 solution. The leaf bits were treated with respective concentrations of aqueous and solvent extracts. The experiment was laid statistically under completely randomized design with seven treatments and were replicated thrice. A standard check (neem leaf extract 3%) and untreated control (water control) were maintained to compare the performance of the seaweed powder on the larva. In the solvent extract's efficiency testing, an additional treatment i.e., one per cent acetone solvent treatment was included for the comparison of solvent's influence on the test insect.

Results

The larval mortality ascertained at 72 hours of exposure displayed that the concentrations 8, 10 and neem leaf extract 3% of aqueous extract exhibited similar rate of mortality (33.33%) whereas at the same concentrations of solvent extract all the three concentrations (8, 10 and neem leaf extract 3%) have demonstrated the highest value of 46.66 per cent mortality. The maximum adult emergence was recorded at the lower concentration (2%) of aqueous (93.33%) and solvent extracts (80%), respectively. The minimum adult emergence was observed 53.33 and 46.66 per cent at 8, 10 per cent and neem leaf extract 3% in the both aqueous and solvent extracts (Fig. 1).

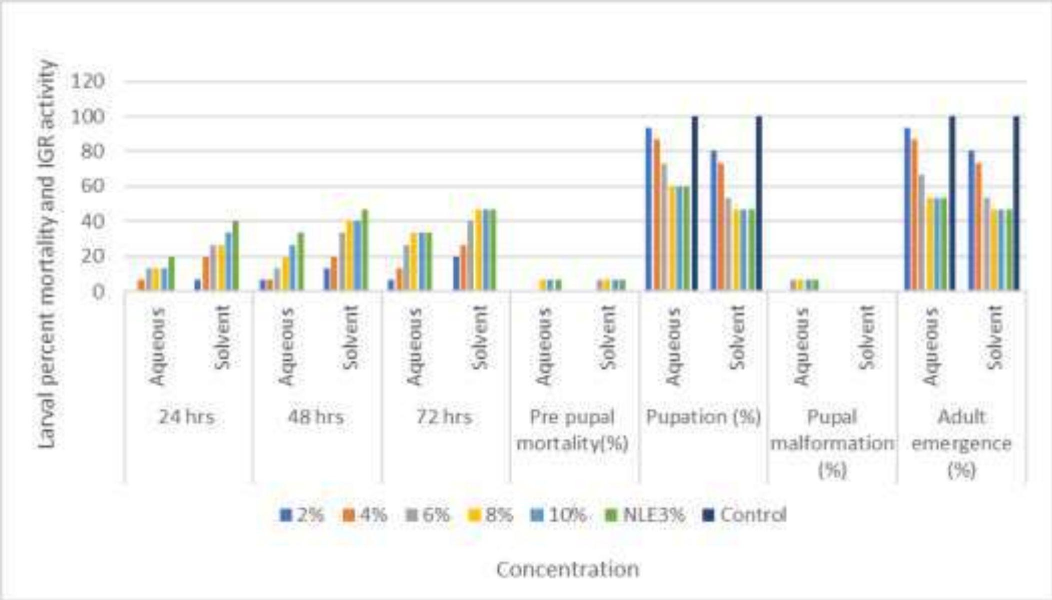


Fig. 1 Larvicidal and IGR activity of Brown algal seaweed *S. wightii* against rice leaf folder

Conclusion

The present study to evaluate the aqueous and solvent extracts of Brown algal seaweed, *Sargassum wightii* Greville against rice leaf folder have demonstrated that both extracts influenced larvicidal and IGR activity on the rice leaf folder wherein the effect of solvent extracts were greater compared to aqueous extracts.

Reference

Javvaji S, Maheswari Telugu U, Damarla Bala Venkata R, Sheshu Madhav M, Rathod S and P Chintalapati. 2021. Characterization of resistance to rice leaf folder, Cnaphalocrocis medinalis, in mutant Samba Mahsuri rice lines. Entomologia Experimentalis et Applicata, 169(9): 859-875.

ICSCI 2022/T3/13

Evaluation of rice cultivars under different duration of weed interference in dry seeded rice

Sridevi, V[*1], Chellamuthu, V[2], Mohan, R[1], Mahendra Kumar, R[3] and Sreedevi, B[3]
[1]*Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal*
[2]*Pushkaram College of Agricultural Sciences, Pudukkottai*
[3]*Indian Institute of Rice Research, Hyderabad*
E-mail: srideviagr@gmail.com

Introduction

Looming water crisis and labor scarcity threatens the sustainability of irrigated rice ecosystem. Aerobic rice as an emerging rice production system addresses the constraints of water scarcity. However, aerobic rice system is more prone to weed infestation. Weed management using herbicides is the most common method; however, herbicide usage has to be minimized due to environmental pollution and evolution of herbicide resistant weeds (Mahajan *et al*., 2014). In this context, development of alternate weed management technologies such as weed suppressive cultivars is the need of the hour. Hence, the present investigation was carried out to screen the popular rice cultivars for their weed competitiveness under different duration of weed interference in the aerobic rice ecosystem.

Methodology

A field experiment was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Pondicherry University, Karaikal, Union territory of Puducherry, India during summer 2018. The experiment was laid out in a split plot design with three replications. Four weed control timings were tried as main plot treatments to identify the critical periods of weed competition and six popular rice varieties were assigned to sub plots to evaluate their weed competitiveness. The crop was dibbled at 20 cm x10 cm. All the recommended crop management practices were practiced except weed management. The weeds were removed manually as per the treatment schedule. The biometric observations on growth and yield attributes were recorded at physiological maturity stage as suggested by Yoshida *et al*. (1976). The grain yield was adjusted to 14 per cent moisture content. The data were statistically scrutinized as given by Gomez and Gomez (2010).

Results

The predominant weed flora present in the field were *Commelina benghalensis* L., *Cyperus rotundus* L., *Dactyloctenium aegyptium*., *Digera arvensis*, *Digitaria sanguinalis*, *Echinochloa colona*, *Grangea maderaspatana* and *Leptochloa chinensis*. Significant difference was observed due to weed control timings and rice cultivars.

Weed control timings

As expected, the performance of all the cultivars was increasing with the weed control timing. Across the weed control timings, weed free up to 60 DAS was found to be the superior, whilst un-weeded control showed its inferiority irrespective of the rice cultivars. The supremacy of weed free up to 60 DAS in all the biometric observations and yield might be attributed to the less interference of weeds with rice.

Rice cultivars

Among the rice cultivars, PMK 3 had taller plants and it was comparable with DRR Dhan 44. The DMP was higher in DRR Dhan 44, but it was similar to that of all cultivars tried except Sahabigidhan. DRR Dhan 41 recorded more number of panicles m^{-2}, but it was statistically at par with Sahabigidhan and DRR Dhan 44. DRR Dhan 42 was with more panicle weight and it was comparable with DRR Dhan 44. At the outset, it was found that DRR Dhan 44 was the best performer by registering significantly the highest grain yield across any of the weed control timings due to the improved growth and yield attributes which shows its weed competitiveness.

Table 1. Evaluation of weed control timings and rice cultivars under aerobic rice ecosystem

Treatment	Plant height (cm)	DMP (g m^{-2})	Panicles m^{-2}	Panicle weight (g)	Grain yield (t ha^{-1})
Weed management practice					
Weed free up to 30 DAS	85.2	74.02	325	1.76	2.22
Weed free up to 45 DAS	87.5	80.45	355	1.91	2.40
Weed free up to 60 DAS	89.4	100.19	426	2.17	3.01
Un weeded control	77.5	49.26	245	1.54	1.45
CD (P= 0.05)	9.3	7.62	35	0.16	0.57
Rice cultivar					
DRR Dhan 44	89.9	80.89	348	2.15	3.60
Sahabigidhan	81.5	67.81	354	1.56	1.95
DRR Dhan 41	72.0	76.12	392	1.57	1.94
DRR Dhan 42	87.9	78.20	288	2.19	1.22
DRR Dhan 46	83.2	75.50	317	1.71	2.54
PMK 3	94.9	77.38	328	1.89	2.37
CD (P= 0.05)	6.5	8.04	45	0.25	0.50

Conclusion

From the present investigation, DRR Dhan 44 can be recommended to improve the yield of aerobic rice irrespective of the weed control timings during summer season at Karaikal region.

References

Gomez KA and AA Gomez. 2010. Statistical procedures for agricultural research (2nd Ed.). Wiley India Pvt Ltd., India.

Mahajan G, MS Ramesha and BS Chauhan. 2014. Response of rice genotypes to weed competition in dry direct-seeded rice in India. The Scientific World Journal, 2014: 1-8.

Yoshida S, DA Forno, JH Cock and KA Gomez. 1976. Laboratory manual for physiological studies of rice. IRRI, Manila, Philippines. 1-86.

ICSCI 2022/T3/15

Evaluation of suitable and promising irrigation management practices with different establishments methods in rice

S. Ravi, R. Narasimman, and R. Mahendera Kumar
Perunthalaivar kamaraj krishi vigyan kendra (pkkvk), Puducherry, India-605009
Department of Agronomy, Indian Institute of Rice Research (IIRR), Hyderabad, India-500030
Email:drsravijapkkvkp@gmail.com

Introduction

In Puducherry region, Rice is the major food crop and increasing water scarcity is becoming a real threat to rice cultivation. Hence water-saving technology needs to be developed which not only economically beneficial but also maintains soil health. Any approach that would lessen the amount of water use without compromising the rice yield. Alternate wetting and drying is also called 'intermittent irrigation' or 'controlled irrigation which can reduce the water requirement by 30 % in irrigated rice system. In order to, identify the Evaluation of Suitable and Promising Irrigation Management Practices with Different Establishments Methods in Rice. The area under rice cultivation has reached 167 million hectares (mha); most of which are grown under continuously flooded conditions (FAO, 2018). However, rice can be successfully grown with less water by the adoption of resource conservation technologies. Among water-saving techniques, DSR and AWD are the attractive options and are being practiced in different parts of the world (Farooq et al., 2011).

Methodology

The field experiments were conducted during *Kharif* 2018 and *Rabi* 2018-19 at Perunthalaivar Kamaraj Krishi Vigyan Kendra, experimental research farm Puducherry State in a split plot design with three replications. The Rice variety CO 52 and ADT 53 was used in the trial *Kharif* 2018 and *Rabi* 2018-19 respectively. The soil type was clay loam in texture and acidic in reaction (pH 6.62), acidic having Electrical Conductivity (EC) of 0.20 dSm^{-1} and available N, P, K content were 291.2kg ha^{-1}, 33.6kg $ha^{-1}$and 138kg ha^{-1} in *Kharif* 2018 and acidic in reaction (pH 7.03), acidic having Electrical Conductivity (EC) of 0.10 dSm^{-1} and available N,P,K content were 145.6 kg ha^{-1}, 35.3 kg $ha^{-1}$and 124kg ha^{-1} in *Rabi* 2018-19. The treatments were consisted of **Main plots** (Three): **Irrigation Management Practices** I1 - Flooding throughout crop growth , I2- Saturation maintenance upto PI and I3- Alternate wetting and drying and **Sub-plots** (Four): **Establishment Methods** S1:Mechanical Transplanting method on puddled soil; S2:Direct wet seeding on puddled soil with Drum seeder ; S3:Normal hand Transplanting and S4:Location Specific (farmers practices) under Puddled Irrigated condition of rice cropping that were tested.

Results

The finding of both the season, the pooled data of Kharif 2018 and Rabi 2018-19 revealed the method of Irrigation that is alternate wetting drying resulted in the highest grain yield of 6.64 and regarding Establishment method the mechanical transplanting register highest grain yield of 6.71 t/ha respectively in clay loam soil of our situation during both the season. Regarding the irrigation method, the results revealed that the water input was significantly reduced in Alternate Wedding and Drying method 1448 mm/h as compared to saturation and flooding throughout crop growth 1528 and 1608 mm/h respectively in both Kharif 2018 and Rabi 2018-19 seasons. In respect of weed management the lower weed dry weight were observed in alternate wetting and drying treated plots. Similarly Mechanical transplanted plots also registered the lowest weed dry weight. Higher cost of cultivation was recorded in Farmers Practice (Location Specific) method 50200 Rs/ha as compared to Mechanical transplanted in puddle (43300 Rs/ha) during Kharif 2018 and Rabi 2018-19. Compared with flood irrigation method of Rice, alternate wetting and drying and mechanical transplanting rice possesses a better yield performance and higher WUE under soil water deficit or under AWD-based water-saving irrigation. There is a saving of 15% cost of cultivation due to mechanical transplanting. The finding that alternate wetting and drying and mechanical transplanting rice has a stronger ability to cope with soil water deficit suggest that adoption of AWD-based water-saving irrigation holds great promising to achieve the dual goal of increasing grain yield and saving water in rice (Belder *et a*l 2004).

Table.1 Yield and water input cum Economics of alternate wetting and drying with mechanical transplanting pooled data of Kharif *2018 and Rabi 2018-19.*

Main Treatment	**Grain yield (kg ha^{-1})**	**Panicle/ m^2 (No.)**	**Weed Dry Weight (g/m^2)**	**Cost of cultivation**	**Water input**
Methods of Irrigation					
I1– Flooding throughout crop growth (3 +/- 2cm)	6.13	3.56	38.21	45283	1608
I2– Saturation maintenance upto PI and (3 +/- 2 cm) after PI	6.34	3.81	30.58	45283	1528
I3– Alternate wetting and drying	6.64	4.16	28.55	45283	1448
CD (P=0.05)	0.10	0.05	0.38	-	-
Method of Establishment					
S1 -Mechanical Transplanting method on puddled soil	6.71	4.04	26.40	43300	1447
S2- Direct seeding (Use of Drum seeder)	5.97	3.64	35.16	42130	1461
S3- Normal Transplanting (20 x 15 cm with flooding water management, transplanting of 3-4 seedlings of 25-30 days old	6.29	3.80	32.14	45500	1580
S4- Optional - Location specific	6.50	3.90	29.42	50200	1698
CD (P=0.05)	0.13	0.08	0.63	-	-

Conclusion

From the above study, it could be concluded that the finding of both the season, alternate wetting and drying with mechanical transplanting resulted in the highest grain yield and it could be Suitable and Promising Irrigation Management Practices in Rice under irrigated condition of Union Territory of Puducherry region.

References

Belder et al 2004. Effect of water-saving irrigation on rice yield and water use in typical lowland conditions in Asia Agric. Water Manage.

Farooq et al. 2011. Rice direct seeding: experiences, challenges and opportunities, Soil Tillage Res.

Global Rice Conference 2021. Deliberation of Advances in Rice Research, September 24-25, 2021, TRRI, Aduthurai, Tanjavur, Tamil Nadu, India. Pp.388

ICSCI 2022/T3/16

Modified Mat nursery & SMSRI -A Climate Smart Mechanization practice in Rice

K. Shekar
Scientist Senior Scale, AICRP Sorghum, ARS, Tandur, PJTSAU
E-mail: kaluvalashekar333@yahoo.com

Introduction

Rice *(Oryza sativa L.)* is one of the Asia's major food crops and as well as for India. Traditional way of rice transplanting is labour intensive and involves drudgery. Modified mat nursery followed by mechanical rice transplanting is cost effective and saves time. It helps in maintaining soil physical properties and is considered to be better from crop management and productivity point of view. In spite of having an edge over the traditional transplanting, adoption rate of mechanical transplanting is low due to high initial investment and lack of knowledge in growing modified mat type nursery. Imparting technical knowledge, ensuring timely availability and encouraging custom hiring through rural youth may increasing the rice area under mechanical transplanting in India. A large-scale Front Line Multi location Demonstrations were conducted in erstwhile Karimnagar District of Telangana to overcome the problem of labour, to save the cost, time and to impart the skill by popularizing the technology in raising modified mat nursery and machine transplantation in rice among the rural youth to spread the cost-effective technology.

Methodology

Multi locations demonstrations were conducted under erstwhile Karimnagar of Telangana State during 2019, 2020 and 2021 with treatments as Demo: Raising of modified mat nursery followed by Transplanting with rice transplanters and Check: Farmer practice (Manual transplanting) with Recommended Fertilizer dose: 120: 60: 40 N, P_2O_5 and K_2O kg ha^{-1} in 25 farmer's fields under unit Plot size of 0. 40 ha in each farmer's field.

Results

This method saved cost ₹4500-6250 ha^{-1}on nursery raising & transplanting. Timely transplanting was carried out during peak periods of labour shortage (5-6 acres' day^{-1}) earlier trays became difficult for them as modified mat is very much useful in saving cost on nursery raising. Under impact of this FLD rural young farmers purchased the machinery. With the intervention of DAATTC, Karimnagar in this area approximatelyjy more than 10,000 acres covered under modified mat nursery followed by machine planting newly in Rajanna Sircilla, Jagtial & Karimnagar Districts of Telangana State.

Conclusion

It can be concluded that, mechanical paddy transplanter is one of the possible options to get rid of labor shortage in farm operations. However, the adoption is slower due to poor response from stakeholders because of the cumbersome process of growing paddy nursery in trays and mats. Providing proper hands-on training to the stakeholders about operating procedure of nursery raising and handling transplanter would enhance the adoption rate of the present available transplanters. Therefore, there is need to develop a small self-propelled type transplanters with suitable power weeders as a national strategy to increase the area under mechanization.

ICSCI 2022/T3/18

Effect of nano silicon on the performance of transplanted rice (*Oryza sativa* L.)

Dharmateja, J[1], Masthana Reddy B. G.[2], Sujay Hurali[2], Umesh, M.R.[1] and Channabasavanna A.S.[1]

[1]*College of Agriculture, UAS, Raichur, Karnataka, India - 584 104*

[2]*AICRIP- Rice, Agricultural Research Station, Gangavathi, Koppal, Karnataka, India - 583 227*

E-mail: bgmreddy2006@gmail.com/morphosis77@gmail.com

Introduction

Rice (*Oryza sativa* L.) is the staple food crop of India with an area of 46.20 million hectares with production of 117.32 million tones. Silicon is long recognized as an important beneficial element for growth of rice and soil application of potassium silicate is usually recommended. However due to non-availability and high cost of the material it is not practiced by farmers. Presently nano silicon products are gaining importance in rice nutrition. Ranjbar and Shams (2009) reported that nano fertilizer is more readily absorbed by the plants and more efficient than conventional silicon fertilizers. Keeping the above facts in view, an investigation was conducted to find out the best silicon fertilizer for transplanted rice.

Methodology

A field experiment was conducted during *summer* season of 2020-2021 at Agricultural Research Station, Gangavathi. The soil of the experimental site was medium black clay in texture. The experiment was laid out in randomized complete block design replicated thrice. The treatments comprised of T_1:soil application of orthosilicic acid 12% effervescent tablets @ 2.5 kg ha^{-1} at 25 days after transplanting (DAT), T_2:soil application of orthosilicic acid 12% effervescent tablets @ 2.5 kg ha^{-1} at 50 DAT, T_3:soil application of orthosilicic acid 12% effervescent tablets @ 2.5 kg ha^{-1} at 25 and 50 DAT, T_4:orthosilicic acid 12% effervescent tablets foliar spray @ 1.0 g l^{-1} at 25 DAT, T_5:orthosilicic acid 12% effervescent tablets foliar spray @ 1.0 g l^{-1} at 25 and 40 DAT, T_6: orthosilicic acid 12% effervescent tablets foliar spray @ 1.0 g l^{-1} at 25, 40 and 55 DAT, T_7: rice husk ash equivalent of silicon 2.5 kg ha^{-1}, T_8:soil application of potassium silicate @ 50 kg ha^{-1} at 25 DAT and T_9:Control (no silicon). The paddy crop was supplied with 150:75:75 kg/ha $N:P_2O_5:K_2O$ and recommended practices were followed. Foliar application of orthosilicic acid effervescent tablets @ 1.0 g l^{-1} were applied as per the treatments, with a spray volume of 500 l ha^{-1}. Observations on growth and yield parameters were recorded and economics was worked out.

Results

Application of orthosilicic acid 12 per cent effervescent tablets as foliar spray @ 1.0 g lit^{-1} at 25, 40 and 55 DAT recorded significantly higher grain yield (5798 kg ha^{-1}) than all the other treatments. The treatment recorded 13.36 per cent higher grain yield than no silicon control indicating the role of silicon as beneficial element in increasing the rice grain yield. This was followed by soil application of orthosilicic acid 12 percent effervescent tablets @ 2.5 kg ha^{-1} at 25 and 50 DAT (5509 kg ha^{-1}) and orthosilicic acid 12 per cent effervescent tablets foliar spray @ 1.0g lit^{-1} at 25 and 40 DAT (5498 kg ha^{-1}). Higher grain yield due to foliar spray of orthosilicic acid is attributed to significantly more number of panicles per square meter and more filled spikelets per panicle indicating the beneficial influence of silicon on yield components and improving the grain yield of rice. Orthosilicic acid 12 per cent effervescent tablets as foliar spray @ 1.0 g lit^{-1} at 25, 40 and 55 DAT also recorded significantly higher net returns and B: C. Higher grain yield and yield attributes due to silicon application in rice was reported by Prakash *et al* (2010), Lavinsky *et al*. (2016) and Sarma *et al* (2017).

Table 1: Grain and straw yield, yield parameters and economics of transplanted rice as influenced by silicon nutrition

Treatment	Panicles m^{-2}	Filled spikelets $panicle^{-1}$	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net returns (Rs ha^{-1})	B:C
T_1	334	127.5	5175	6123	50673	1.79
T_2	343	132.6	5300	6221	53396	1.83
T_3	372	137.3	5509	6407	52721	1.76
T_4	336	126.3	5270	6132	56627	1.94
T_5	368	135.8	5498	6274	60257	1.98
T_6	386	145.8	5798	6534	65517	2.04
T_7	341	126.4	5063	6102	51550	1.85
T_8	356	134.2	5421	6271	58487	1.95
T_9	320	125.4	5023	6003	52611	1.89
C.D. (P=0.05)	13.8	5.46	217	251	4555	0.07

Conclusion

Application of silicon in the form of orthosilicic acid 12 per cent effervescent tablets as foliar spray @ 1.0 g lit^{-1} ha^{-1} at 25, 40, and 55 DAT recorded better yield parameters and resulted in significantly higher grain yield and net returns and proved beneficial for transplanted rice

References

Lavinsky AO, KC Detmann, JV Reis, RT Avila, ML Sanglard, LF Pereira, LM Sanglard, FA Rodrigues, WL Araujo and FM Da Matta. 2016. Silicon improves rice grain yield and photosynthesis specifically when supplied during the reproductive growth stage. Journal of Plant Physiology, 20(6): 125-132.

Prakash NB. 2010. Different sources of silicon for rice farming in Karnataka. Paper presented in Indo-US workshop on silicon in agriculture, held at University of Agricultural Sciences, Bangalore, India.

Ranjbar M and GA Shams. 2009. Using nano technology. Journal of Environmental Green, 3(1): 29-34.

Sarma RS, D Shankhdhar, SC Shankhdhar and P Srivastava. 2017. Effect of silicon solubilizers on growth parameters and yields attributes in different rice genotypes. International Journal of Pure Appled Biological Science, 5(5): 60-67.

ICSCI 2022/T3/20

Single Plant Transplanting of Rice in Natural Farming Saves Cost of Production

Anupam Paul and Soumik Banerji
Deputy Director of Agriculture, Kangsabati Command Area Development Authority, Water Resource Investigation Development Directorate, Bankura, West Bengal
Email: anupampaul99@gmail.com

During the last couple of decades, farmers are facing the wrath of climatic aberration couple with erratic rainfall. Rice being a water guzzling crops needs water to complete its life cycle. Application of fertilizer in modern rice needs water. Conventional system of transplanting needs 18 kg of seed and an appropriate area for seed bed and its management. While Single Seedling Planting (SSP) requires 3 kg of seed and comparatively lower area of seedbed and subsequent management. The concept of Single Seedling Planting is not new in India but it has been made popular under a new name System of Rice Intensification since1990s. Basically, it's a method of System Crop Intensification or Root Intensification. Agricultural Training Centre, Fulia, West Bengal has been practicing SSP since 2002 with more than 400 traditional varieties what has been termed as Folk Rice. SSP does not compromise with yield but gives profuse plant and root growth without any close competition between plants as young single seedling of 15-18 days old are transplanted wide apart. After 22 DAT, first intercultural operation is over and azolla is allowed to float in one inch of standing water. No external organic matter is applied. Within 10 days, azolla doubles itself in the field covering the entire area. It retains moisture, controls the growth of associated plants (weeds), provides Nitrogen, Potassium, micronutrients and organic matter is utilized in the next crop. This forms the basis of natural farming. After harvesting of rice pulse crop is usually followed and in some years ground nut or Dhaincha is used prior to transplanting. Performance of selected 20 folk rice varieties has been given. The non-aromatic folk varieties like Kerala Sundari, Bahurupi, Megha Dambaru , Kesabsal and Bangla Patnai give substantial grain yield ranging from 5 to 6 ton per ha. Farmers also experience the same results. Soil analysis shows that NPK content is not up to the mark but Colony Forming Units of Soil Microbes including saprozoic nematodes are substantial that provides adequate nutrients to the plants.

Key words: Azolla, Single Seedling Planting, Colony Forming Units, Folk Rice

ICSCI 2022/T3/22

Estimation of Soil Organic Carbon Stocks of Semi-arid *Vertisol*s under Different Land Use Pattern in Vikarabad District, Telangana

M. R. Apoorva[1], G. Padmaja [2], S. Harish Kumar Sharma [3], K. Bhanu Rekha[4] and S. Triveni[5]

Professor Jayashankar Telanagana State Agricultural University, College of Agriculture, Rajendranagar, Hyderabad-500030

Introduction

Carbon sequestration is a process by which the atmosphere CO_2 is captured and stored in ocean, vegetation and soil for a specific time period. Of the many options for terrestrial C sequestration, sequestering C in soil organic matter is among the most preferred as it offers a win-win solution to the problem of climate change. The soil organic carbon stock varies with land use types due to difference in source material and it is increasingly becoming clear that the ability to sequester carbon on a long-term basis is governed by the protective capacity of the soil. Soil carbon sequestration is a viable strategy where land use change and soil management act as a net sink for carbon. As the source of the major bulk of the soil carbon is contributed by the soil organic carbon (84 to 97%) it is necessary to embark upon regional level studies focused on the organic carbon dynamics in relation to climate change. Hence the present study was taken up for knowing the soil organic carbon stocks of semi-arid *Vertisol*s under different land use pattern of Vikarabad district, Telangana state.

Methodology

Soil samples (400) at two depths (0-15 and 15-30 cm) were collected from *Vertisol*s covering 10 mandals of Vikarabad district from four different land use pattern. Out of which, two were from agricultural land use with different cropping intensity *i.e.,*100% cropping intensity (redgram-fallow), 200% cropping intensity (rice-rice) and two from natural conditions *i.e.,* forest and fallow land. Each of the land use pattern had been under the designated land use for more than 10 years. Bulk density of the soil at the two depths was determined using the core sampler method. Organic carbon in the 2 mm sieved soil was determined by the wet oxidation method. The soil organic carbon stock (SOC) was calculated by multiplying OC content (g g^{-1}) with bulk density (Mg m^{-3}) and depth (cm) of soil (Bhattacharya *et al.*, 2000). Carbon sequestration potential was obtained from the difference of the mean SOC density of a given land use and the pristine land use. $C_{\text{sequestration potential}} = SOCD_{nj} - SOCD_{uj}$.. Where, $C_{\text{sequestration}}$ (Mg ha^{-1}) is the potential carbon sequestration, $SOCD_{nj}$ (Mg ha^{-1}) is the mean SOC density for native land cover, $SOCD_{uj}$ (Mg ha^{-1}) is the mean SOC density for any other land use within the same study region (Akpa *et al.*, 2016). The native land use type in our study area was forest and it was considered as pristine land use. Carbon dioxide sequestration potential was obtained by multiplying carbon sequestration potential (Mg ha^{-1}) × 3.67 *i.e.,* 1 tonne of OC sequestered in the soil is equivalent to 3.67 tonnes of CO_2 from the atmosphere. All the soil parameters were analyzed by two-way ANOVA, where depth and land use pattern were the fixed factors and number of mandals was considered as the replicates. The Duncan's multiple range test was used to segregate the significance of difference among the mean values obtained in each land use pattern and depth at $P < 0.05$ which were considered to be statistically significant at 5% level of significance.

Results

The values of bulk density (Table 1) varied significantly among land use patterns. The comparison of land use patterns for bulk density indicated that 200% cropping intensity (rice-rice) recorded the highest bulk density (1.47 Mg m^{-3}) and forest land recorded the lowest bulk density (1.36 Mg m^{-3}). Among all the land use patterns, the soil bulk density increased with increase in soil depth from 0-15 cm (1.39 Mg m^{-3}) to 15-30 cm (1.44 Mg m^{-3}). Organic carbon content was recorded highest under forest land (7.50 g kg^{-1}) and lowest was seen in fallow land (3.22 g kg^{-1}). With increase in depth the soil organic carbon decreased from 5.27 g kg^{-1} to 4.28 g kg^{-1}. The soil organic carbon stock varied across the land use patterns and soil depth. Among the land use patterns, the highest soil organic carbon stock (Figure 1) was recorded in forest land (15.22 Mg ha^{-1}) and lowest was seen in fallow land (6.78 Mg ha^{-1}). Soil organic carbon stock recorded a significant decrease in soil along the depth from 10.90 Mg ha^{-1} to 9.21 Mg ha^{-1}. The potential carbon sequestration (Table 2) ranged from 10.75 to 16.89 Mg C ha^{-1} and the fallow land had the highest capacity to sequester carbon. Carbon dioxide Sequestration Potential for 0-30cm depth was significant in fallow land (61.99 CO_2 t Equivalent ha^{-1}) which was followed by 100% cropping intensity (50.20 CO_2 Mt Equivalent ha^{-1}) and 200% cropping intensity (39.46 t equivalent ha^{-1}).

Table 1. Bulk density, organic carbon in 0-15 cm and 15-30 cm soil layers of semi-arid *Vertisol*s under different land use pattern

Land Use Pattern	Bulk density (Mg m^{-3})			Organic carbon (g kg^{-1})		
	Depth (cm)			Depth (cm)		Mean
	0-15	15-30	Mean	0-15	15-30	
100 % cropping intensity (redgram-fallow)	1.42 ± 0.01^{c}	1.46 ± 0.01^{b}	1.44^{b}	4.38 ± 0.25^{d}	3.40 ± 0.31^{f}	3.89^{c}
200 % cropping intensity (rice-rice)	1.44 ± 0.02^{b}	1.50 ± 0.01^{a}	1.47^{a}	5.08 ± 0.23^{c}	3.88 ± 0.12^{de}	4.48^{b}
Forest land	1.32 ± 0.02^{e}	1.39 ± 0.02^{d}	1.36^{d}	8.00 ± 0.15^{a}	7.01 ± 0.23^{b}	7.50^{a}
Fallow land	1.38 ± 0.03^{d}	1.43 ± 0.03^{c}	1.40^{c}	3.62 ± 0.16^{e}	2.83 ± 0.28^{g}	3.22^{d}
Mean	1.39^{A}	1.44^{B}		5.27^{A}	4.28^{B}	

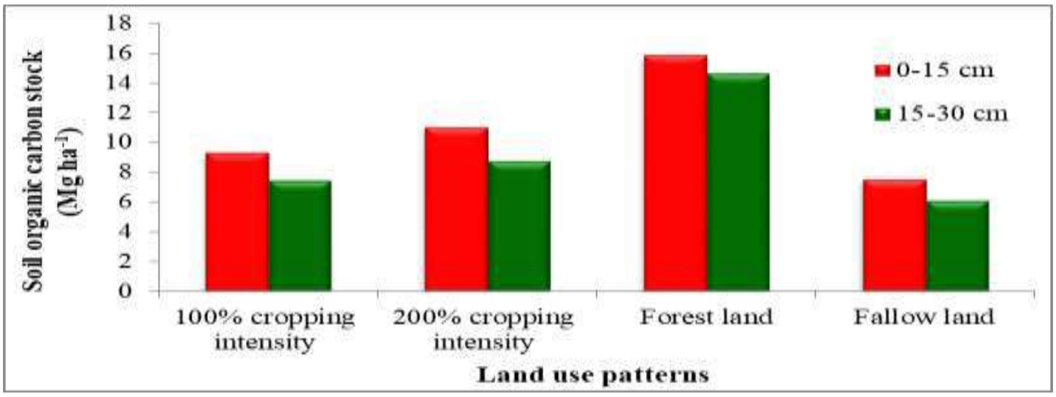


Figure 1. Soil organic carbon sStock (Mg ha^{-1}) of semi-arid *Vertisol* under different land use pattern

Mean values with lower case superscript letters indicate significant difference between land use pattern for each soil depth and all land uses. Uppercase superscript letters indicate significant difference between depths for all land use pattern respectively at (P<0.05). ± indicates standard deviation of mean.

Table 2. Carbon and CO_2 sequestration potential of semi-arid *Vertisol*s under different land use patterns

Land use pattern (LUP)	Carbon sequestration potential 0-30 cm	CO_2 sequestration potential 0-30cm
100 % cropping intensity (redgram-fallow)	13.68[b]	50.20[b]
200 % cropping intensity (rice-rice)	10.75[c]	39.46[c]
Forest land (Reference)	-	-
Fallow land	16.89[a]	61.99[a]

Mean values with different superscript letter indicate significant differences for LUP (P<0.05).

Conclusion

A close perusal of the data indicated that higher amount of organic carbon stock in forest system may be because of higher leaf litter as well as zero pedoturbation. Compared to both the cropping patterns, rice-rice system recorded higher soil organic carbon stock which may due to the retardation of oxidation due to submergence and higher content of lignin and polyphenol content of rice crop residue which reduce the decomposition rate.

References

Akpa SICC, IOAA Odeh, TFAA Bishop, AE Hartemink and IY Amapu. 2016. Total soil organic carbon and carbon sequestration potential in Nigeria. Geoderma, 271: 202-215.

Bhattacharyya T, DK Pal, M Velayutham, P Chandran and C Mandal. 2000. Total carbon stocks in Indian soils: Issues, priorities and management. In Special Publication of the International Seminar on Land Resource Management for Food, Employment and Environmental Security (ICLRM). 8-13.

ICSCI 2022/T3/23

Advances in breeding strategies for climate resilient crops

Lakshmi Shyamala Sreeramakavacham, Shiva Kumar Reddy Mudedla, Nagaraju Berla, Shivani D, Sushmita Dey, Sasi Priya S
School of Agricultural Sciences, Malla Reddy University, Hyderabad, Telangana.
Email: sr.shyamala98@gmail.com

In spite of rising demand of food for the growing population, food security has become a threat globally due to rapid climate change. As a result of climate change, the crop production and productivity were reduced by various biotic and abiotic factors. Plant breeding has always played a crucial role in revolutionizing agriculture to feed the ever-growing population. It can rescue mankind from various threats to agriculture posed by changing climatic conditions globally. With modern breeding techniques, innovations, and recent advancements, it can explore and exploit variation in underutilized crops and pave the way forward to fulfill the food requirements of the present and future. Using recent innovations and advancements such as next-generation breeding (NGB) tools, genome-assisted breeding (GAB), high throughput phenotyping, genomic sequencing, and breeding methodologies along with genome editing tools like clustered regularly interspaced short palindromic repeat/CRISPR-associated (CRISPR/Cas) systems, in integration with artificial intelligence (AI) and machine learning (ML), it can open new doors to accelerate the development of climate-ready crops to ensure global food security.

ICSCI 2022/T3/24

Farm Ponds within the Changing Scenario of Agriculture Growth, Sustainability and Equity: A Case Study of Gujarat

Amita Shah[1], Jignasu Yagnik[2], Hasmukh Joshi[3]
[1 & 3]Professor, Research Associate, Centre for Development Alternatives, Ahmedabad – 380 009, Gujarat, India, [2] Professor, Lok Jagruti Kendra University, Ahmedabad – 382 210, Gujarat (India)
E-mail: amitagidr@gmail.com

Introduction

Small Farm Ponds (FPs) have been an integral part of the soil-water conservation system in various parts of India, especially in arid, semi-arid regions in a state like Gujarat (Shah, 2001). Over time, FPs have been shadowed by the emergence of medium-large irrigation systems. In this process, it has missed out on two important aspects of FPs viz. location specificity of crops (leading to increased use of water), and equity. Fortunately, not all is lost. FPs have once again started regaining their due, with state support. Capturing this new phase of FPs and bringing out important aspects of the processes could be quite instructive, especially at the initial stages. This paper is an effort in this direction. The objective of the study is to gauge the impact of FPs in terms of financial benefits, changes in water and soil-moisture levels, irrigation and livestock, cultivable land, etc.

Methodology

Data for this study have been collected through a primary survey of 108 existing FPs created in the last two years across 62 villages in three districts of Gujarat viz. Surendranagar, Narmada and Banaskantha represent different geophysical characteristics, within dry land. The schedule focused mainly on questions related to socio-economic background, access to land, soil-water, and economic benefits. In addition, a few open-ended questions were also included to capture the viewpoint of farmers to improve the ongoing approach of FPs.

Results

Our analysis showed varying cash benefits across land holding sizes and districts due to farm ponds in line with observations by Rao et al. (2019). Although the differences across districts were observed to be statistically significant, Banaskantha differed significantly from the other two districts. The difference across the three land holding classes viz. small and marginal, medium, and large, was not found to be statistically significant. However, with the use of small land holding as a dummy variable it was observed that the cash benefits by small landholders were significantly lower than medium and large landholders. Table 1 presents the percentage of farmers reporting different benefits like an increase in water level, irrigation area, soil moisture, drinking water for livestock, grass, etc. Overall, except for the increase in the cultivated area during summer, and the change in cropping pattern, a large but varying proportion of farmers reported a positive impact due to farm ponds. Though the proportions vary across districts.

Table 1: Percentage of Farmers Reporting Various Benefits as a Result of Farm Pond by District

Benefits	Districts			All
	Surendranagar	Narmada	Banaskantha	
Water Level Increased	100.0	88.0	65.4	87.6
Irrigation Area Increased	100.0	100.0	84.6	95.9
Soil Moisture Increased	97.8	88.0	73.1	88.7
Drinking Water For Livestock	100.0	100.0	100.0	100.0
Grass/Greenery Increased	91.7	100.0	80.8	90.7
Increase in cultivated Area(winter)	95.7	92.0	38.5	79.7
Increase in cultivated Area (summer)	15.2	4.0	7.6	10.3
Growing New Crop	37.0	56.0	46.2	44.3
Change in Cropping Pattern	36.2	20.0	16.7	25.9
No Cultivation to Some Cultivation	43.5	46.1	72.7	51.0

Conclusion

It is concluded from the study that FPs have led to an increase in cultivated area and overall economic gains. There is, however, a large difference with respect to economic gains by land holding size and region. It is important to note that small landholders were not the major gainers. Support may be extended to them, especially by the state.

References

Shah A. 2001. Promoting Small Water Harvesting Structures in Dryland Regions: A Case Study of Farm Ponds Scheme in Gujarat. Agricultural Economics Research Review, 14(1): 47-64.

Rao CAR, KV Rao, BMK Raju, S Josily, D Ravi, M Osman and RN Kumar. 2019. Levels and determinants of the economic viability of rainwater harvesting farm ponds. Indian Journal of Agricultural Economics, 74(4): 539–551.

ICSCI 2022/T3/25

Pre evaluation of *Echinochloa crus-galli* accessions for herbicide resistance

Sushmita Munda, Meghana Mohapatra, Sanjoy Saha, Dibyendu Chatterjee, Totan Adak and AK Nayak
ICAR-National Rice Research Institute, Cuttack-753006, India
E-mail: sustot@gmail.com

Introduction

Herbicides are the most widely used method of weed management, accounting for up to 50% of the worldwide plant protection industry. Herbicides being most efficient and dependable weed control agents, are heavily reliant in case of intensive cropping systems (Panozzo et al., 2015). However, an over-reliance on herbicides and the advent of selective herbicides with a very precise metabolic target has resulted in a huge increase in the number of resistance occurrences in weeds. Despite the fact that herbicide resistance poses a severe danger to agriculture and rice ecosystems in general, not much research has been done in India regarding the monitoring and systematic reporting of herbicide resistance in rice weeds, even though wheat ecosystems weeds have already been showing all types of herbicide resistance. Very limited studies from India about herbicide resistance development in weeds of rice ecosystem especially *Echinochloa crus-galli*, make this study even more important.

Methodology

The study comprised of pot bioassay experiment as well as lab experiments to determine the dose response of the *Echinochloa crus-galli* to different post-emergence herbicides. Four accessions of *Echinochloa crus-galli* (NRRI Farm, Cuttack; Kandharpur, Cuttack; Bargarh, Odisha; Hubli, Karnataka) were treated with three herbicides (Bispyribac sodium, BPS; Penoxulam, PNX; and Fenoxoprop-p-ethyl, FPE) at five doses of each herbicide taken - 0X (control), 0.25X, 0.5X, 1X, 2X, 3X, where X being the standard recommended dose of application in the field. Observations were carried out 7 and 21 days after spraying.

Results

The 'Bargarh' accession was found to have significantly higher fresh and dry weight whereas lowest were recorded in 'Hubli' accession. The dry weight recorded by Bargarh accession was significantly higher than the other accessions. Highest plant height was also recorded by Bargarh accession (3.84 mg $plant^{-1}$) while significantly lower plant height was recorded in the Hubli accession. The lowest value in relative growth was recorded by NRRI farm accession (7.01%). Hubli and NRRI farm accessions being at par with each other have recorded the highest herbicide damage (76.94% and 76.59%) indicating that they were most sensitive to herbicides. The herbicide efficacy for NRRI farm accession based on the biomass data observed was: FPE>PNX>BPS. In case of Hubli accession herbicide efficacy was observed as: FPE>BPS>PNX. In case of Kandharpur accession the efficacy was: FPE>PNX>BPS. In case of Bargarh accession the efficacy was: BPS>PNX>FPE.

Table 1 Effect of different herbicides and their doses on fresh weight, dry weight and plant height of barnyard grass accessions

Treatments	Fresh weight (mg $plant^{-1}$)	Dry weight (mg $plant^{-1}$)	Plant height (cm)	Relative Growth (%)	Herbicide damage (%)
Accession (A)					
NRRI Farm	**0.87** (0.26)	**0.77** (0.10)	**2.50** (7.81)	**2.74** (7.01)	**8.78** (76.59)
Kandharpur	**0.94** (0.38)	**0.78** (0.11)	**2.69** 9.08)	**4.49** (19.66)	**7.80** (60.34)
Hubli	**0.88** (0.27)	**0.76** (0.08)	**2.42** (6.94)	**3.88** (14.55)	**8.80** (76.94)
Bargarh	**1.33** (1.27)	**0.95** (0.43)	**3.84** (16.2)	**6.50** (41.75)	**6.30** (39.19)
CD (P=0.05)	0.03	0.01	0.18	0.49	0.42
Herbicide (H)					
Bispyribac Sodium	**0.96** (0.49)	**0.80** (0.15)	**2.69** (9.10)	**3.80** (13.94)	**8.47** (71.24)
Penoxulam	**0.99** (0.59)	**0.81** (0.17)	**2.77** (9.70)	**4.14** (16.64)	**7.97** (63.02)
Fenoxaprop -p-ethyl	**0.97** (0.54)	**0.81** (0.16)	**2.56** (8.77)	**3.47** (11.54)	**8.34** (69.06)
CD (P=0.05)	0.02	0.01	0.12	0.40	0.37
Dose (D)					
0% RDH	**1.34** (1.24)	**0.94** (0.38)	**4.33** (18.25)	-	-
25% RDH	**1.13** (0.85)	**0.87** (0.26)	**3.93** (14.94)	**7.46** (55.15)	**5.33** (27.91)
50% RDH	**1.07** (0.64)	**0.84** (0.21)	**3.70** (13.19)	**6.54** (42.27)	**6.68** (44.12)
100% RDH	**0.92** (0.35)	**0.79** (0.12)	**2.54** (5.95)	**4.17** (16.89)	**8.42** (70.39)
200% RDH	**0.8** (0.14)	**0.74** (0.05)	**1.57** (1.96)	**2.29** (4.74)	**9.42** (88.24)
300% RDH	**0.75** (0.06)	**0.72** (0.02)	**1.09** (0.69)	**1.54** (1.87)	**9.74** (94.37)
CD (P=0.05)	0.02	0.01	0.15	0.37	0.29
Interaction (AxHxD)	*	*	*	**	**

Values within parentheses are original and values in bold are square root transformed using $\sqrt{(0.5+x)}$.
RDH- recommended dose of herbicide, * and ** indicate significance at 5 and 1%.

Conclusion

The fenoxaprop-p-ethyl as well as penoxulam seemed to control the weeds of NRRI farm and Kandharpur accessions. The Hubli accession was controlled by the fenoxaprop-p-ethyl and bispyribac sodium. The Bargarh accession was only controlled by the bispyribac sodium and shows least susceptibility to all other herbicides. This might be due to the high amounts and higher dose of herbicide application (more than half of the entire state's consumption) in this district of Odisha.

Reference

Panozzo S, L Scarabel, A Collavo and M Sattin. 2015. Protocols for Robust Herbicide Resistance Testing in Different Weed Species. Journal of Visualized Experiments, 101: e52923. DOI: 10.3791/52923.

ICSCI 2022/T3/26

Screening of drilled paddy genotypes against yellow stem borer, *scirpophaga incertulas* (walker) and leaf folder, *Cnaphalocrocis medinalis* (Guenee)

G. D. Hadiya*, C. B. Damor, H. R. Adsul and M. B. Patel
Agricultural Research Station, Anand Agricultural University, Derol, Panchmahals (Gujarat)-389320
E-mail: hadiyagirish@aau.in

Introduction

One of the most significant staple food grain crops in the world is rice (*Oryza sativa* L.), which is the primary source of nutrition for two-thirds of Indians and 60% of the global population. (Ankita *et. al*., 2021). Farmers are switching to drilled paddy from transplanted one owing to 25% less water use resulting in 27% diesel use for pumping water for field preparation, nursery raising, puddling, and less frequent irrigation water application, save 35 to 40 man days/ha and gain the advantages of earlier crop maturity by 7 to 10 days, which helps in the timely sowing of succeeding crops (De Datta, 1986). The input requirements and the investment in direct seeded rice are much lower than in transplanted rice (Sunil *et al.*, 2002). More than 100 insect species, 20 of which are significant economically attack rice plants. Among these, yellow stem borer, *Scirpophaga incertulas* Walker and rice leaf folder, *Cnaphalocrocis medinalis* Guenee are the dominant and the most destructive insect-pest occurring throughout the country causing the yield loss of about 10-60 per cent (Chatterjee and Mondal Palash, 2014). Yellow stem borer, *Scirpophaga incertulas* Walker is considered as the serious and specific pest of irrigated and lowland rice that caused heavy yield loss (Singh *et al.*, 2005). The use of modern synthetic insecticides in crop pest control programmes around the world has resulted in the disturbance of eco-bio-balance. However, host plant resistance is crucial in the ever-changing world of pest management programmes. Considering the foregoing, an effort has been undertaken in the current study to screen rice genotypes against the yellow stem borer and the leaf folder.

Methodology

Total 28 drilled paddy genotypes were evaluated against stem borer and leaf folder in natural field conditions at Agricultural Research Station, Anand Agricultural University, Derol during *kharif,* 2021. The crop was raised by adopting standard agronomic practices. Three replications, 30 x 10 cm spacing and a randomized block design were used to set up the experiment. A gross and net plot size of 4.0 x 2.4 m and 4.0 x 1.8 m was used. For recording the observations on the infestation of stem borer, 5 hills were selected randomly from each net plot at 15 days before harvesting. Observation on percent white ear infestation was recorded by counting the total number of panicles bearing tillers and total number of white ear head was calculated by using the following formula.

$$\text{White ears (\%) due to stem borer} = \frac{\text{Total number of white ear head}}{\text{Number of panicle bearing tillers}} \times 100$$

For recording the observations of the leaf folder incidence in terms of number of damaged leaves by leaf folder, 5 hills were selected randomly from each net plot at the time of peak leaf folder infestation. Observation on percent leaf folder damage was recorded by counting the total number of leaves and number of damaged leaves was calculated by using the following formula.

$$\text{Per cent leaf folder damage} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

Results

During *kharif* 2021, the stem borer and leaf folder infestation was low. The entries NWGD 1804 has recorded significantly lower per cent white ears due to stem borer (2.61%) and it was at par with NWGD 1803, NWGD 1805, NWGD 1806, NWGD 1810, NWGD 1825, NVSR 2305, NVSR 2601, NVSR 2842, NVSR 2846, NVSR 2837, NVSR 3031, NVSR 3033, NVSR 3313, NVSR 3332, NVSR 3347, NVSR 3340 and NVSR 3488. Significantly higher white ears was recorded in PURNA (6.44%). In case, leaf folder damage was very low (1.27 to 3.86%) in all the entries. NVSR 2837 and NVSR 3031 was registered significantly lowest leaf folder damage (1.27%), whereas higher leaf folder damage recorded in AAUDR 1 (3.86%).

Table 1: Reaction of different entries against yellow stem borer and leaf folder

Sr. No.	Entries	Stem borer (% white ears)	Leaf folder (% leaf damage)
1	NWGD-1803	1.88 (3.02)	(1.29)
2	NWGD-1804	1.76 (2.61)	1.51 (1.80)
3	NWGD-1805	2.17 (4.22)	1.33 (1.28)
4	NWGD-1806	2.13 (4.04)	1.41 (1.49)
5	NWGD-1807	2.35 (5.01)	1.61 (2.09)
6	NWGD-1810	2.21 (4.39)	1.36 (1.35)
7	NWGD-1825	1.84 (2.87)	1.45 (1.59)
8	NVSR-2305	1.87 (3.01)	1.63 (2.16)
9	NVSR-2601	2.24 (4.51)	1.69 (2.34)
10	NVSR-2842	2.27 (4.65)	1.65 (2.23)
11	NVSR-2846	2.07 (3.80)	1.61 (2.08)
12	NVSR-2837	2.13 (4.04)	1.33 (1.27)
13	NVSR-3031	1.87 (3.01)	1.33 (1.27)
14	NVSR-3033	2.03 (3.61)	1.34 (1.31)
15	NVSR-3313	2.02 (3.58)	1.52 (1.82)
16	NVSR-3332	1.92 (3.20)	1.38 (1.39)
17	NVSR-3334	2.43 (5.39)	1.70 (2.40)
18	NVSR-3356	2.31 (4.85)	1.90 (3.10)
19	NVSR-3382	2.41 (5.30)	1.98 (3.44)
20	NVSR-3347	2.10 (3.90)	1.89 (3.08)
21	NVSR-3340	2.16 (4.17)	1.42 (1.50)
22	NVSR-3527	2.52 (5.83)	2.02 (3.60)
23	NVSR-3488	2.24 (4.51)	1.78 (2.66)
24	AAUDR-1 (C)	2.48 (5.66)	2.09 (3.86)
25	PURNA (C)	2.63 (6.44)	2.08 (3.83)
26	GR-8 (C)	2.55 (6.00)	1.99 (3.45)
27	GR-16 (C)	2.32 (4.89)	1.85 (2.94)
28	GR-5 (C)	2.54 (5.95)	1.86 (2.96)
C.D. at 5%		0.51	0.48

Figures outside parenthesis are $\sqrt{x+0.5}$ transformed value and those inside parenthesis are retransformed values.

Conclusion

On the basis of present investigation, it can be concluded that those genotypes showed less damage against yellow stem borer and leaf folder, can be used as donor for varietal developmental programme against yellow stem borer and leaf folder in rice.

References

Ankita MG, NV Kashid, JD Jadhav and KM Kamble. 2021. Suitable drilled paddy varieties and sowing windows for drilled paddy in Sub Mountain Zone of Pune district of Maharashtra. International Journal of Current Microbiology and Applied Sciences, 10(1): 485-490.

Chatterjee S and P Monda. 2014. Management of rice yellow stem borer, *Scirpophaga incertulas* Walker using some biorational insecticides. Journal of Biopesticides, 7(supp): 143-147.

Sharma PK and De datta SK. 1986. Physical properties and processes of puddled rice soils. Advances in soil Sciece, 5: 139-178.

Singh RA, RB Singh and G Singh. 2005. Drougt-induced shifting of stem borer species in shallow deep water rice. IRRN, 30(2): 24.

Sunil K, SN Khajanji, GK Shrivastava, RS Tripathi and S Kumar. 2002. Comparative study of different methods of sowing on morpho-physiological traits and economics of medium duration rice (*Oryza sativa*) inceptisols. Journal of Interacademician, 6(2): 244–249.

ICSCI 2022/T3/27

Effect of intensification and diversification on productivity and water use of basmati rice-based cropping sequences under water logged conditions

Vijay Bharti [1], Shakti Singh[2], Anuradha Saha[3], A. Samanta[4] and A. K. Sharma[5]
Water Management Research Centre, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu Main Campus, Chatha, Jammu and Kashmir Union Territory, INDIA-180009
E-mail: vibhrt25@gmail.com

Introduction

Waterlogging in many low-lying agricultural farms results in saturated to over-saturated conditions throughout the year and makes it difficult for farmers to grow anything other than rice. The situation is made worse particularly in foothills and extensive plains of Jammu region with flat topography and the sizeable area remains fallow in *rabi or* under wheat with poor yield levels. The arable status of soil for growing of crops other than rice can be achieved through modification in land configuration. The configurations may be permanent or temporary, depending on the farmers' preferences, crops to be cultivated, and labour availability. Intensification and diversification of rice-based cropping systems by introducing short-duration pulses/ vegetables/ floriculture is well recognized in Indian agriculture as an effective strategy for achieving the goals of food security, nutritional security, income growth, poverty alleviation, job creation, wise use of land and water resources. In this context, a basic field arrangement using raised and sunken beds is a valuable technology for effective land and water management under water logged situations. Fields can be transformed to alternate raised and sunken beds (4-5m wide) and the length can be adjusted according to land availability. Keeping this in view, a study on diversification and intensification of rice based cropping system was carried to identify the most promising sequence under waterlogged situations.

Methodology

A field experiment was conducted during during July 2020 to July, 2021 at Multiple Water Use Model, SKUAST-Jammu, Main Campus, Chatha, Jammu which is geographically situated at $32^0 40'$ North latitude and $74^0 58'$ East longitude and at an altitude of 332 meters above mean sea level. Soil was sandy clay loam in texture with pH 7.77 and EC 0.33 dS/m, low organic carbon (0.48%), nitrogen (208 kg/ha) and phosphorus (8.6 kg/ha) but medium in available potassium (220 kg/ha). The experiment was laid at established Raised-sunken beds in randomised block design with three replications comprising 8 crop sequences (Table 1). The economic yield obtained from each crop in a sequences was converted into basmati rice equivalent yield based on the minimum support price/ prevailing market price of each product. The data were statistically analyzed using analysis of variance test and the critical difference at 5% level of significance was calculated to find out the significance of different treatments.

Results

The data (Table 1.) depicts comparison of different crop sequences in terms of equivalent yield, water used by crop sequences and water productivity. Among the crop sequences, S8 i.e rice (short duration) - fenugreek - knolkhol - green onion - cowpea on raised beds (50 % area) + sunken beds (50 % area) recorded significantly higher basmati rice equivalent yield than the other crop sequences. Improvement in desirable conditions for the crops due to effective land and water management through formation of raised and sunken beds ultimately increases the cropping intensity and yield (Sharma, 2003). Significantly lower basmati rice equivalent yield was recorded in S2 sequence *i.e.*, basmati rice - wheat on raised beds (50% area) + sunken beds (50% area). Likewise, crops grown under different sequences used varied quantity of irrigation water. Sequence water use calculated was found to be maximum in sequence S8 and minimum sequence water use was recorded in sequence S1 *i.e.*, basmati rice - wheat (Control plot). Sequential water productivity for different crop sequences was found to be significantly higher under sequence S8. The least sequential water productivity was recorded under S2 sequence. Higher water productivity under raised-sunken bed land configuration was recorded by Das *et al.* (2014).

Table 1. Effect of different crop sequences on basmati rice equivalent yield, sequence water use and water productivity under raised-sunken bed land configuration

Cropping sequence	Basmati rice equivalent yield (kg/ha)	Sequence water use (m^3)	Water productivity (kg/m^3)
S1:Basmati rice-Wheat (Control)	3531	10930	0.34
S2: Basmati rice-Wheat	2330	12280	0.15
S3: Okra-Cauliflower-Toria	9095	12818	0.71
S4: Maize-marigold-Radish-mixed fodder (MF)	5652	12052	0.47
S5: Black gram (BG)-Potato-MF	4493	11774	0.38
S6:BG-Knolkhol-(KK)-KK-Radish (R)-cowpea (CP)	7560	12524	0.60
S7:BG-KK-KK-R-Gren gram	7279	12524	0.58
S8: Rice (short duration)-Fenugreek-KK-Green onion-CP	11261	13802	0.82
CD(P=0.05)	386.7		

Conclusion

The results of one year shows that altered land configuration as raised-sunken beds under water-logged conditions provide arable status of soil for round the year cultivation and is a viable option to intensify and diversify basmati rice based crop sequences.

References

Das A, DP Patel, GI Ramkrushna, GC Munda, SV Ngachan, M Kumar, J Buragohain and Naropongla. 2014. Crop diversification, crop and energy productivity under raised and sunken beds: results from a seven-year study in a high rainfall organic production system. Biological Agriculture and Horticulture, 30(2): 73-87

Sharma PK. 2003. Raised-sunken bed system for increasing productivity of rice-based cropping system in high rainfall areas of Himachal Pradesh. Journal of the Indian Society of Soil Science, 51(1): 10-16.

ICSCI 2022/T3/29

Effect of locations, breeds of cow and different hours after preparation of Beejamrutham on its microbial characteristics

Puja Priyadarsini Naik, K. Pavan Chandra Reddy, T. Anjaiah and S. Triveni
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad-500030
E-mail: kpcreddyssac@gmail.com

Introduction

Continuous use of chemical fertilizers in the 1960s with the advent of green revolution has played an important role in making India self-sufficient. However, the use of continuous dose of chemical fertilizers over a long period of time led to drastic changes in the population of soil beneficial micro-organisms leading to the soil becoming barren and reduction in soil fertility (Boraiah *et al.*, 2017). A number of agricultural products have been developed based on the fermentation of cow dung and this has been resultant in various number of formulation like Beejamrutham, Jeevamrutham, Vermicompost, Vermiwash, Panchagavya, etc. Beejamrutham is one of the products that have been used since a long time. The beneficial microorganisms present in Beejamrutham have been shown to protect the crop from soil borne and seed borne pathogens and diseases and also provide the beneficial microorganisms for improving soil health (Sreenivasa *et al.,* 2010). Van Faassen and Van Dijk (1987) reported that many factors like cattle breeds, type and age of the animal, nutrient composition of the feed and climate of the region influence the chemical composition of dung and urine so the quality of Beejamrutham. Hence, this experiment was conducted to study the interaction between cow breed and time of storage and their effect on microbial population of Beejamrutham.\

Material and method

Ten cows were selected from 9 different districts of Telangana for the preparation of Beejamrutham. Details of collection of samples are given in Table 1.

Table 1. Details of location and breed of cow and type of fodder for the collection of cow dung, cow urine and soil

S.NO	Given serial no.	District	Breed of cows	Fodder fed to them
01	C_1	IFS unit, College farm, PJTSAU, Rajendranagar, Rangareddy	Gir	Hybrid napier grass (fresh as well as dried and crushed)
02	C_2	Dairy farm, PVNRTVU, Rajendranagar,Rangareddy	Sahiwal	Super napier and hybrid napier
03	C_3	Venkatapur	Sahiwal	Paddy straw
04	C_4	Kothagudem	Gir	Paddy straw
05	C_5	Navabpet	Jersey	Paddy straw along with napier grass, green gram haulm and concentrate
06	C_6	Navegaon	Lal khandhari	Saybean, redgram, Bengal gram haulm and jowar straw
07	C_7	Monkanpally	Ongle	Paddy straw and super napier grass
08	C_8	Ghannmukhula	Ongle	Super napier , paddy straw and jowar
09	C_9	Obulapur	Deoni	Paddy straw and fodder jowar
10	C_{10}	Kondapanthi	Ongle	Paddy straw

Results

There was a decrease in bacteria population from 0 HAP (64.85 × 10^6 CFU/mL) to 48 HAP (36.15 × 10^6 CFU/mL). However, the bacteria population recorded at 12 HAP (56.55 × 10^6 CFU/mL) and 24 HAP (58.80 × 10^6 CFU/mL) were on par with each other. The highest bacteria population was recorded in Beejamrutham obtained from C_5 (104 × 10^6 CFU/mL) and this was followed by C_1 (77.70 × 10^6 CFU/mL). The Beejamrutham obtained from C_2 (63.50 × 10^6 CFU/mL) and C_4 (62.70× 10^6 CFU/mL) were on par with each other and followed C_1 in recording higher bacterial population. These were followed by C_9 (59.10 × 10^6 CFU/mL) and C_6 (54.40 × 10^6 CFU/mL) which were on par with each other and these were followed by C_8 (39.50 × 10^6 CFU/mL), C_7 (33.20 × 10^6 CFU/mL) while the lowest population was recorded in C_3 (11.40 × 10^6 CFU/mL) followed by C_{10} (16.10 × 10^6 CFU/mL).

There was an increase in total fungal population from 0 HAP (2.75× 10^5 CFU/mL) to 12 HAP (3.05 × 10^5 CFU/mL) and further it declined from 12 HAP to 48 HAP (0.55 × 10^5 CFU/mL). Among the cows, the Beejamrutham obtained from C_5 was recorded higher population i.e. 5.40 × 10^5 CFU/mL followed by C_4 (3.30 × 10^5 CFU/mL) and lowest was recorded in C_6 and C_3 (0.5 × 10^5 CFU/mL). At 0 HAP, the Beejamrutham obtained from C_5 recorded higher fungal population i.e. 9.00 × 10^5 CFU/mL, followed by C_4 (6 × 10^5 CFU/mL), C_1 (3 × 10^5 CFU/mL), C_3 (1.50× 10^5 CFU/mL) and C_6 (1.50× 10^5 CFU/mL). At 12 HAP, higher fungal population was recorded in C_7 (7 × 10^5 CFU/mL) followed by C_8 (5 × 10^5 CFU/mL) and C_9 (1 × 10^5 CFU/mL). At 24 HAP interval Beejamrutham obtained from C_2 recorded higher fungal population. The decline in fungal population might due to the addition of lime which might have resulted in increase in pH of the formulation and it is well documented that there is a sharp decline in fungal population with increase in pH and fungi thrived well under acidic condition and their population decreased as the pH increase.

There was increase in actinomycetes population from 0 HAP (50× 10^5 CFU/mL) to 12 HAP (57.40 × 10^5 CFU/mL) and further it declined from 12 HAP to 48 HAP (17.68 × 10^5 CFU/mL) and showed lowest population 48 HAP. The highest population was recorded in Beejamrutham obtained from C_6 (91.20 × 10^5 CFU/mL) followed by C_5 (87.50 × 10^5 CFU/mL) and these counts were significantly not differed from each other. These were followed by C_4 (64.10 × 10^5 CFU/mL), C_3 (47 × 10^5 CFU/mL), C_{10} (26.90× 10^5 CFU/mL). Beejamrutham obtained from C_1 (18.35 × 10^5 CFU/mL), C_8 (17.70 × 10^5 CFU/mL) and C_7 (16 × 10^5 CFU/mL) followed C_{10} and these were on par with each other. The lowest population was recorded in C_2 (10.60 × 10^5 CFU/mL) followed by C_9 (11.20 × 10^6 CFU/mL) and actinomycetes population obtained from C_9 and C_2 were on par with each other.

Conclusion

The data obtained on microbial population in Beejamrutham at different interval of storage indicates that the maximum microbial load was recorded in Beejamrutham in between 0 HAP to 24 HAP and this result is in accordance with the result obtained by Devakumar *et al.* (2014). Beejamrutham obtained from different cows also indicates that the C_5 (Jersey breed) recorded maximum microbial load as compared to the other cowdung obtained from desi cows. This may be attributed to the maximum microbial load present in the cow dung of Jersey breed which can be attributed to the composition of feed and fodder and types of cattle breed.

References

Boraiah B, N Devakumar, S Shubha and KB Palanna. 2017. Effect of Panchagavya, Jeevamrutha and cow urine on beneficial microorganisms and yield of capsicum (*Capsicum annuum* L. var. grossum). International Journal of Current Microbiology and Applied Science, 6(9): 3226-3234.

Devakumar N, S Shubha, SB Gowder and GGE Rao. 2014. Microbial analytical studies of traditional organic preparations Beejamrutha and Jeevamrutha. Building organic bridges. 2: 639-642.

Sreenivasa MN, N Naik and SN Bhat. 2010. Beneficial traits of microbial isolates of organic liquid manures. Plant Growth Promotion by Rhizobacteria for Sustaianble Agriculture, 10: 223.

Van Faassen HG and H Van Dijk. 1987. Manure as a source of nitrogen and phosphorus in soils. Animal Manure on Grassland and Fodder Crops. Fertilizer or Waste Springer Dordrecht. 27-45.

ICSCI 2022/T3/30

Productivity, Profitability and Energetics of Direct Seeded Rice under Different Establishment Methods

Ashok Kumar Singh[1], Ekhlaque Ahmad[2], C. S Singh[1], A.K. Singh[1], Jaya Bharti[1] and O. N Singh[2,3]

[1 & 2] Scientist cum Assistant Professor, [3]Vice Chancellor

[1]Department of Agronomy; [2] Department of Genetics and Plant Breeding, Birsa Agricultural University, Ranchi, Jharkhand-834006, India

E mail: aksinghbau65@gmail.com

Introduction

Rice is primarily grown by transplanting of seedling in puddled field in India which is very cumbersome and labour intensive. Both raising nursery and transplanting in Jharkhand are monsoon dependent, which is extremely erratic in onset, distribution, intensity and cessation. Many times seedlings overgrow in nursery waiting for adequate rains to perform puddling operations. Delayed transplanting with over good aged seedlings, starts flowering soon after planting that results in drastic reduction in grain yield. Sometimes it becomes difficult to raise nursery due to very delayed and erratic monsoon. Often, farmers fail to transplant the seedlings in time either due to prolonged dry spell or intense rainfall resulting lower yields. So, there is need to search for suitable crop establishment methods top overcome these problems.

Methodology

An investigation on "Productivity, profitability and energetics of direct seeded rice under different establishment methods" was conducted at rice agronomical farm of agronomical farm of Birsa Agricultural University, Ranchi, Jharkhand during *Kharif* seasons of 2016 and 2017 with objectives to find out the effect of establishment methods on productivity, energetics and economics under direct seeded rice. The treatments comprised of six different rice establishment methods-dry direct seeded rice (20 cm x 15 cm), dry direct seeded rice (broadcasting), aerobic rice and semi dry rice, Rice (line sowing) + *Sesbania aculeata* (broadcasting) and transplanted rice. The experiment was laid out in randomized block design with four replications and the rice variety used was Naveen. The soil was clay loam in textures and slightly acidic (5.9) in reaction, low in organic carbon (3.9) and available nitrogen (206 kg/ha), whereas medium in available phosphorus (31.35 kg/ha) and potassium (186.06 kg/ha).

Results

Results revealed that among the various establishment methods, rice + *Sesbania aculeata* produced maximum grain yield (5.03 t/ha) being on par with transplanting method (4.92 t/ha) having 39.41, 25.12, 20.33 and 19.19% higher than dry direct seeded rice broadcasting, line sowing (20cm x 15cm), aerobic rice and semi dry rice, respectively. In line with the above-said facts, the experimental findings are also in agreement with those of Mohanty *et al.* 2014.

Table: Grain yield, economics and energetics of rice as influenced by establishment methods

Treatment	Grain Yield (t/ha)	Net return (Rs/ha)	B:C	Gross energy output (MJ/ha x1000)		Specific energy (MJ/t grain)
				Grain	Biomass	
T1 Dry direct seeded rice (20cm x 15cm)	4.02	43719	1.68	59.09	140.35	2199.11
T2 Dry direct seeded rice (broadcasting)	3.61	39733	1.73	53.03	127.28	2397.77
T3 Aerobic rice	4.18	43458	1.53	61.44	142.47	2341.66
T4 Semi dry rice	4.22	46442	1.79	62.03	142.68	2104.09
T5 Rice (line sowing)+ *Sesbania aculeata* (broadcasting)	5.03	57991	2.08	73.94	167.47	1894.86
T6 Transplanted rice (puddle system)	4.92	54630	1.84	72.32	165.35	1962.02
CD (P=0.05)	0.59	8377	0.31	8.73	13.61	297.49

The gross biomass energy output was maximum with rRice + *Sesbania aculeata* (167.47 x 10^3 MJ/ha) followed by transplanting method (165.35 x 10^3 MJ/ha) and specific energy of Rice + *Sesbania aculeata* was lowest *i.e.* 1894.86 MJ/t followed by transplanting method (1962.02 MJ/t). The higher energy use efficiency under transplanted rice + *Sesbania aculeata* treatments was mainly attributed to higher energy production with relatively lesser energy requirement (Jha *et al.* 2011). The net return (Rs.57991/ha) and B:C ratio (2.08) of Rice + *Sesbania aculeata* comparable with transplanting but 45.9, 33.47, 32.6 and 24.86% higher than dry direct seeded rice broadcasting, aerobic rice, line sowing (20 cm x 15 cm) and semi dry rice, respectively. This confirms the findings of Jha *et al.* (2011).

Conclusion

On the basis of two years' experimentation it may be concluded that Rice (line sowing) + *Sesbania aculaeta* (broadcasting) may be practiced for higher productivity and profitability and energy return in chotanagpur plateau region of Jharkhand.

References

Jha AK, ML Kewat, VB Upadhyay and SK Vishwakarma. 2011. Effect of tillage and sowing methods on productivity, economics and energetic of rice (*Oryza sativa* L.)- wheat (*Triticum aestivum*) cropping system. Indian Journal of Agronomy, 56(1): 35-40.

Mohanty, Tushar Ranjan, Maity, Swapan Kumar, Roul, Pravat Kumar and Sahoo Kishore Chandra. 2014. Studies on yield, economics and energetics of rice (*Oryza sativa* L.) in relation to crop establishment methods and nutrient management practices. International Journal of Bio-resource and Stress Management, 5(4): 495-501.

ICSCI 2022/T3/31

Eco- friendly sustainable weed management practices in organic paddy cultivation

B. Sandhya Rani, G. Karuna Sagar and A. Suryakala
Department of Agronomy, S.V. Agricultural College, Tirupati - 517 502, Andhra Pradesh, India
Acharya N G Ranga Agricultual University, Guntur
*Corresponding Author E-mail: sandhya.reddy010@gmail.com

Rice is one of the major crops that receives higher quantity of fertilizers and pesticides. The rampant use of chemical and fertilizers contributes largely to the deterioration of the environment and soil fertility which has adverse impact on agricultural productivity and soil degradation. The average productivity of rice is 1.44 t/ha, which is low due to use of local varieties, weed competition, erratic and uneven distribution of monsoon rain with frequent prolonged dry period. Adoption of ecological and sustainable farming practices can only reverse the declining trend in the global productivity and environment protection. Organic farming is a production system that avoids the use of synthetic chemical fertilizer, pesticides and growth regulating hormones and raises the rice with the use of organic manures, bio-fertilizers, oil cake, crop rotation, legumes, cover crops, biologically based bio- fertilizers, green manure, brown manuring, mulches and biological pest control. Weeds become most limiting factor in organic farming. None of the cultural practices were found effective to reduce the weeds in rice under organic production system and grain yield of rice is reduced by 57 to 61% due to weed competition. Organic weed control encourages weed suppression rather than elimination. Some cultural practices like intercropping of sesbania in rice, close row spacing or high seed rate, stale seed bed, mulching by crop residues or tree leaves, hand weeding and hoeing are found effective to reduce the weeds under organic rice production system. Preventive measures like sowing of clean seed is one of the most important weed management techniques. Usually, hand weeding was practiced two or three times for growing a rice crop depending upon the nature of weeds, their intensity and the method of rice establishment. Any practices aimed at enhancing competitive availability of the crop and weed can bring down the adverse effect of weeds on rice crop. Cultivation of rice at narrow/close row spacing has been found effective to reduce the weed growth and increase the rice yield as compared to wider row spaced rice crop. Aqueous extracts of rice bran could suppress the germination and early growth of some paddy weeds during the initial stages. Both crop and weed species respond to increases in soil fertility. Initial dose of nitrogen application may be delayed to reduce weed growth and nitrogen application should be done after effective weed control and under appropriate soil moisture condition.

ICSCI 2022/T3/32

Extreme temperature and rainfall events trend over Kerala

S Vijayakumar*, R Mahender Kumar, R M Sundaram
ICAR-Indian Institute of Rice Research, Hyderabad, Telangana, 500030, India
E-mail: vijitnau@gmail.com; vijayakumar.s@icar.gov.in

Introduction

The regional level studies are vital to identify the existence, magnitude and statistical significance of different types of extreme weather events and to understand the regional-level climate change (Vijayakumar et al., 2021). As a result, research on changing extreme weather events is gradually becoming one of the hottest topics in climate change research.

Methodology

A computation study was carried out with the objective to assess the trend in the temperature extremes over Thiruvananthapuram and Kottayam district of Kerala state during the period 1975-2020 using ETCCDI indices through RClimDex software and statistical significance is estimated using Mann–Kendall (MK) non-parametric test and linear regression.

Results

In Kottayam, the annual mean maximum temperature (mean T_{max}), Warm days (TX90p), Warm spell duration indicator (WSDI), diurnal temperature range (DTR), and maximum of maximum temperature (TXx) increased by 0.019 °C, 0.41 days, 0.404 days, 0.023 days and 0.034 °C, respectively. Similarly, in Thiruvananthapuram district, the annual mean maximum temperature (mean T_{max}), annual mean minimum temperature (meanT_{min}), warm nights (TN90p), warm days (TX90p), warm spell duration indicator (WSDI), diurnal temperature range (DTR), maximum of maximum temperature (TXx) minimum of maximum temperature (TXn) and maximum of minimum temperature (TNx) increased by 0.037 °C, 0.018 °C, 0.544 days, 0.545 days, 0.405 days, 0.018 °C, 0.037 °C, 0.019 °C and 0.022°C, respectively while cool nights (TN10p) and cool days (TX10p) were decreased by -0.168 days and -0.355 days, respectively. In Thiruvananthapuram districts, 9 warming indices showed a strong positive trend and 2 cooling indices showed a strong negative trend. Similarly, in Kottayam district, 5 warming indices showed a strong positive trend and 1 cooling index showed a strong negative trend. It shows that the warming and occurrence of temperature related extreme weather events are more in Thiruvananthapuram in comparison to Kottayam district as many indices show significant change. In Thiruvananthapuram district, the warming is due to increase in both maximum and minimum temperature while in Kottayam district it is only due to increasing maximum temperature, not minimum temperature.

Out of 9 rainfall related indices studied, only two indices showed a significant decreasing trend in Kottayam and no index showed a significant trend in Thiruvananthapuram. The weak and non-significant trend reveals the change in total precipitation its distribution is less in both the districts and also the occurrence of rainfall related extreme events were very less. The simple daily intensity index (SDII) and consecutive dry days (CDD) showed a significant decreasing trend in Kottayam. The non-significant increasing rainy days (R2.5) and decreasing CDD reveal better distribution of rainfall in both the district although total precipitation found decreasing in Kottayam and increasing in Thiruvananthapura districts.

Conclusion

Based on the trend of various extreme weather events, it is anticipated that the extreme temperature events will occur more frequently while rainfall associate extreme events are less likely to occur in both the study areas.

Reference

Vijayakumar S, AK Nayak, AP Ramaraj, CK Swain, V Geethalakshmi, V Pazhanivelan, Rahul Tripathi and NS Sudarmanian. 2021. Rainfall and temperature projections and their impact assessment using CMIP5 models under different RCP scenarios for the eastern coastal region of India. Current Science, 121(2): 222-232.

ICSCI 2022/T3/33

Efficacy and response of liquid bio-fertilizers in rice

Manukonda Srinivas, D. Mounika, B. Anusha, K.M.D. Murthy and G. Jogi Naidu
Acharya N.G. Ranga Agricultural University, Regional Agricultural Research Station, MARUTERU, West Godavari District - 534 122, Andhra Pradesh, India.
Email: manukonda.s@angrau.ac.in

Introduction

Agriculture is the backbone of Indian economy and accounted for 30% to GDP and 50-70% employment. Per capita land holding in India is 0.33 ha that is lesser than other nations. Our traditional farming is not able to feed country and hence need some improvements in it. Green revolution has drastically increased food production but harmed the soil too. It needs advance technology to sustain yield without soil health deterioration so as to pass on it to our future generations. In India, rice is cultivated over 45.07 m ha producing 122.27 m t rice at an average productivity of 2713 kg/ha (DES, 2021). In Andhra Pradesh, rice is grown on 2.3 m ha with a production of 13.0 m t at a productivity of 5.8 t/ha (Anonymous, 2020) and Godavari delta is the rice bowl of Andhra Pradesh. Indiscriminate use of chemical fertilizers increases the pest and disease load besides yield and soil health reduction. Biofertilizers have ability to mobilize nutritionally important elements from non-usable to usable form. With this background field experiment was conducted to study the effect of liquid biofertilizer on *rabi* rice under deltaic alluvial soils of Andhra Pradesh.

Methodology

A field experiment was conducted at Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Maruteru, Andhra Pradesh during *rabi* 2020-21 season to find out the optimum dose and best combination of liquid biofertilizers for *rabi* rice cultivation under deltaic alluvial soils. The experiment was conducted with short duration *rabi* rice variety MTU 1121 in a Randomized Block Design with eight treatments (Table 1) and three replications. Combination and application of liquid bio fertilizers were done as per the treatment details based on using the calculations developed for Krishna Godavari Agro Ecological Region of Andhra Pradesh. The experimental soil was clay loam in texture, slightly alkaline in reaction, non-saline, low in available nitrogen, low in organic carbon, medium available phosphorus and high potassium.

Results

Maximum number of tillers m^{-2} and number of panicles m^{-2} were recorded with 100% RDF + liquid bio fertilizers for N, P & K (*Azospirillum*, PSB & KSB) application. Whereas, panicle length, panicle weight and grains/panicle were maximum with application of 75% RDF + liquid bio fertilizers for N & K (*Azospirillum*& KSB) which were statistically superior over control and other treatment combinations (Sarkar *et al.*, 2014). Grain yield of *rabi* rice was significantly higher with application of 100% RDF along with liquid bio fertilizers for N, P & K (*Azospirillum*, PSB & KSB) which was statistically at par with 75% RDF + liquid bio fertilizers for N, P& K (*Azospirillum*, PSB & KSB), 100% RDF and soil test-based fertilizer application compared to the rest of the treatments. Straw yield also followed the similar trend but at par with only 75% RDF + liquid bio fertilizers for N, P& K (*Azospirillum*, PSB & KSB) application. Harvest index recorded was higher with 75% RDF + liquid bio fertilizers for N & K (*Azospirillum* & KSB) application (Md. Zahurul Islam *et al*., 2012). The results of the study clearly indicated that application of liquid biofertilizers of N, P & K (*Azospirillum*, PSB & KSB) in combination with 75% RDF is better option for 100% RDF and soil test-based fertilization in view of soil health and yield perspective.

Table.1 Growth, yield attributes and yields of rice under liquid biofertilizers trial during *Rabi*, 2020-21

Treatment	Plant Height (cm)	No. of Tillers /m²	No. of Panicles /m²	Panicle Length (cm)	Test Weight (g)	No. of grains/ panicle	Panicle weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest Index (%)
Control	115.2	329	257	24.9	18.9	219	2.67	6407	9233	40.97
100% RDF	113.7	367	283	23.7	20.2	217	2.37	7947	10740	42.53
75% RDF + liquid bio fertilizers for N, P & K (*Azospirillum*, PSB & KSB)	113.4	336	302	24.1	22.0	214	2.90	8370	11567	41.98
75% RDF + liquid bio fertilizers for N & P (*Azospirillum* & PSB)	114.7	366	291	24.9	21.2	233	3.43	6743	8997	42.84
75% RDF + liquid bio fertilizers for N & K (*Azospirillum* & KSB)	115.8	402	323	26.5	21.5	255	4.50	7537	9503	44.23
75% RDF + liquid bio fertilizers for P & K (PSB & KSB)	116.1	388	323	25.5	21.6	212	4.00	7233	9473	43.30
100% RDF + liquid bio fertilizers for N, P & K (*Azospirillum*, PSB & KSB)	115.7	432	363	24.3	21.5	211	3.97	8512	12020	41.46
Soil Test Based Fertilizer application	111.3	364	284	24.7	22.2	222	4.23	7657	9873	43.68
CD (P=0.05)	NS	29	52	0.37	1.05	21	0.39	1185	1192	NS

Conclusion

Based on the results of this study, it is clearly show that even with reduction of 25% RDF along with all major nutrients N, P & K liquid biofertilizers (8370 kg/ha) or either N & K liquid bio-fertilizers (7537 kg/ha), rice can yield on par with 100% RDF with or without liquid biofertilizers. But either without K or without N, the reduction in the yields by 19.44% and 13.58%, respectively during *rabi* in rice cultivation under deltaic soils.

References

Anonymous. 2020. Agricultural Statistics at a Glance: Andhra Pradesh: 2019-20, Govt. of Andhra Pradesh, Ministry of Agriculture, Department of Agriculture and Cooperation, Directorate of Economics and Statistics, Amaravathi.

DES (Directorate of Economics and Statistics). 2021. Pocket Book of Agricultural Statistics 2021. Department of Agriculture, Cooperation and Farmers welfare, Ministry of Agriculture & Farmers Welfare, Govt. of India. Available at http://eands.dacnet.nic.in/

Zahurul Islam MD, MA Sattar, M Ashrafuzzaman, Halimi Mohd Saud and MK Uddin. 2012. Improvement of yield potential of rice through combined application of biofertilizer and chemical nitrogen. African Journal of Microbiology Research, 6(4): 745-750.

Sarkar S, M Mandal and DK Das. 2014. Effect of integrated application of green manure and biofertilizers on soil fertility in rice-pea cropping system. Environment and Ecology, 32(3): 1010-1015.

ICSCI 2022/T3/34

Prediction of heterosis by correlating the morphological and molecular divergence with standard heterosis for grain yield and other yield contributing traits in parental lines of rice hybrids

Pavani M, Sundaram R M, Ramesha M S, Kavi Kishore P B, A S Hari Prasad, Sruthi K, Senguttuvel P, Revathi P, Koteswar Rao P, Gireesh C, Anantha M S, Abdul Fiyaz R and Kemparaju K B

Indian Institute of Rice Research, Rajendranagar, Hyderabad

Email: kbkemparaju@gmail.com

Introduction

Prediction of heterosis is very much important in hybrid breeding since evaluating of individual cross combinations is very laborious and time consuming at field.

Methodology

The present investigation in rice was undertaken to study the extent of genetic divergence among the breeding lines through morphological traits and marker assisted selection and to correlate the molecular divergence with the standard heterosis to predict heterosis. Estimation of heterosis in F_1's, by using Line x Tester mating design are the other aspects of the study.

Results

In the present study, prediction of heterosis was done by correlating the CMP (coefficient of marker polymorphism) and standard heterosis among the generated F_1 hybrids. The CMP value ranged from 0.40 to 0.80 for all the 40 hybrids studied using EST derived SSR markers and higher CMP value (0.80) is obtained for the parental combinations APMS6A x RPHR1005 and PUSA5A x EPLT109, while low CMP value (0.40**)** obtained for the parental combination PUSA5A x RPHR1004. In the same way the standard heterosis value for the quantitative trait grain yield per plant over the commercial hybrid KRH2, for all the forty F_1 hybrids ranged from **-**38.32 percent (PUSA5A x RPHR1004) to 8.4 percent (APMS6A x RPHR1005). The values of correlation between CMP and standard heterosis for grain yield and other yield contributing traits for parental combinations contributing hybrids revealed positive and significant correlation for the characters, grain yield per plant (r = 0.58**), productivity per day (r = 0.54**), productive tillers (r = 0.34*) and panicle weight (r = 0.42**).

Conclusion

Therefore, the present investigation revealed the relationship of molecular marker heterogygosity with hybrid performance in rice, with the grouping based on molecular characterization which helps to identify heterotic patterns for hybrid rice breeding.

References

Rahimi, M., Rabiei, B., Samizadeh, H. and Kafi G.A., 2010. Combining ability and heterosis in rice (*Oryza sativa* L.) cultivars.

Xiao, Jinhua, Jiming Li, Longping Yuan, and Steven D. Tanksley. "Dominance is the major genetic basis of heterosis in rice as revealed by QTL analysis using molecular markers." *Genetics* 140, no. 2 (1995): 745-754

ICSCI 2022/T3/35

Exogenous application of osmoprotectants for improving crop physiological, biochemical parameters, seed yield and quality of rice under heat stress

S. Das[1*], S. Mohanty[2] G. B. N. Jyothi[3] and J. K. Beura
Department of Seed Science and Technology, College of Agriculture, OUAT, Bhubaneswar
E-mail: sumitadas.sst@gmail.com

Introduction

Climate change is harshly affecting cereal production all over the world through increased temperature and CO_2 concentration, which is one of the main causes of heat stress. Rice is the second most important cereal crop in the world, after maize. It is estimated that there will be a need for increasing the food production by about 30-40% in the next 30 years, so as to feed the ever-increasing world population. The changing climate scenario is making it increasingly difficult, if not impossible, to achieve this goal. Though high temperature and other abiotic stresses are limiting factors for future crop production goals, crop productivity many a times also suffers from random environmental fluctuation.

Environmental stresses lead to generation of reactive oxygen species (ROS) in plants. Heat stress can induce oxidative stress along with tissue dehydration. Reduction in yield of rice facing high temperature stress due to drier and warmer climate or late sowing can be minimised by exogenous foliar spray of some osmoprotectants. Common osmoprotectants include Glycine betaine, Salicylic acid, Ascorbic acid, Citric acid, α-Tocopherol, Potassium chloride, Brassinolides, etc. Keeping in mind the above problem relating to rice production under high temperature stress, an investigation was undertaken to study the efficiency of some osmoprotectants in improving crop physiological, biochemical parameters and seed yield of rice.

Methodology

The field experiment was conducted during summer season of 2016-17 and 2017-18 in the Department of Seed Science and Technology, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar, to study the role of some osmoprotectants on crop physiology and seed yield of rice grown under heat stress. Rice variety Naveen (120 days' duration) was chosen for the experiment. The field experiment was laid out in Split Plot Design, with three replications, the main plot factor being date of sowing (D_1 – 30th November, D_2 – 15th December and D_3 – 30th December) and the sub-plot factor being foliar spray of chemicals at vegetative and seed filling stage (9 treatments). The foliar sprays included Glycine betaine 600 ppm (T_1), Salicylic acid 400 ppm (T_2), Salicylic acid 800 ppm (T_3), Ascorbic acid 10 ppm + Citric acid 1.3% (T_4), α-Tocopherol 150 ppm (T_5), KCl 1% (T_6), Brassinolides 5 ppm (T_7) and Brassinolides 10 ppm (T_8). An untreated Control (T_0) was also taken in which equal volume of water was sprayed

Results

Observations on various crop physiological and yield attributing parameters as well as seed yield and quality were taken and the pooled analysis values have been presented in Tables 1 to 10. Foliar application of osmoprotectants showed positive effects in mitigating high temperature stress. The possible mechanisms of positive effects of osmoprotectants are discussed hereunder. With delay in sowing time, there was considerable decrease in the SOD and POD activity of the leaves. Spray of KCl 1% (T_6)

recorded significantly higher SOD activity, followed by Ascorbic acid 10 ppm + Citric acid 1.3% (T_4) at both the stages of observation. The treatments T_4, T_6 and T_8 recorded highest increment in SOD activity of leaves during vegetative and seed filling stages. During vegetative and seed filling stage, maximum POD activity was recorded from spray treatment with Ascorbic acid 10 ppm + Citric acid 1.3% (T_4) followed by Brassinolides 10 ppm (T_8). The treatments T_1, T_4 and T_8 recorded highest increment in POD activity of leaves during vegetative and seed filling stages. Ascorbic acid (Vitamin C) is water soluble and acts as a modulator of plant development through hormone signalling and as coenzyme in reactions by which carbohydrates and proteins are metabolized. They catch the free radicals or the ROS produced during altered photosynthesis and respiration process under heat stress. They also regulate photosynthesis flowering and senescence (Barth *et al*., 2006) under elevated temperature.

Table 1: Leaf superoxide dismutase (SOD) activity during vegetative stage of summer rice grown under heat stress as influenced by spray of osmoprotectants

Treatment	Leaf SOD activity (units/mg of soluble protein/min) during vegetative stage							
	Before spray				Two days after spray			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
T_0 : Control	7.21	6.84	6.08	6.71	7.22	6.86	6.08	6.72
T_1 : GB 600	7.27	6.91	6.24	6.80	7.30	6.95	6.28	6.84
T_2 : SA 400	7.29	6.95	6.16	6.80	7.34	7.00	6.21	6.85
T_3 : SA 800	7.23	6.87	6.13	6.74	7.28	6.92	6.17	6.79
T_4 : AA + CA	7.33	6.98	6.33	6.88	7.40	7.05	6.41	6.95
T_5 : α-T	7.31	6.97	6.28	6.85	7.33	7.01	6.32	6.88
T_6 : KCl	7.36	7.10	6.37	6.91	7.44	7.08	6.46	6.99
T_7 : Br 5	7.24	6.86	6.10	6.73	7.29	6.91	6.15	6.78
T_8 : Br 10	7.26	6.89	6.19	6.78	7.33	6.95	6.25	6.84
Mean	7.28	6.92	6.21	6.80	7.32	6.97	6.26	6.85
	D	T	D within T	T within D	D	T	D within T	T within D
CD (P=0.05)	0.02	0.03	0.95	0.04	0.01	0.02	0.94	0.02

Table 2: Leaf superoxide dismutase (SOD) activity during seed filling stage of summer rice grown under heat stress as influenced by spray of osmoprotectants

Treatment	Leaf SOD activity (units/mg of soluble protein/min) during seed filling stage							
	Before spray				Two days after spray			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
T_0 : Control	7.10	6.75	6.05	6.63	7.11	6.77	6.07	6.65
T_1 : GB 600	7.15	6.82	6.16	6.71	7.18	6.86	6.20	6.74
T_2 : SA 400	7.18	6.84	6.12	6.71	7.22	6.89	6.17	6.76
T_3 : SA 800	7.12	6.80	6.10	6.67	7.16	6.84	6.14	6.71
T_4 : AA + CA	7.24	6.91	6.25	6.80	7.30	6.98	6.32	6.87
T_5 : α-T	7.15	6.83	6.19	6.72	7.17	6.85	6.22	6.75
T_6 : KCl	7.26	6.92	6.30	6.82	7.34	7.10	6.38	6.90
T_7 : Br 5	7.16	6.82	6.12	6.70	7.20	6.88	6.18	6.75
T_8 : Br 10	7.18	6.84	6.17	6.73	7.24	6.90	6.23	6.79
Mean	7.17	6.83	6.16	6.72	7.21	6.88	6.21	6.77
	D	T	D within T	T within D	D	T	D within T	T within D
CD (P=0.05)	0.02	0.02	0.98	0.03	0.01	0.02	0.95	0.02

Table 3: Leaf peroxidase activity during vegetative stage of summer rice grown under heat stress as influenced by spray of osmoprotectants

Treatment	Leaf peroxidase activity (units/mg of soluble protein/min) during vegetative stage							
	Before spray				Two days after spray			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean

T_0 : Control	19.99	19.63	19.09	19.57	20.00	19.65	19.12	19.59
T_1 : GB 600	20.11	19.73	19.22	19.68	20.24	19.87	19.38	19.83
T_2 : SA 400	20.04	19.67	19.16	19.62	20.13	19.77	19.28	19.72
T_3 : SA 800	20.00	19.65	19.13	19.59	20.06	19.72	19.22	19.66
T_4 : AA + CA	20.16	19.80	19.31	19.76	20.33	19.99	19.50	19.94
T_5 : α-T	20.01	19.70	19.23	19.65	20.08	19.78	19.33	19.73
T_6 : KCl	20.07	19.74	19.25	19.69	20.17	19.85	19.38	19.80
T_7 : Br 5	20.10	19.72	19.24	19.68	20.20	19.84	19.39	19.81
T_8 : Br 10	20.13	19.76	19.24	19.71	20.29	19.92	19.42	19.88
Mean	20.07	19.71	19.21	19.66	20.17	19.82	19.33	19.77
	D	T	D within T	T within D	D	T	D within T	T within D
CD (P=0.05)	0.02	0.02	0.96	0.03	0.01	0.02	0.95	0.02

Table 4: Leaf peroxidase activity during seed filling stage of summer rice grown under heat stress as influenced by spray of osmoprotectants

Treatment	Leaf peroxidase activity (units/mg of soluble protein/min) during seed filling stage							
	Before spray				Two days after spray			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
T_0 : Control	19.90	19.58	19.03	19.50	19.91	19.60	19.06	19.52
T_1 : GB 600	20.08	19.72	19.20	19.66	20.23	19.87	19.36	19.82
T_2 : SA 400	20.00	19.66	19.14	19.60	20.10	19.78	19.27	19.72
T_3 : SA 800	19.95	19.62	19.12	19.56	20.01	19.71	19.22	19.65
T_4 : AA + CA	20.13	19.80	19.26	19.73	20.31	19.98	19.45	19.91
T_5 : α-T	19.97	19.64	19.12	19.58	20.06	19.73	19.23	19.67
T_6 : KCl	20.02	19.67	19.17	19.62	20.14	19.81	19.31	19.75
T_7 : Br 5	20.05	19.70	19.18	19.64	20.19	19.85	19.33	19.79
T_8 : Br 10	20.11	19.75	19.22	19.69	20.27	19.92	19.39	19.86
Mean	20.02	19.68	19.16	19.62	20.13	19.80	19.29	19.74
	D	T	D within T	T within D	D	T	D within T	T within D
CD (P=0.05)	0.02	0.02	NS	NS	0.01	0.02	0.95	0.02

Ascorbic acid-sprayed plants can postpone the leaf senescence by peroxide/phenolic/ascorbate system which is involved in scavenging the ROS produced during leaf senescence (El-Aziz *et al*., 2009). Ascobin (compound composed of ascorbic acid and citric acid) as one of exogenous protectants which could partially alleviate the harmful effect of certain abiotic stresses like heat, salinity, etc. (Sadak *et al*., 2015).

Conclusion

From the investigation, it can be concluded that rice seed production is adversely affected under heat stress leading to lower seed yield. High temperatures, especially during panicle development, anthesis and seed set, adversely affect crop physiological parameters and yield attributing parameters, causing drastic reduction in seed yield of summer rice. In case of late sowing of the crop in summer and if the variety is a heat susceptible one, spray of certain chemicals such as Salicylic acid 400 ppm, Salicylic acid 800 ppm, Brassinolides 10 ppm or Ascorbic acid 10 ppm + Citric acid 1.3% at vegetative and seed filling stages can be effective in mitigating the effects of heat stress on crop physiological parameters, yield attributing parameters, seed yield and quality to a considerable extent.

References

Barth C, M Tullio and PL Conklin. 2006. The role of ascorbic acid in the control of flowering time and the onset of senescence. Journal of Experimental Botany, 57: 1657−1666.

El-Aziz A, G Nahed and MM Kandil. 2009. Some studies on the effect of ascorbic acid and α–tocopherol on the growth and some chemical composition of Hibiscus rosasinenses L. At Nubaria. Ozean Journal of Applied Science, 2(2): 315-326.

Sadak MS and SA Orabi. 2015. Improving thermo tolerance of wheat plant by foliar application of citric acid or oxalic acid. International Journal of ChemTech Research, 8(1): 333-345.

ICSCI 2022/T3/36

Biochar: A sustainable technique for water conservation and water productivity enhancement in brinjal

Mini Abraham[1] Bhindhu P. S.[2] Anitha S.[3] and Mariya Dainy M. S.[4]

Professor and Head, Agronomic Research Station, Chalakudy, Kerala Agricultural University, Thrissur, Kerala, 680307, India.

Professor, Kerala Agricultural University, Vellanikkara, Thrissur, Kerala,680654, India.

Associate Professor (Soil Science and Agricultural Chemistry), Krishi Vigyan Kendra, Kottayam, Kerala Agricultural University, Thrissur, Kerala, 686563, India.

Assistant Professor (Soil Science and Agricultural Chemistry), Agronomic Research Station, Chalakudy, Kerala Agricultural University, Thrissur, Kerala, 680307, India

E-mail: mariya.dainy@kau.in

Introduction

Conversion of crop residue biomass into biochar and using the char as a soil amendment is a nascent approach. Biochar is a fine-grained, carbon-rich, porous product obtained when organic biomass is heated under limited or without oxygen conditions. Biochar is commonly alkaline, and thus can be used as a soil amendment to neutralize soil acidity and increase soil pH. Beneficial properties of biochar like high carbon content, alkaline pH and high water and nutrient holding capacity could be utilized for water conservation and to minimize the problems associated with fertigation. The most efficient management to conserve water and nutrient is fertigation. Most important problem noticed in fertigation is high acidity in the root zone leading to nutrient imbalances. Taking all these into account the present study was conducted.

Methodology

Biochar was prepared by drum method using crop residues available at the farm after the harvest of previous crop. Biochar was characterized for physical and chemical properties. Field experiments were done for three years. Brinjal variety Haritha was planted at a spacing of 60 cm x 45 cm distance during the summer season. Manures and fertilizers were given as fertigation as per package of practices recommendation once in a week. Quantity of water used for irrigation was 2 liter water per plant per day as per the treatments. Soil amendments such as biochar 2 t ha^{-1}, 4 t ha^{-1} and lime-based on soil test value (350 kg ha^{-1}) were applied in the field before planting.

Results

Application of drip irrigation at a frequency of once in two days along with the application of biochar at 4 t ha^{-1} could improve the yield of crops, enhance the water productivity and nutrient use efficiency (NUE) significantly. The treatment combination resulted in higher net return and B:C ratio. Application of biochar (4 t ha^{-1}) as soil amendment resulted in the increase of brinjal yield by 12% and the yield of brinjal ratoon crop by 25% when compared to application of lime. Slavich *et al.* (2013) reported that feedlot manure biochar @ 10 t ha^{-1} increased total pasture productivity by 11 per cent and improved the agronomic nitrogen use efficiency by 23 per cent in acidic ferralsols.

Table 1. Effect of irrigation frequency and soil amendments on water productivity, nutrient use efficiency and economics of Brinjal

Treatment	WP (kg m^{-3})	NUE	BCR	Yield (t ha^{-1})	Moisture content in soil (%)
Irrigation frequency (I)					
Drip irrigation – Daily	0.76	46.05	2.09	3.98	9.71
Drip irrigation -Once in 2 days	2.15	37.52	1.71	3.25	7.96
Drip irrigation -Once in 3 days	2.19	26.24	1.29	2.27	7.59
CD (P=0.05)	0.25	4.79	0.22	0.41	NS
Soil amendment (A)					
Biochar - 2t /ha	1.49	32.41	1.47	2.80	6.96
Biochar - 4t ha	1.99	41.88	1.95	3.62	9.12
Lime-based on soil test	1.61	35.53	1.68	3.07	9.18
CD (P=0.05)	0.25	4.79	0.22	0.41	1.99
Interaction					
I_1xA_1	0.71	43.40	1.91	3.75	8.34
I_1xA_2	0.80	48.40	2.21	4.19	9.31
I_1xA_3	0.76	46.36	2.14	4.01	11.45
I_2xA_1	1.61	28.11	1.25	2.43	5.53
I_2xA_2	2.77	48.52	2.23	4.20	9.70
I_2xA_3	2.06	35.94	1.67	3.11	8.63
I_3xA_1	2.14	25.71	1.24	2.22	6.99
I_3xA_2	2.39	28.73	1.41	2.49	8.34
I_3xA_3	2.02	24.29	1.23	2.10	7.44
CD (P=0.05)	0.44	8.30	0.38	0.72	3.45

Conclusion

Biochar can release water and nutrients slowly and thus improves the nutrient use efficiency. Biochar when used as soil amendment along with drip irrigation can save water and nutrients and can be considered as a technology for resource conservation. Biochar application can thus enhance water productivity and ultimately crop yield.

Reference

Slavich PG, K Sinclair, SG Morris, SWL Kimber, A Downie and L Van Zwieten. 2013. Contrasting effects of manure and green waste biochars on the properties of an acidic ferralsol and productivity of a subtropical pasture. Plant and Soil, 366: 213–2

ICSCI 2022/T3/39

Response of nitrogen levels on different rice varieties in transplanted condition

Divya Singh, R. K. Tiwari, Radha Singh and I. M. Khan
AICRIP On Rice, College of Agriculture, Rewa, J.N.K.V.V., Jabalpur.
E-mail: singh.divya.kushwah@gmail.com

The treatments comprising 2 levels of nitrogen (N1: 80 and N2: ,120 kg/ha) in main plots and 8 varieties (V1, IET - 26767 V2, IET -26477 V3, IET-24914 V4, IET-25713 V5, Sahbhagi V6, Vandana, V7 Govindand and V8 MTU1010) sub-plot layout in split-plot design, replicated 3 times. The objectives were (i) To identify the suitable rice varieties for Rewa reason of M.P. under rainfed condition, (ii) Interaction between rice varieties and nitrogen levels for higher yield under rainfed condition, (iii) To study the economics of Different treatment. The soil was low in available nitrogen, medium in phosphorus and high in available potassium. The pH of the soil was nearly neutral. A uniform dose 60 kg P_2O_5/ha through SSP and 40 kg K_2O/ha through MOP along with N as per treatment were applied in all the experimental plots. Total nitrogen was applied through urea, 50% as basal dose + 25% at tillering stage + 25% at panicle initiation. The varieties were sown on 4th July, 2015 keeping a seed rate of 50 kg/ha with row spacing of 20 cm. The total rainfall received during the crop season was 1316.84 mm. Other packages of practices rather than treatments were followed as per recommendation for transplanted rice crop.

From the experiment it was observed that Growth parameters like plant height, number of tillers/hill and leaves/plant were all affected significantly or non- significantly by the doses of nitrogen at all the stages of crop growth. The maximum values of these parameters were recorded with the highest dose of nitrogen (120 kg N/ha) at all the stages of crop growth. Furthermore, differences between any two adjoining levels of nitrogen in respect of these growth parameters were also found significant or non-significantly. The increasing levels of nitrogen reflected in increased panicles/hill, panicle length, grains/panicle, number of filled grains/panicle and test weight. Therefore, the highest level of 120 kg N/ha was registered with the maximum panicle length (21.29 cm), number of grains/panicle (132.03). The highest grain yield of 3689 kg/ha was recorded with 120 kg N/ha and it was 20.09 and 33.10% higher over the grain yield obtained with 40 kg N/ha, respectively. Application of N from 80 to 120 kg/ha with each increment of 80 kg/ha significantly increased the straw yield and highest straw yield of 7757 kg/ha was recorded with 120 kg N/ha. Harvest index varied from 31.79 to 32.24 per cent under different levels of nitrogen without significant margin. In relation to Effect of varieties The growth parameters like plant height, number of tillers/hill and leaves /plant were significantly influenced by varieties at all the growth stages. At harvest stage the varieties Vandana and Sahbhagi produced significantly highest number of tillers and leaves/plant over rest of the varieties. Significantly lowest number of tillers/hill along with dwarf plants was produced by variety IET-25713.Yield attributing characters viz. panicle length, and grains/panicle varied significantly due to varieties. Variety Vandana produced maximum number of panicles/hill (7.89), panicle length (23.91 cm), number of grains per panicle (148.29) and test weight (24.72) while variety IET-25713 attained minimum value of these yield attributing characters. Straw yield was significantly highest (7884.67 kg/ha) over rest of the varieties. IET-25713 produced the lowest straw. Economics of treatments. The variety Vandana with 80 kg N/ha gave highest gross and net return along with B:C ratio (Rs. 83754/ha Rs. 51262/ha and 2.58 respectively). From the experiment that it was concluded that The variety Vandana gave higher values of most of the growth and yield component characters and resulted in significantly highest grain yield (4039 kg/ha) in the Rewa region. Application of 120 kg N/ha produced highest growth characters: yield attributing traits and grain yield (3689 kg/ha). The combination of variety Vandana and 80 kg N/ha was found the best in respect of most of the growth and yield attributing characters along with grain yield (4026kg/ha). The net return as well as benefit cost ratio was also highest from the treatment V_6N_2 (Vandana + 120 kg N) followed by treatment V_5N_2 (Sahbhagi + 80 kg N).

ICSCI 2022/T3/40

Effect of planting techniques with integrated nutrient management on nutrient uptake of rice (*Oryza sativa* L.)

G. Naveen Kumar[3], P.K. Singh[2], R.K Naresh[3],
[1]*Department of Agronomy, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, Pin code 250110, India*

Introduction

Rice contributes about 43% of total food grain production and 55% cereal production in the country. In Uttar Pradesh, rice occupies 5.86 million ha and produces 15.54 million tonnes of rice with a productivity of 2.46 tonnes per acre. The productivity and sustainability of rice-based cropping systems are jeopardised due to fertiliser imbalances and poor crop establishment. Nitrogen management is critical for puddled rice as it is lost through leaching and denitrification. Integrated nutrient management is the most fundamental agronomic solution for increasing nitrogen use efficiency. Considering this, the current study has been undertaken to investigate the "Effect of planting techniques with integrated nutrient management on nutrient uptake of rice (*Oryza sativa* L.)" with the goal of assessing nutrient uptake (NPK) in rice in a rice-wheat cropping system influenced by different planting techniques, organic and inorganic nutrients.

Methodology

The field experiment was carried out at Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.), during the *Kharif* season 2019 in split plot design with three replications. The main factor consisted of four planting techniques (M_1-Reduced Tillage-Transplanted Rice (RT-TPR), M_2-Conventional Tillage-Transplanted Rice (CT-TPR), M_3-Furrow Irrigated Raised Beds (FIRB), M_4-Unpuddled-Transplanted Rice (UP-TPR)) and sub factor six fertility levels (S_1-Control, S_2-100% NPK Chemical fertilizer, S_3-100% N (FYM), S_4-50% NPK + 50% N (FYM), S_5-75% NPK + 25% N (FYM), S_6-100% NPK + 25% N(FYM)). At harvest, N, P, and K uptake was calculated by multiplying the nutrient content by the dry matter weight and expressed as kg ha^{-1}. All the results were then analysed statistically for drawing conclusion using standard statistical analysis tools.

Results

The highest N uptake by grain and straw (43.0 and 25.85 kg ha^{-1}) was found under the treatment M_2 (CT-TPR). The application 100% NPK + 25% N (FYM) resulted in resulted in significantly higher N uptake by grain (54.27 kg ha^{-1}), straw (31.34 kg ha^{-1}). It might be due to the fact that FYM stimulates nutrient uptake by increasing the activity of nitrogenase and nitrate reductase enzymes in the soil under favourable soil physical conditions. Similar findings were observed by Puli *et al.* (2017). Significantly higher P uptake by grain (13.45 kg ha^{-1}), straw (8.87 kg ha^{-1}) was recorded under M_2 (CT-TPR) and with fertility level S_6 (100% NPK + 25% N(FYM) i.e. 15.59 and 9.24 kg ha^{-1}. Increased K uptake by grain (18.58 kg ha^{-1}), straw (69.98 kg ha^{-1}) was found under M_2 (CT-TPR) and with S6 i.e. 21.49 and 68.99 kg ha^{-1}. Organic manures were found to reduce nutrient losses, conserve soil nutrients for the formation of organo-mineral compounds, maintain a source of nutrients for rice plants, and increase total NPK uptake. Furthermore, the positive impact of these treatments may be due to the slow and consistent availability of nutrients throughout the crop growth period. The outcomes are in close proximity to Tomar *et al*. (2018).

Table 1: Effect of planting techniques fertility levels on nutrient uptake of rice

Treatment	Nitrogen uptake (kg ha^{-1})		Phosphorus uptake (kg ha^{-1})		Potassium uptake (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw
Planting technique						
M_1 RT- TPR	35.4	19.0	10.26	5.98	13.35	55.09
M_2 CT- TPR	43.0	25.8	13.45	8.87	18.58	69.98
M_3 FIRB - TPR	36.8	19.4	11.18	6.70	14.51	57.93
M_4 Unpuddled -TPR	39.8	22.8	12.21	7.50	16.79	61.56
CD (P=0.05)	1.08	0.44	0.22	0.15	0.32	1.74
Fertility level						
S_1 Control	15.9	11.0	5.47	4.70	6.93	46.92
S_2 100% NPK Chemical fertilizer	45.9	23.7	13.34	7.82	17.84	64.31
S_3 100% N (FYM)	30.6	16.2	9.69	6.24	12.81	58.88
S_4 50% NPK + 50% N(FYM)	35.2	20.9	11.65	7.08	15.72	61.53
S_5 75% NPK + 25% N(FYM)	50.78	27.41	14.90	8.48	20.07	66.20
S_6 100% NPK + 25% N(FYM)	54.27	31.34	15.59	9.24	21.49	68.99
CD (P=0.05)	2.34	6.98	0.23	0.17	0.34	1.45

Conclusion

The results showed that integrated nutrient management that 50% from organic sources and 50% from inorganic sources is the best combination in rice-wheat cropping system to improve soil physico-chemical properties, availability and uptake of nutrients over chemical fetilizers alone.

References

Puli MR, PRK Prasad, M Jayalakshmi and BS Rao. 2017. Effect of organic and inorganic sources of nutrients on NPK uptake by rice crop at various growth periods. Research Journal of Agricultural Sciences, 8(1): 64-69.

Tomar R, NB Singh, V Singh and D Kumar. 2018. Effect of planting methods and integrated nutrient management on growth parameters, yield and economics of rice. Journal of Pharmacognacy Phytochemistry, 7(2): 520-527.

ICSCI 2022/T3/42

Comparative performance of mulches in weed control of dry direct sown rice

B. Sreedevi* J.S. Sudharani, A. Sandhyarani, M. Anathaiah, M.D. Tuti and R. Mahender kumar
Indian Institute of Rice Research, Rajendranagar, Hyderabad – 500 030, Telangana, India
E-mail: sreedevi.palakolanu@gmail.com

Introduction

In the present scenario of increasing water scarcity, dry direct seeded rice (DSR) is one of the contingent production system. Weeds are the severe constraint for widespread adoption of dry DSR. The aerobic soil dry-tillage and alternate wetting & drying conditions are conducive to the germination and growth of weeds causing grain yield losses of 50-91%. Organically certified crop production is restricted from using synthetic herbicides for weed control. In non-chemical weed management will never eliminate the weeds but only manages. The cultural and mechanical means of weed control made it difficult for conventional farmers to readily take up organic production since no herbicide use may cause a potential increase in weed population and negatively affect crop yields and profits. Limited information is available on non-chemical weed management practices and weed crop dynamics, which influence grain yield of aerobic rice. The current emphasis in agriculture is on reducing the use of pesticides including herbicides due to their adverse effects on environment. One of the alternative methods for the control of weeds is use of mulches. Organic mulches are also commonly applied to soil surface to suppress weeds, conserve soil moisture. Mulches should be part of integrated weed management programme in an agro-ecosystem. With this background a study was taken up to utilize different mulching materials to improve crop competitiveness against weeds, by reducing weed biomass, increasing grain yield and resource use efficiency.

Methodology

The experiment was conducted in *kharif* seasons of 2019 and 2020 in Randomized Block Design with three replications, with different weed management practices viz., Weed free, paddy straw mulching @5 t/ha, Maize straw mulching, Neem leaf mulching, Legume mulching, Herbicide two applications, Mechanical weeding twice, Un weeded control. The experimental field was naturally infested with weeds, such as *Echinochloa colona, Cyperus difformis, Cyperus iria, Eclipta alba,* Ammania baccifera, Paspalum spp etc.

Results

The results showed that the order of dominance of weed flora during study period was Grasses, BLW and Sedges. At 25 DAS, grasses were more in legume mulching plots, sedges and BLW were more in maize straw mulching plots. At 45 DAS, highest weed population and biomass were seen in legume mulching and maize straw mulching. At 25 DAS, paddy straw mulching resulted in lower weed population and biomass. At 45 DAS, neem leaf mulching resulted in lower weed population and biomass. Weed index was lower and weed control efficiency was higher with neem leaf mulching fb paddy straw mulching (Fig 1-3).

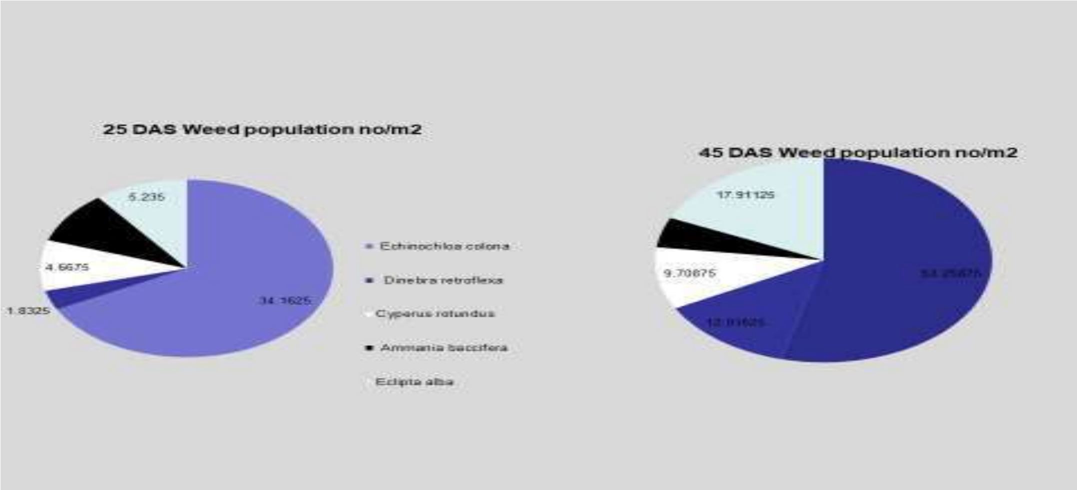


Figure 1: Weed population (Species wise) at 25 and 45 DAS of Rice

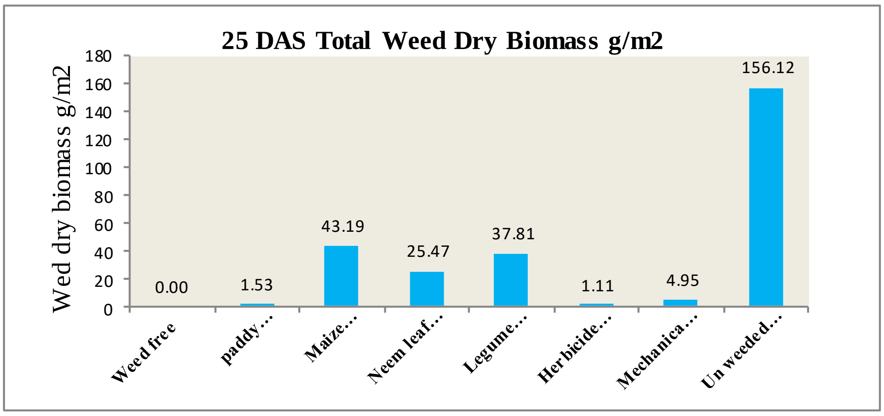


Figure 2: Weed Dry Biomass at 25 DAS of Rice

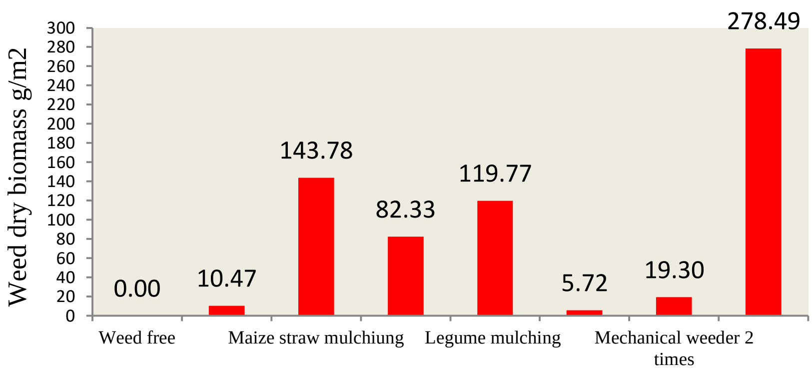


Figure 3: Weed Dry Biomass at 45 DAS of Rice

Conclusion

Neem leaf mulching/ legume stubble mulching @ 5 t/ha has recorded lower weed population, weed index, weed biomass and higher weed control efficiency was comparable with chemical weed control and promising in weed management of dry DSR.

ICSCI 2022/T3/43

Suppression of plant hoppers by enhancing population of predators through ecological engineering in rice ecosystem

Jyothi Sara Jacob, Surendran M, Gayathri P and Ambily A.K.
Rice Research Station (Kerala Agricultural University), Thekkekkara P.O., Moncompu, Alappuzha- 688 503, Kerala, India
E-mail: jyothi.sj@kau.in

Introduction

Rice is the major cereal crop cultivated in Kerala. Among the biotic stresses, insect pests cause about 10-15 per cent yield loss. Among the insect pests, plant hoppers especially the brown plant hopper is considered as a serious insect in rice. The occurrence of favourable field and climatic conditions results in fast population build up leading to severe crop loss. The farmers rely mainly on the application of insecticides for the immediate suppression of this insect. The injudicious use of pesticides may cause several problems like insecticide resistance development, insect resurgence, environmental hazards and reduce the natural enemy population in the rice fields. Biological control is an important and effective strategy in Integrated Pest Management. Conservation of existing population of bioagents in the field assists the suppression of insect pests. For this Ecological Engineering is being implemented as a practice in different rice ecosystems. Ecological engineering for pest management mainly focuses on increasing the abundance, diversity and function of natural enemies in agricultural habitats by providing refuges and alternate or supplementary food resources (Gurr, 2009; Lu *et al.*, 2015). In the present study, effect of ecological engineering interventions using flowering plants on population of hoppers and its predators' were studied.

Methodology

The trials were carried out during *kharif* 2019 to *kharif* 2021 at the experimental fields of Rice Research Station, Moncompu. The study was carried out in two blocks *viz*., Ecological engineered (EE) plots and Farmer Practice (FP) plots. Each block is divided again to five sub-blocks of equal size. In EE plots alleys were maintained at every 2 m distance. Organic manures were only applied in EE plots. As ecological engineering interventions, the floral diversity along the bunds was maintained by growing flowering weeds, planting marigold and cowpea around bunds of EE plots. Application of insecticides was avoided in EE plots whereas necessary applications were done in FP plots. Ten hills were selected randomly from each sub plots (EE and FP plots) and number of hoppers and its predators, namely, spiders, coccinellids (Family: Coccinellidae) and green mirid bugs (*Cyrtorhinus lividipennis*, Reuter, 1884) were recorded at 15 days' interval in all seasons. Each hill was examined carefully and visual observation was made from the whole plant. The data related to abundance of plant hopper and predator populations were subjected to independent 't' test to compare the population in EE and FP plots. The data recorded from three seasons were separately analysed.

Results

The number of hoppers recorded at three different seasons from 10 hills/ block was represented in Figure 1. Among the seasons studied, hopper population was recorded to be higher during Kharif 2019. The maximum hopper population was recorded from FP plots (322/10 hill) compared to EE plots (107/10 hills). The number of hoppers remained higher in FP plots during other two seasons also, even though population was comparatively less during *kharif* 2020 and *kharif* 2021.

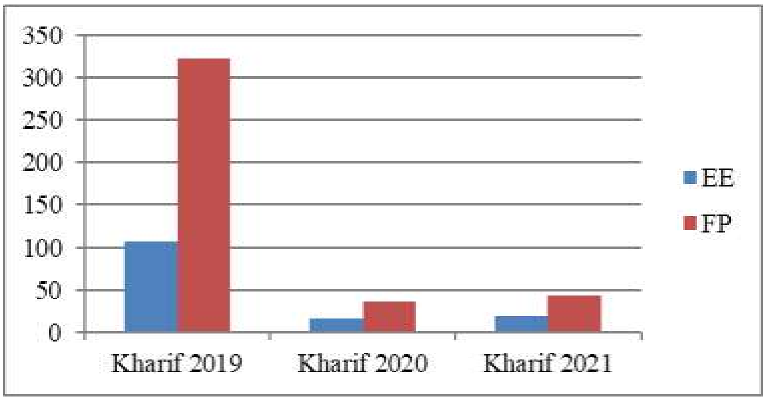


Figure 1. Relative abundance of hoppers in different seasons

Among the natural enemies recorded, number of coccinellids were significantly higher in EE plots (5.85/10 hills) compared to in FP plots (4.13/ 10 hills) during *kharif* 2019. No significant difference was observed in population of spiders and green mired bugs. During *kharif* 2020 and *kharif* 2021, spider population was significantly higher ie. 3.36/10 hills and 4.67/10 hills, respectively in EE plots which showed their frequent abundance in the plots. The population of coccinellids also remained higher during *kharif* 2020 in EE plots (2.96/10 hills) than FP plots (1.76/10 hills). No significant difference was observed in population of green mired bugs. During *kharif* 2021, number of coccinellids in EE plots and FP plots were recorded as 2.65/10 hills and 2.48/10 hills, respectively and that of green mirid bugs as 3.33/10 hills and 2.47/10 hills respectively which proved their abundance in EE plots than FP plots.

Conclusion

Growing of crop plants in combination with rice was reported to enhance the ecosystem services such as biological control (Gurr, 2010). The habitat manipulation and crop diversification in rice fields by growing flowering plants and vegetable crops along the bunds favour the reduction of insect pest populations by favouring population buildup of natural enemies.

References

Gurr GM and OL Kvedaras. 2010. Synergizing biological control: Scope for sterile insect technique, induced plant defences and cultural techniques to enhance natural enemy impact. Biological Control, 52: 198–207.

Gurr GM. 2009. Prospects for ecological engineering for planthoppers and other arthropod pests in rice. In: Planthoppers: New threats to the sustainability of intensive rice production systems in Asia, Heong KL, Hardy B. (eds). Los Baños: International Rice Research Institute, 371-388.

Lu Z, P Zhu, GM Gurr, X Zheng, G Chen and KL Heong. 2015. Rice pest management by ecological engineering: a pioneering attempt in China. In: Rice planthoppers: Ecology, management, socio economics and policy, Heong KL, Cheng J and Escalada MM. (eds). Springer Science and Buisness Media, Beijing, 161-178 pp.

Shearer PW and A Atanassov. 2004. Impact of peach extrafloral nectar on key biological characteristics of *Trichogramma minutum* (Hymenoptera: Trichogrammatidae). Journal of economic entomology, 97: 789–792.

Wackers FL, J Romeis, P VanRijn. 2007. Nectar and pollen feeding by insect herbivores and implications for multitrophic interactions. Annual Review of Entomology, 52: 301-323.

ICSCI 2022/T3/44

Weed management options in drum seeded wetland rice

Gayathri P, Nimmy Jose, Jyothi Sara Jacob, Ambily AK and Surendran M
Rice Research Station, Moncompu, Kerala Agricultural University, 688502, Kerala, India.
E-mail: gayathri.p@kau.in

Introduction

Broadcasting using pre-germinated paddy seeds in puddled soil offers faster and easier crop establishment, reduces labour and irrigation water requirements. But, heavy weed infestation is a major constraint for its adoption, as emerging seedlings in DSR are less competitive with concurrently emerging weeds and the initial flush of weeds cannot be controlled by maintaining water immediately after seeding. Moreover, 2-3 manual weedings by engaging more than 120-150 person days/hectare is required to keep the weed population below the threshold level in DSR. Therefore, herbicide-based weed control or combination of herbicide and mechanical weeder are considered as alternatives to manual-weeding (Sanjoy Saha *et al.*, 2019). Huge seed requirement together with the chances for high incidence of pests and diseases in broadcasting at seed rate of 100-125 kg/ha has necessitated the option for mechanization in rice cultivation. Drum seeding has advantages like less seed cost, optimum plant population, less requirement of fertilizers and plant protection chemicals and labour requirement, and ease of operation, thus rendering it as an economically and technologically viable practice in wet DSR (Muralidharan *et al.*, 2015). With this background, a study was conducted to identify suitable and cost effective agronomic management practices to enhance the productivity of drumseeded rice and to maximise its resource use efficiency.

Methodology

The experiment was conducted at Rice Research Station, Moncompu, Kerala Agricultural University during the *kharif* 2020-21 and *rabi* 2021-22, with eight treatments and three replications in randomised complete block design. The treatments included broadcasting of seeds + manual weeding once, drum seeding + application of post-emergent herbicide, broadcasting + application of post-emergent herbicide, drum seeding + conoweeding twice, drum seeding + application of post-emergent herbicide followed by conoweeding once, drum seeding + application of post-emergent herbicide followed by conoweeding once with four split application of N, drum seeding + application of pre-emergent herbicide followed by post-emergent herbicide and drum seeding + conoweeding once followed by application of post-emergent herbicide. Uma (MO 16), the most popular rice variety of the state was used in the experiment. Observations on plant height, tiller count, total dry matter production, weed count and weed dry weight were recorded at 30, 55, 80 and 110 DAS of the crop. Yield attributes, grain and straw yield were also recorded at harvest.

Results

The experimental data showed that there was significant difference between treatments in plant population at 30 and 55 DAS during both the seasons. In broadcasting, application of post-emergent herbicide recorded highest plant population at 30 and 50 DAS and was on par with broadcasting of seeds with one manual weeding. Though the plant population in drum seeding was significantly lower in all treatment combinations, tiller count at 55 DAS was on par in all drum seeded plots except for conoweeding twice without herbicide application and the treatment with pre-emergent followed by post-emergent herbicide application without conoweeding. The weed dry weight was significantly influenced by weed control treatments and it was significantly lower in drum seeding with post emergence herbicide application followed by conoweeding and on par with broadcasting with hand weeding showing the advantage of conoweeding in drum seeding. Weed dry weight at 50 DAS in the treatments, drum seeding with conoweeding once followed by application of post-emergent herbicide, drum seeding with application of post-emergent herbicide alone, drum seeding with conoweeding twice and drum seeding with application of pre-emergent followed by post-emergent herbicide were on par and significantly higher than the best treatments (Table 1 and 2).

Table 1. Growth and yield of rice and weed dry weight in the experimental field during *kharif*, 2020-21

Crop establishment methods	Plant population, Number/ m2		Weed dry weight, g /m^2		Grain yield, t/ha	Straw yield, t/ha
	30 DAS	55 DAS	30 DAS	55 DAS		
T1	112	23	0.0	21.6	6.3	7.1
T2	69	13	16.0	96.0	5.6	6.9
T3	129	26	4.4	23.3	6.5	8.0
T4	75	13	30.0	90.1	5.4	8.1
T5	69	13	17.1	11.1	6.5	8.5
T6	68	14	16.4	38.9	5.6	6.0
T7	69	16	24.0	55.9	5.5	6.6
T8	75	14	67.9	67.1	5.9	8.4
CD(0.05)	11.01	1.73	13.5	36.36	0.7	1.4
CV	7.54	6.00	35.29	41.1	6.60	10.62

Table 2. Growth and yield of rice and weed dry weight of the experimental field during *rabi*, 2021-22

Crop establishment methods	Plant population, Number/ m2		Weed dry weight, g /m^2		Grain yield, t/ha	Straw yield, t/ha
	30 DAS	55 DAS	30 DAS	55 DAS		
T1	101	65	13.6	48.5	3.2	5.7
T2	40	26	65.3	115.9	1.6	2.7
T3	109	42	9.5	125.3	3.2	6.3
T4	41	31	32.3	264.8	2.5	4.2
T5	43	39	13.6	84.8	3.0	5.0
T6	43	35	51.9	104.5	2.5	4.0
T7	51	27	62.5	220.0	1.6	3.6
T8	41	33	78.8	198.5	2.2	3.6
CD(0.05)	11.3	17.5	26	37	0.52	1.67
CV	10.98	26.98	36.34	14.4	11.87	21.53

T1 broadcasting of seeds + manual weeding once;
T2 drum seeding + application of post emergent herbicide
T3 broadcasting + application of post emergent herbicide
T4 drum seeding + conoweeding twice
T5 drum seeding + application of post emergent herbicide + conoweeding once
T6 drum seeding + application of post emergent herbicide + conoweeding once + four splits application of N
T7 drum seeding + application of pre-emergent herbicide + post emergent herbicide
T8 drum seeding + conoweeding once + application of post emergent herbicide

The experiment proved that conoweeding alone cannot control weeds in drum seeding technique and combination of post-emergence herbicide application followed by conoweeding performed well for weed management in drum seeding. As conoweeding cannot control weeds within the plants in a row, application of herbicides becomes necessary. The experiment proved that application of herbicides must be done at 15 DAS so as to control the emerged weeds and the later emerged ones in the inter spaces can be controlled by conoweeding at 30 DAS. Results also proved the efficiency of conoweeding in enhancing the tiller production in drum seeding. Sheeja *et al*. (2015) has reported that conoweeding alone fail to control weeds effectively in drumseeding, but influences crop growth and yield by stimulating aeration and root growth.

During both the seasons, grain yield in drum seeding with post-emergence herbicide application followed by mechanical weeding was significantly higher and on par with broadcasting of seeds with hand weeding and broadcasting of seeds with post-emergence herbicide application alone (Table 1 and 2).

Conclusion

The experiment conducted to identify suitable and cost-effective agronomic management practices to enhance the productivity of drum seeded wetland rice revealed drumseeding as a viable crop establishment method in wet seeded puddled rice, for reducing the seed requirement, pest and disease infestation and sustaining yield. Weed management option found feasible in drum seeding was post-emergence application of herbicide at 15 DAS followed by conoweeding at 30 DAS for getting on par yield with broadcasting with herbicide application.

References

Muralidharan P, MS Rajeev, R Anand and RN Anjali. 2015. Short communication. Drum seeding for enhanced profitability of paddy cultivation in Kuttanad region of Kerala. Journal of Tropical Agriculture, 53(1): 66-69.

Raj SK, N Jose, R Mathew and S Leenakumary. 2013. Influence of Stand Establishment Techniques on Yield and Economics of Rice Cultivation in Kuttanad. International Journal of Scientific and Research Publications, 3 (4): 1-6.

Saha S, AK Nayak, R Tripathi, M Shahid, S Mohanty, BB Panda, S Vijayakumar, SD Mohapatra, S Priyadarsini, DR Sarangi, US Nagothu and H Pathak. 2019. Weed Management in Dry Direct-sown Rice. Resilience, Technology Brief No. 7.

ICSCI 2022/T3/45

Screening of rice genotypes against water stress and salinity at seedling stage

Veronica N*, Ramana Rao P V and G Jogi Naidu
Regional Agricultural Research Station, Maruteru, Acharya N. G. Ranga Agricultural University, Andhra Pradesh, India – 534 122
E-mail: *n.veronica@angrau.ac.in

Introduction

Rice is cultivated in tropical climate and is mainly affected by drought and salinity and these abiotic stresses cause a drastic reduction in the yield and quality (Anami et al., 2019). Exposure of rice crop to abiotic stresses during the seedling stage generally results in poor crop establishment mainly because of the early death of seedlings. Hence, tolerance to abiotic stresses at the seedling stage of rice is very essential. The objective of this study was to identify genotypes tolerant to both water stresses (mild and severe) and salinity at an early seedling stage.

Methodology

Twenty-one rice genotypes were screened for salinity and water stress at early seedling stage in *kharif* 2021. Seeds were germinated in 1% and 2% mannitol solutions (1% M and 2% M), sodium chloride (200 mM) (Water potential: -1.26 MPa) along with a control. The experiment was conducted in CRD design with four replications in every treatment and genotype. Germination percentage (%) was recorded and Seedling vigour index was computed after 14 days of imposition of stress.

Results

Higher germination under mannitol stress (1% and 2%) was noted in FL 478 (89% and 85% respectively) and AC 43025 (88% and 82% respectively). Lowest under 1% mannitol was recorded in NPS 17 (72%) followed by CR 2862 IC 10 (77%). Similarly, under 2% mannitol lowest germination was observed in NPS 17 (61%) followed by Varshadhan (70%). Under salt stress, highest germination was in FL 478 (82%) followed by White Gora (81%). Lowest was in IET 27051 (60%) followed by Black Gora (64%) (Table 1). Highest seedling vigour under 1% and 2% mannitol and salt stress treatments was noted in AC 43025 (620,554,521 respectively) (Fig 1).

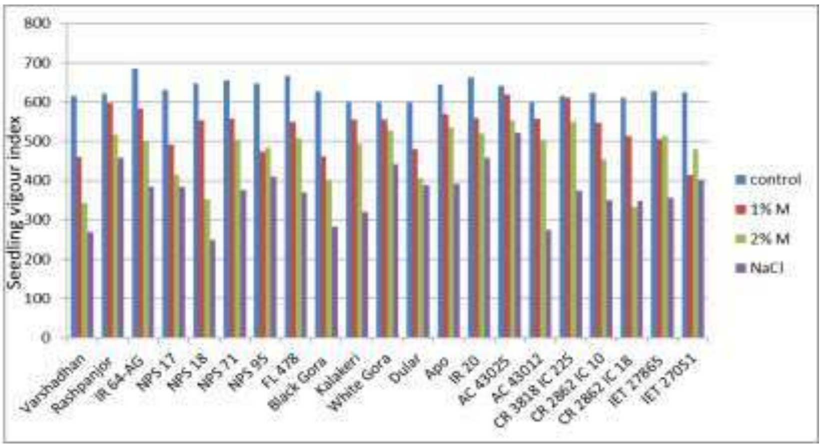


Fig 1: Impact of mild (1% M) and severe water stress (2% M) and salinity stress on Seedling vigour index

Table 1: Impact of mild (1% M) and severe water stress (2% M) and salinity stress on germination percentage (%)

Entry	Seed Germination (%)				
	Control	1% Mannitol	2% Mannitol	Saline test	Grand mean
Varshadhan	94	83	70	67	79
Rashpanjor	90	86	82	79	84
IR 64-AG	93	80	76	74	81
NPS 17	87	72	61	67	72
NPS 18	89	84	74	68	79
NPS 71	92	83	81	71	82
NPS 95	88	81	74	77	80
FL 478	95	89	85	82	88
Black Gora	92	83	78	64	79
Kalakeri	88	83	78	72	80
White Gora	90	85	81	81	84
Dular	84	83	82	77	82
Apo	91	82	77	74	81
IR 20	89	81	79	74	81
AC 43025	92	88	82	80	86
AC 43012	88	82	77	66	78
CR 3818 IC 225	87	87	84	77	84
CR 2862 IC 10	85	77	76	71	77
CR 2862 IC 18	90	82	74	70	79
IET 27865	90	81	75	72	80
IET 27051	87	80	75	60	76
Mean	90	82	77	73	
LSD (T)	1.12				
LSD (V)	2.51				
LSD (TxV)	5.08				

Seed germination hampered in rice under water stress and also induced reduction in plant growth and development (Islam et al., 2018). Similarly, under salinity stress reduction in seed germination percentage was evident in the tested genotypes (He et al., 2019).

Conclusion

Under mild and severe water stress at seedling stage, AC 43025 and CR 3818 IC 225 and under salinity stress AC 43025, Rashpanjor and White Gora could be identified as physiological donors for respective stresses.

References

Anami BS, NN Malvade and S Palaiah. 2019. Classification of yield affecting biotic and abiotic paddy crop stresses using field images. Information Processing in Agriculture. 7(2): 272-285. https://doi.org/ 10.1016/j.inpa.2019.08.005.

He Y, B Yang, Y He, C Zhan, Y Cheng, J Zhang, H Zhang, J Cheng and Z Wang. 2019. A quantitative trait locus, qSE3, promotes seed germination and seedling establishment under salinity stress in rice. The Plant Journal, 97(6): 1089-1104.Islam MM, E Kayesh, E Zaman, TA Urmi and MM Haque. 2018. Evaluation of rice (*Oryza sativa* L.) genotypes for drought tolerance at germination and early seedling stage. The Agriculturists, 16(1): 44-54.

ICSCI 2022/T3/46

Precision nitrogen management on the growth and yield of *rabi* rice (*Oryza sativa* L.)

D. Sowmya[1], S. Hemalatha[2], U. Vineetha[3], A. Prasanthi[4] and G. Karunasagar[5]

[1,2,5,] PG student, Professor & Head, Assisstant Professor, Department of Agronomy, [4]Assisstant Professor (SSAC), SV Agricultural College, ANGRAU, Tirupati 517502, [3] Principal Scientist and Head, Agricultural Research Station, Nellore

E-mail: hemalathasingana@gmail.com

Introduction

Nitrogen (N) is one of the most important and limited nutrients for rice production and synthetic N fertilizer plays a critical role in increasing the yield. However, only 30 to 40 per cent of the applied N is absorbed by the crop, resulting in significant losses of reactive N. The most feasible technique for increasing N use efficiency is to improve the synchronization between crop N demand and supply from soil or through applied N fertilizer. Keeping in view to generate more information on the need based nitrogen management the present study was proposed.

Methodology

A field experiment entitled "Precision nitrogen management in *rabi* rice (*Oryza sativa* L.)" was conducted during *rabi*, 2021-22 on sandy clay loam soils of Agricultural Research Station, Nellore. The experiment was laid out in randomized block design with ten treatments and replicated thrice. The treatments consisted of ten nitrogen management practices *viz*., Control (without N) (T_1), Farmer's practice (200 kg N ha^{-1}) (T_2), Soil test based N fertilizer application (T_3), Recommended dose of FYM @ 5 t ha^{-1} + N (120 kg N ha^{-1}) (T_4), N application at LCC 4 scale (T_5), N application at LCC 5 scale (T_6), N application at NDVI Threshold 0.7 (T_7), N application at NDVI Threshold 0.8 (T_8), N application at SPAD Threshold of 35 (T_9) and N application at SPAD Threshold of 40 (T_{10}). The variety Nellore dhanyarasi (NLR 3354) was tested in the present experiment. A basal dose of 30 kgNha^{-1} was applied along with need-based N fertiliser application based on the treatments at 10 days' interval. A common dose of P and K @ 60 and 40 kg was applied to all the treatments.

Results

Growth parameters *viz*., plant height, number of tillers m^{-2}, leaf area, leaf area index, dry matter production, SPAD and NDVI values were significantly influenced by different nitrogen management practices (Table 1). Significantly higher values were noticed with Farmer's Practice (T_2), which was on par with Soil test based N fertilizer application (T_3), LCC-5 (T_6), NDVI-0.8 (T_8) and SPAD-40 (T_{10}) followed by Recommended dose of nitrogen (T_4),) which might be due to increase in the nitrogen which enhanced carbohydrate synthesis that directly or indirectly involved in the cell division, cell elongation and production of new tissues (Shantappa *et al* 2014, Naik *et al.*, 2019). Significantly lower stature of growth parameters except plant height were observed with control (without N) (T_1).

Grain and straw yields of rice were significantly influenced due to different nitrogen management practices. Higher grain and straw yields were obtained with the application of N through Soil test based N fertilizer application

(STBNF) (T_3), which was statistically at par with farmer's practice (FP) (T_2), LCC-5 (T_6), NDVI-0.8 (T_8) and SPAD-40 (T_{10}) Fig.1. Higher yields in these treatments might be due to timely and adequate supply of nitrogen as per the crop need that led to better root growth and greater use efficiency. (Suresh *et al* 2017, Prabhudev *et al* 2017). The lower grain and straw yields were registered with control (without N) (T_1).

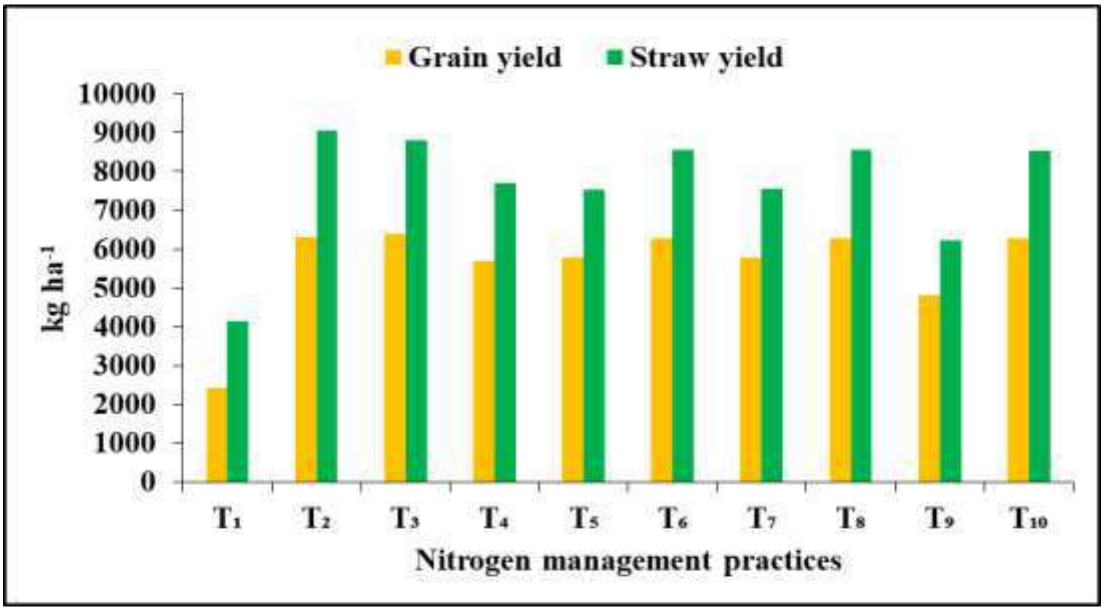


Fig. 1. Grain and straw yield of *rabi* rice as influenced by N management practices.

Table 1. Growth parameters as influenced by different nitrogen management practices in *rabi* rice

Treatment	Plant height (cm)	Number of tillers m^{-2}	Leaf area (cm^2)	Dry matter production (kg ha^{-1})	SPAD values	NDVI values
T_1 - Control (no N)	65	238	386	7561	23.1	0.41
T_2 - Farmers practice (200 kg N/ha)	90	371	672	16456	34.0	0.59
T_3 - Soil Test Based Fertilization	88	360	646	16273	33.3	0.57
T_4 - Recommended dose of N (120 kg/ha) + FYM @ 5 t/ha	76	302	556	14186	29.5	0.51
T_5 - N application at LCC 4 scale	77	296	564	14098	30.4	0.52
T_6 - N application at LCC 5 scale	87	346	639	15938	35.1	0.57
T_7 - N application at NDVI Threshold 0.7	76	301	576	14025	30.4	0.52
T_8 - N application at NDVI Threshold 0.8	86	347	621	15864	35.2	0.57
T_9 - N application at SPAD Threshold of 35	68	267	486	11496	26.6	0.46
T_{10}- N application at SPAD Threshold of 40	86	348	627	15776	35.5	0.58

Conclusion

It can be concluded that application of 30 kg N ha^{-1} as basal and split application of 20 kg N ha^{-1} at 10 days' interval guided through LCC-5, NDVI-0.8 or SPAD - 40 at different intervals was found to be optimum for achieving higher yield of *rabi* rice in the southern Agro-climatic Zone of Andhra Pradesh.

References

Naik MR, S Hemalatha, ARK Reddy, KV Naga Madhuri and V Umamahesh. 2019. Calibrating leaf colour chart for nitrogen management in rabi maize (Zea mays L.) under varied plant density. Journal of Pharmacognosy and Phytochemistry, 8(3): 4360-4364.

Prabhudev DS, Nagaraju, T Sheshadri, Basavaraja, MN Timmegouda and GB Mallikarjuna. 2017. Precision management practices - PK a much needed set of agro-techniques to improve rice productivity and cutback the resources in aerobic rice condition under drip irrigation, International Journal of Current Mirobiology and Application Sciences, 6(8): 2800-2810.

Shantappa D, AS Channabasavanna, S Rao and AS Halepyati. 2014. Effect of LCC and SPAD based nitrogen management on growth and yield of lowland rice (Oryza sativa L.). The Bioscan, 9(2): 663-665.

Suresh M, D Balaguravaiah and G Jayasree. 2017. Calibrating the LCC and SPAD based nitrogen management on leaf N content and yield in rice. International Journal of Pure & Applied Bioscience, 5(4): 1382-1386.

ICSCI 2022/T3/47

Nutri-Millets and its cultivation in relation to Global Water Foot print and Nutritional Security

Subbalakshmi Lokanadhan
Professor (Agronomy), Department of Agronomy, Tamil Nadu Agricultural University (TNAU), Coimbatore - 641 003 Tamil Nadu, India
Corresponding Email: kplokanadhan@yahoo.co.in

Millets are rich in nutrients and at present also considered as climate change compliant crop scoring highly over other grains in terms of marginal growing conditions and high in nutritive value. They are named as nutri-cereals also which by nature abode vitamins, minerals, essential fatty acids, phyto-chemicals and antioxidants, that can help to eradicate the plethora of nutritional deficiency and its causes. At present the World is facing agrarian as well as nutritional challenges. Agricultural lands with irrigation facilities have been exploited to maximum. Millets cultivation in the dry lands keep it productive under rainfed conditions and ensures future food and nutritional security. Due to the richness of millets with polyphenols and other biological active compounds, they are considered to impart role in lowering fat absorption rate and slow release of sugars. The additional beneficial properties of millets like gluten-free proteins, high fibre content, low glycaemic index and found non allergenic among consumers with richness in bio-active compounds which make them, a suitable health food.

Water foot print in millets is discussed in terms of its water use and its' efficiency, defined as the amount of carbon assimilated as biomass or the grain produced per unit of water used (consumed) by the crop. The whole concept and the process depends upon the carbon and water dynamics with bio-chemical and metabolic process during the plant growth. Millets can easily thrive in extreme conditions like drought, and some varieties prevail in flooded areas and swampy grounds. These extraordinary crops are highly nutrient rich and thus can be elevated to climate change compliant crops to the present change in the climatic conditions, by which the present farmers will have an option to shift towards reasonable water usage and promote a low water foot print through millet cultivation in future.

Key words: Millets cultivation, Global Water footprint, Nutritional security

ICSCI 2022/T3/48

Performance of soybean (*Glycine max* L.) as influenced by crop residue retention and nutrient levels under conservation agriculture

Bharti Parmar[1*], A. K. Vishwakarma[2], Varsha Gupta[1], Pramod Jha[2], A. K. Biswas[2], K. M. Hati[2], A. K. Patra[2]
[1]*Rajmata Vijayaraja Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh (474002) India*
[2]*ICAR-Indian Institute of Soil Science, Berasia Road, Nabi Bagh Bhopal, Madhya Pradesh*
**E-mail: parmarbharti1223@gmail.com*

Introduction

Soybean (*Glycine max* L.) is the major legume crop of the world in terms of total production, native to East Asia, widely grown for its edible beans, which has numerous uses. The area under soybean in India increased to 11.64 million hectares in 2020 from 10.76 million hectares in 2019, Soybean Processors Association of India. Almost 90% of soybean is grown in three states, namely Madhya Pradesh, Maharashtra and Rajasthan, which account for more than 90% of the country's total production with productivity of 1,052 kilograms per hectare. Soybean producing about 13.5 t crop residue annually. Soybean residue contains about 41.4% C, 2.8% N, 0.5% P, and 1.3% K (Wang et al., 2020) and has a high nutrient recycling capacity. Every year, more than 92 million tonnes (Mt) of crop residues are burned in India, resulting in substantial emission of particulate matter, air pollution and smog. According to Dutta et al., 2022 the country produces more than 683 Mt of crop residue per year, with a surplus of 178 Mt, of which 87 Mt is burned each year. Retention of crop residues on soil surface is one of the most important aspects of CA, which is critical to its success and improvement in crop productivity, soil properties and environmental services. Tillage practices and crop residue retention as mulch have significant impact on soil moisture regime, improvement in soil biota, soil organic carbon and nutrient recycling, nutrient availability and nutrient use efficiency (Choudhary et al., 2019). Therefore, the residue can be used to improve soil quality and reduce soil degradation it has been also hypothesized that optimizing the residues retention rate from soybeans residues can accelerate the beneficial interaction of soil complexes of black soil and residues, which may be a major factor in developing higher soil carbon and thus reducing land degradation (Yadav et al., 2021). In addition, crop residue application into soil can prevent the loss of nutrients and improve essential nutrient availability. Conservation agriculture systems is being promoted due to its potential to conserve, improve and make efficient use of resources like soil, water and nutrients besides energy savings and environmental benefits. Farmers can save up to 40% of time, labour and fuel in conservation agriculture besides reducing soil erosion, increasing soil moisture conservation, lowering surface run-off of herbicides and fertilizers, and improving profits as compared to conventional agriculture. In the coming decades, a crucial challenge for agriculture in small scale agriculture (SSA) will be meeting food demands without undermining further the environment. Increasing productivity and economic returns to smallholder farming in a sustainable manner will be a key challenge in achieving global poverty reduction and environmental management objectives (FAO, 2012). Keeping in view above background the study is proposed to be conducted in an ongoing experiment Consortium Research Platform on CA in the research farm of ICAR- IISS, Bhopal in Vertisols during 2 years of research with the following objectives 1**.** To evaluate the impact of crop residue and nutrient levels on growth and productivity of soybean 2**.** To determine the most suitable combination of crop residue and nutrient levels for soybean

Methodology

Field experiments were conducted with soybean-wheat cropping system under conservation agriculture systems in Vertisols of Central India during Kharif 2021 at the Research Farm of ICAR-Indian Institute of Soil Science, Bhopal, Madhya Pradesh. The soil of the experimental field was clayey in texture with medium in available nitrogen (296 kg ha^{-1}) and high in available phosphorus (30 kg ha^{-1}) and potassium (697 kg ha^{-1}). The experiment was laid out in Factorial Randomized Block Design (FRBD) comprised of 16 combinations of 4 residue level (0%, 30%, 60% and 90%) and 4 nutrient doses (N_1-RDF (25:60:20 kg N, P_2O_5 and K_2O ha^{-1}), N_2-75% N+100% P_2O_5 and K_2O ha^{-1}, N_3-75% P_2O_5+100% N and K_2O ha^{-1}, N_4-75% K_2O+100% N and P_2O_5 ha^{-1}) with 3 replications. Soybean variety RVS 2001-4 was sown in the experimental field at a row spacing of 27.5 cm during the last week of June, 2021 with the help of zero seed cum fertilizer drill. All other agronomic and plant protection measures were adopted as per the recommended package of practices. Observations on plant growth and yield attributes were recorded.

Results

Effect on growth parameters

Among different residue levels of residue retention and nutrient levels significant response has been recorded. Maximum plant height (58.58 cm) at harvest, leaf area (901.17) 90 days after sowing, dry matter accumulation per plant (23.36 g) at harvest and branches per plant (6.25) at harvest was recorded with higher level of crop residue (90%) retention followed by 60% crop residue retention treatment and these were significantly superior to 30% and without residue treatment. Among the various nutrient doses, maximum leaf area (808.82) and dry matter accumulation per plant (19.55 g) were retain with N_1 (100% RDF) followed by N_4 (75% K_2O+100% N and P_2O_5) and significantly superior to N_3 (75% P_2O_5+100% N and K_2O) and N_2 (75% N+100% P_2O_5 and K_2O), effect of different nutrient doses on plant height and branches found to be non-significant. Interactive effect of residue levels and nutrient doses on leaf area found to be significant (table 1).

Table 1. Effect of different residue retention and nutrient levels on growth parameters of soybean

Treatment	Plant height (cm)	Leaf area	Dry matter accumulation (g)	Branches $plant^{-1}$
Residue level				
ZT R_0	45.17	644.99	16.32	3.58
ZT R_{30}	52.25	750.38	17.47	4.83
ZT R_{60}	55.25	859.01	19.46	5.25
ZT R_{90}	58.58	901.17	23.36	6.25
CD (P=0.05)	1.59	16.57	0.49	0.63
Nutrient level				
N_1 (100% RDF)	53.83	808.82	19.55	5.33
N_2(75% N+100% P_2O_5 and K_2O)	52.50	770.74	18.85	4.75
N_3(75%P_2O_5+100% N and K_2O)	52.25	777.03	18.91	4.83
N_4(75%K_2O+100% N and P_2O_5)	52.67	798.95	19.29	5.00
CD (P=0.05)	NS	16.57	0.49	NS
Intercation: SE(m)	1.10	11.47	0.34	0.44
CD (P=0.05)	NS	33138	NS	NS
Grand mean	52.81	788.89	19.15	4.98

Effect on crop yield

Significant response of various residue retention and nutrient doses was recorded as compared to without residue retention treatment. Maximum seed yield and straw yield 1175 kg ha^{-1} and 3171 kg ha^{-1} respectively were recorded with 90% crop residue retention followed by 60% crop residue retention. Among the various nutrient doses, maximum seed yield 876 kg ha^{-1} and straw yield 3015 ha^{-1} were obtained with N_1 (100% RDF), although effect of different nutrient doses found to be non-significant (Table 2). Interactive effect of residue levels and nutrient doses on yield also found no significant effect (Table 2).

Table 2. Effect of different residue retention and nutrient doses on crop yield

Treatment	Seed yield kg ha^{-1}	Straw yield kg ha^{-1}
Residue level		
ZT R_0	605.08	2631.67
ZT R_{30}	712.83	2652.88
ZT R_{60}	844.71	2765.58
ZT R_{90}	1175.04	3171.38
SE(m)	44.34	184.49
CD (P=0.05)	128.055	NS
Nutrient level		
N_1 (100% RDF)	876.83	3015.13
N_2(75% N+100% P_2O_5 and K_2O)	817.38	2779.83
N_3(75%P_2O_5+100% N and K_2O)	820.21	2580.92
N_4(75%K_2O+100% N and P_2O_5)	823.25	2845.63
CD (P=0.05)	NS	NS
Interaction		
SE(m)	88.67	368.98
CD (P=0.05)	NS	NS
Grand mean	834.42	2805.38

Conclusion

Adoption of conservation agricultural practices along with higher level of crop residue retention (90%) and reduced rate of fertilizer application (-25%) in established CA fields can produce crop yield equivalent to crop productivity as recorded under recommended rates of fertilizer application and significantly higher yields can be obtained with higher level of crop residue retention as compared to without residue retention treatment with same level of fertilizer application.

References

Wang X, Z Yang, X Liu, G Huang, W Xiao and L Han. 2020. The composition characteristics of different crop straw types and their multivariate analysis and comparison. Waste Management, 1(110) :87-97.

Dutta A, A Patra, KK Hazra, CP Nath, N Kumar and A Rakshit. 2022. A state of the art review in crop residue burning in India: Previous knowledge, present circumstances and future strategies. Environmental Challenges, 8: 1-16.

Chaudhary A, RS Chhokar, DB Yadav, VK Sindhu, H Ram, S Rawal, RS Khedwal, RK Sharma and SC Gill. 2019. In-situ paddy straw management practices for higher in Indo- Gangetic Plains (IGP). Indian Journal of Cereal Research, 11(3): 172-198.

Yadav D, AK Vishwakarma and NK Sharma. 2021. Sustaining the properties of black soil in Central India through crop residue management in a conservation-agriculture-based soybean–wheat system. Land Degradation and Development, 32: 2906–2921.

ICSCI 2022/T3/49

Suitable alternate crops for command area under delayed sowing conditions under NSP left canal of Andhra Pradesh

K. Sathish babu and Y. Padmalatha
Agricultural Research Station, Garikapadu– 521175
Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh, India
Email : ksb6465@gmail.com

Introduction

Globally, agriculture accounts for 80–90% of all freshwater used by humans, and most of that is in crop production. In many areas, this water use is unsustainable; water supplies are also under pressure from other users and are being affected by climate change. Much effort is being made to reduce water use by crops and produce 'more crop per drop'. At present and more so in the future, irrigated agriculture will take place under water scarcity. Insufficient water supply for irrigation will be the norm rather than the exception, and irrigation management will shift from emphasizing production per unit area towards maximizing the production per unit of water consumed, the water productivity. Water is essential for crop production, and any shortage has an impact on yields. Therefore, farmers have a tendency to over-irrigate, an approach that runs counter to the conservation of scarce resources. A short duration of water deficit during tasselling stages in maize reduced biomass production by 30% and grain yield by up to 40% (Cakir 2004). In Nagarjuna sagar project area of Krishna district of Andhra Pradesh experiences late release of water into canals which leads to delay in transplanting of kharif paddy crop and sometimes they may skip the paddy and cultivating ID crops in early rabi season. Under this situations, there is need to find optimum irrigation schedules and suitable ID crops for better utilization of natural resources and farm income. Hence, the present investigation was carried out to find the suitable ID crop under delayed release of canal water.

Methodology

A field experiment was conducted during 2018-19 to 2019-20 in early rabi season in sandy loam soils at Agricultural Research Station, Garikapadu, Krishna district, ANGRAU under irrigation source of Nagarjuna Sagar left canal ayacut area with an objective to establish and identify suitable alternate crops under delayed release of canal water. The experimental site was characterized as red sandy loams with shallow depth (25-30 cm) with water holding capacity 14.5 %, well drained in nature, P^H 6.9, EC 0.14 ds m^{-1}, Organic carbon 0.48%, high in available Nitrogen (183.1 kg/ha), high in available phosphorus (64.8 kg/ha) and medium in available potassium (252.7 kg/ha). The rainfall 92 mm (2018-19) and 132 mm (2019-20) received during crop growth period in two years respectively. The experiment was carried out in split plot design with three replications with twelve treatments. The treatments consist of three irrigations levels as main plots i.e., I_1= three irrigations of 50 mm each at sensitive stages, I_2= four irrigations when field capacity reaches < 50 %, I_3= Five irrigations when field capacity reaches < 75 % with four ID crops as sub plots i.e., Groundnut, Castor, redgram and maize. The crops were sown during early rabi season during the month of September 2nd F.N. Recommended high yielding varieties with highly genetical and physical purity seeds were used with prior seed treatment. The crops were raised in sub plots with recommended packages of practices for this zone. Pre irrigation commonly applied for all the main plots and sowing taken up under optimum soil moisture condition. Irrigation schedule treatments were imposed as I_1 three irrigations at crop sensitive stages at 50 mm depth of water. I_2 irrigation levels were imposed based on field capacity moisture level at soil moisture reaches 50% and four irrigations were performed during crop growth period. Likewise, I_3 irrigation level treatment imposed at field capacity reaches 75% and performed five irrigations during the crop growth period. For all crops calculating the water requirement. Biometrical observations at 30 days' interval, yield of crops, irrigation water use efficiency studies and economics were recorded.

Results

Maize equivalent yield (MEY)

Results pertaining to maize equivalent yields (MEY) were presented in table no.1 indicating that irrigation levels and ID crops were found significant effect but interaction effects in both levels were found no significant effect. Among the irrigation levels I_3 treatment (five irrigations at FC < 75%) has recorded significantly higher maize equivalent yields (4283 kg/ha) followed by I_2 treatment (Four irrigations at FC < 50%) 4271 kg/ha and both are superior over I_1 treatment (Three irrigations at crop moisture sensitive stage) (3705 kg/ha). These results are in agreement with those of Milani and Neishabouri (2001) who reported that irrigation interval may be decided in such a way to avoid excessive use of water to optimize the irrigation water requirement of maize. Maqsood (2010) repoted that six irrigations improved all the physiological traits over five and four irrigations in maize. Among the four ID crops tested maize crop recorded significantly higher kernel yield (5579 kg/ha). Oilseed crops Groundnut and castor recorded maize equivalent yields (MEY) of 4564 kg/ha and 4560 kg/ha respectively. Pulse redgram crop recorded significantly lower yield. Kang *et al*., 2000 reported that maize growth and development of water stressed plants rapidly recovered to the control level only three days after being re-watered. Hsiao and Bradford also reported that water deficits, by affecting growth, development and carbon assimilation reduce the yield of most annual crops which is also similar line of results reported.

Table 1: Maize equivalent yields (MEY) (kg/ha) of different crops (B) as influenced by irrigation schedules (A) during *rabi*, (Pooled data of 2018-19 & 2019-20)

Factor	A X B MEAN Table				Mean of irrigation levels (A)
	Groundnut	Castor	Redgram	Maize	
Irrigation levels (3)					
I_1:Three irrigations at moisture sensitive stage	4227	3432	758	6405	3705
I_2:Four irrigations at field capacity < 50%	4208	5400	499	4314	4271
I_3:Five irrigations at field capacity < 75%	5257	4847	890	6019	4283
Mean of MEY (B)	4564	4560	715	5579	
	SEm+	CD (P=0.05)			
Mean of irrigation levels (A)	111	335			
Different crops (B)	172	516			
Factor A X B	368	NS			
Factor B X A	561	NS			

Economics

Economics of different ID crops under experimentation was calculated and presented in Table no.2 which indicate that oilseed crop castor has recorded maximum net returns Rs 82,560/ha followed by maize crop Rs 48,240/ha. However, maize crop recorded highest cost-benefit ratio of 1:1.8.

Table 2. Economics of different crops as influenced by irrigation schedules during *rabi*.

ID crops	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	C:B ratio
Groundnut	72,250	103560	31060	1:1.4
Castor	39750	122310	82560	1:1.3
Redgram	32045	14940	-17105	1:0.4
Maize	57756	106001	48240	1:1.8

Conclusion

From the above study it was concluded that growing of oilseed castor crop or cereal maize crop is best option with four irrigations at FC < 50% under limited water availability in NSP ayacut of Krishna district of Andhra Pradesh.

References

Cakir, R. 2004. Effect of water stress at different development stages on vegetative and reproductive growth of corn. Field crops Research, 89:1-16.

Hsiao TC, Bradford KJ. 1983. Physiological sequences of cellular water deficits. Journal of Experimental Botany, 58 (2): 147-159.

Kang S, Shi, W and Zhang, J. 2000. An improved water use efficiency for maize grown under regulated deficit irrigation. Field crops Research, 67:207-214.

Maqsood, M., 2010. Effect of integrated plant nutrition and irrigation scheduling on growth, yield and radation use efficiency of hybrid maize (Zea mays L.). Agric Water Management, 98:148-152.

Milani, A. A. And Neishabouri, M.R., 2001. Different methods of determining irrigation timing and their effects on yield, water use and water use efficiency of fodder maize. Iranian Journal of Soil and Water Sciences, 13 (1):75-85.

ICSCI 2022/T3/51

Impact of weather on the population dynamics of Brown planthopper, Nilaparvata lugens (Stal) in rice

Anand Kumar A D V S L P[1], Nanda Kishore M[2], Srinivasa Rao N [1] and Anusha B[1]

[1]*Regional Agricultural Research Station, Maruteru, W. G. Dist., A. P., India,*
Acharya N G Ranga Agricultural University, Lam, Guntur, Andhra Pradesh
Email: advslp.anandkumar@angrau.ac.in

Introduction

Rice (*Oryza sativa* L.) is an important staple food crop for more than half of the world population and accounts for more than 50 per cent of the daily calorie intake. Warm and humid climate which is essential for rice cultivation, also conducive to the survival and proliferation of insect pests. Among the insect pests infesting rice, planthoppers considered as the major yield limiting factor in all rice growing areas both in tropics and temperate regions (Krishnaiah, 2014). Both nymphs and adults of the planthoppers suck plant sap from phloem cells resulting in “hopper burn” symptoms and it can cover large irregular patches in the rice fields under heavy pest pressure. In order to formulate any effective location specific pest management strategies and to fore warn the pest outbreak in advance, knowledge of population dynamics of insect pests in relation to abiotic and biotic factors becomes vital. In this context, the present investigation entitled “ Impact of weather on the population dynamics of brown planthopper, *Nilaparvata lugens* (Stal) (Hemiptera: Delphacidae) in rice” was undertaken at Regional Agricultural Research Station (RARS), Maruteru, West Godavari district, Andhra Pradesh, India for two consequtive seasons during *kharif* 2018 and 2019 with an objective to study the seasonal abundance, effect of weather parameters on BPH incidence and also the relation between field incidence and light trap catches of brown planthopper in rice.

Methodology

An observational plot (bulk) of 500 m^2 was planted with highly susceptibla and popular rice variety, Swarna (MTU 7029) during *kharif* 2018 and 2019. One to two seedlings per hill were planted with a spacing of 20 cm x 15cm during *kharif* with a help of a marked rope. The experimental plot was managed as per the standard agronomic practices recommended by Acharya N. G. Ranga Agricultural University for the Godavari delta region. No plant protection measures were given in bulk plot throughout the crop growth period to facilitate the infestation and build up of brown planthoppers.

Observations on the population of brown planthoppers (nymphs and adults) were recorded on 50 hills selected at random starting from 45 days after transplanting (DAT) at weekly intervals coinciding with standard meteorological week (SMW) and continued till harvesting. Weather data on temperature (maximum and minimum), relative humidity, (morning and evening) and rainfall recorded in the class “B” observatory located at RARS, Maruteru were used to establish relationship between different weather parameters and incidence of brown planthopper. Correlation coefficient values (r) were worked out by taking weather parameters as independent variables and population of BPH as dependent variables to know the effect of different weather parameters on the population build up of BPH after log transformations.

Results

Population Dynamics of BPH in relation to weather parameters

The incidence of brown planthopper was first noticed in 37th SMW (September 10-16) in the month of September during *kharif*, 2018 and *kharif*, 2019 but the population was very low (52/50 hills & 79/50 hills). The BPH population increased progressively from 37th SMW to 41st SMW and reached a peak population of 2238/50 hills and 8710/ 50 hills during 41st SMW, *i. e*., during second week of October (October 8-14) during *kharif*, 2018 and *kharif*, 2019, respectively (Table 1).

Based on data on the field incidence and light trap catches of BPH, activity of brown planthopper is high from September to October during *kharif* season (Table 1). This is in agreement with observations made by Anandkumar *et al*., 2019, who reported that BPH population increased from 36th SMW to 41st SMW and reached a peak population of 432/10 hills during 41st SMW, i.e. during second week of October.

Table 1: Field incidence and light trap catches of BPH during *kharif* 2018 and *kharif* 2019

Standard Meteorological Week (SMW)	Field population of BPH (No./50 hills)	Weekly light trap catches of BPH	Field population of BPH (No./50 hills)	Weekly light trap catches of BPH
	***Kharif* 2018**		***Kharif* 2019**	
35 (August 27-Sep 2)	-	419	-	12
36 (September 3-9)	-	2936	-	21
37 (September 10-16)	52	3015	79	1854
38 (September 17-23)	286	2228	371	545
39 (September 24-30)	478	5048	864	1620
40 (October 1-7)	727	11665	1200	8939
41 (October 8-14)	2238	3113	8710	9673
42 (October 15-21)	372	10905	8350	7310
43 (October 22-28)	115	4763	7310	7528
44 (October 29- Nov 4)	67	3000	5330	13870
45 (November 5-11)	18	1407	1963	17133
46 (November 12-18)	-	-	341	3932

Correlation between population of BPH and weather parameters

During *kharif*, 2018, minimm temperature of current week (r=0.928**) and past one week (r=0.820*) and morning relative humidity of past one week (r=0.759*) had significant positive relationship with population of brown planthopper (Table 2). No single abiotic factor showed a significant relationship with BPH incidence durng *kharif*, 2019 (Table 2). The present findings also corroborate with results of Ashrith *et al*. (2017) who reported that minmum temperature had a positive correlation with BPH incidence. Positive correlation observed between relative humidity and BPH in the present study is in conformity with the findings of Ashrith *et al*. (2017).

Relationship between field population and light trap catches of BPH

The data presented in Table 3 revealed that current week field population of BPH has showed positive relationship with light trap catches of current week, past one week and past two weeks during *kharif* season. But it was non-significant during 2018 (r=0.534, r=0.342 & r=0.151) and significant during 2019 (r=0.688*, r=0.696* & r=0.686*). Thus, based on the light trap catches of BPH population, field infestation can be predicted. The present findings are supported by the observations made by Anandkumar *et al*., 2019, who reported significant positive relationship between light trap catches and field incidence of BPH.

Table 2: Correlations between field population of BPH and weather parameters during *kharif* 2018 and *kharif* 2019

Weather parameters	Correlation coefficient (r) of BPH	
	***Kharif* 2018**	***Kharif* 2019**
Maximum Temperature (^{O}C) current week	0.290	- 0.465
Minimum Temperature (^{O}C) current week	0.928**	0.579
Rainfall (mm) current week	0.229	- 0.002
Relative Humidity (morning) (%) current week	0.195	0.094
Relative Humidity (evening) (%) current week	- 0.365	0.161
Maximum Temperature (^{O}C) past one week	0.535	0.023
Minimum Temperature (^{O}C) past one week	0.820*	0.432
Rainfall (mm) past one week	0.415	- 0.091
Relative Humidity (morning) (%) past one week	0.759*	- 0.174
Relative Humidity (evening) (%) past one week	- 0.303	- 0.091

Table 3: Correlation between field population of planthoppers and light trap catches of plant hoppers during *kharif 2018* and *kharif* 2019

Parameter	Correlation (r) between field population of BPH (current week)	
	***Kharif* 2018**	***Kharif* 2019**
Light trap catches of BPH (current week)	0.534^{NS}	0.688*
Light trap catches of BPH (past one week)	0.342^{NS}	0.696*
Light trap catches of BPH (past two weeks)	0.151^{NS}	0.686*

** Highly significant at 1% level; *Significant at 5% level; NS-Non significant

Conclusion

Activity of brown planthopper is high from September to October during *kharif* season. Minimm temperature of current week and past one week and morning relative humidity of past one week had significant positive relationship with population of brown planthopper during *kharif*, 2018. Field population of BPH has showed positive relationship with light trap catches of current week, past one week and past two weeks during kharif season.

References

Anand Kumar ADVSLP, CV Rama Rao, N Mallikharjuna Rao, S Krishnam Raju and SK Nafeez Umar. 2019. Effect of abiotic factors on the population dynamics of rice brown planthopper, Nilaparvata lugens (Stal). Multilogic in Science, IX(XXX): 11-15.

Ashrith KN, AG Sreenivas, GS Guruprasad, NB Patil, SG Hanchinal and I Chavan. 2017. Influence of weather parameters on the occurrence of major insect-pests in conventional rice ecosystem. Oryza, 54(3): 324-329.

Krishnaiah NV. 2014. A global perspective of rice brown planthopper management III-Strategies for BPH management. Rice Genomics and Genetics, 5(1): 1-11.

ICSCI 2022/T3/52

Rice farming-An experience with cost reduction technologies

Chandragiri Cheralu[1], N. Venkateshwar Rao and J. Vijay
Professor JayashankarTelangana State Agricultural University, Rajendranagar[1], Telangana and KrishiVigyan Kendra, Jammikunta Dist: Karimnagar, Telangana State, India.
E-mail: cheralu_2006ars@yahoo.co.in

Introduction

Rice is an important staple food crop of India and is grown differently under various agro ecological situations. It is a labour intensive crop and one-hectare area needs around 850-900 man –hours at different stages of cultivation. With a population growth rate of 0.91percent (>141 crores at present), India is going to occupy number one position in the Globe. Yield stagnation and increase in production cost threatens the countries food and livelihood security. To meet the demand of future population there is every need to produce more rice at lesser cost by reducing pressure on natural resources. Objectives of the study are to overcome the drudgery, labour shortage, water scarcity, ensure timely plantings and to get more net returns per hectare in rice cultivation.

Methodology

On farm testing and Front line demonstrations of proven technologies of rice in large number in farmer's fields. With the available experimental results large scale on farm trials were conducted in farmer's fields to popularize the rice production technologies and to get feed back on machine transplantation, drum seeding of sprouted seed, alternate wetting and drying (AWD) of fields, broad casting of sprouted seed and SRI with farmers practice (normal transplantation) and the results are discussed in this paper.

Results

Though the yields are high and profits are more (Table 1) by machine planting, farmers are not in reach of machine transplanters due to high initial cost, lack of service centers at village level, difficulties in nursery raising (trays/mat/polythene sheets). Mahapatra *et al.* (2012) also reported more net returns with mechine transplanting. Fluctuations in oil prices are also discouraging machine transplanting. Due to more net returns with less labour and drudgery (Table 2) most of the small and marginal farmers are accepting the drum seeding technology and picked up the momentum as per the situation demand. Parameshwari *et al.* (2014) reported that drum seeding under puddled condition is an alternative to transplantation. Broad casting system was also accepted (Table 3) due to high C: B ratio (1: 3.26 compared to 1: 2.04) but due to problem in maintenance of optimum population, technology is not taking momentum. Ali *et al.*, (2012) reported superiority of broadcasting over conventional method. Production costs can be further reduced and yields can be increased by perfecting broadcasting of sprouted seed technology by introducing machine tools like drones for maintaining optimum population rather than the human force, as perfect weedicides are available for rice ecosystem. Alternate wetting and drying (AWD) was also accepted in the water limited areas as it is not only saving water but increasing yields (Table 4). Though the SRI technology was widely accepted in the initial years due to high yield (Table 5) and saving of water but due to many practical problems (raising and planting of young seedlings, marking of main field, operation of rotary weeder) farmers withdrawn practicing of SRI method in the region. But SRI technology could sensitize the farmers on water use in rice fields.

Table 1: Comparison of Machine Transplantation with normal transplantation

Treatment	Yield (Q/ha)	Net returns (Rs/ha)	B:C Ratio
Demonstration (Machine transplantation)	72.33	79354	1:2.70
Farmers practice (Manual transplantation)	66.00	70940	1:2.61

Table 2: Comparison of Drum seeding with normal transplantation

S.No	Name of the parameter	Drum seeding	Normal transplantation
1	Cost of Cultivation	35,350/-	38,937/-
2	Yield (Q/ha)	66.50	63.00
3	Market Rate (Rs/q)	1770/-	1770/-
4	Gross Income (Rs/ha)	1,17,705/-	1,11,510/-
5	Net Income (Rs/ha)	82,355/-	72,573/-
6	C:B Ratio	1: 2.32	1:1.86

*Additional income gained is Rs. 9,782/ha and 6.4 crores from 6546 ha.

Table 3: Comparison of broad casting with normal transplantation

Name of the parameter	Broadcasting	Normal Transplantation
Cost of Cultivation	25,250/-	37,125/-
Yield (Qt/ha)	70.00	73.50
Gross Income (Rs)	1,07,800/-	1,13,190/-
Net Income (Rs)	82,550/-	76,065/-
C:B Ratio	1: 3.26	1:2.04

*Additional income gained is Rs. 6,485/ha and 10.38 crores from 160 ha.

Table 4: Comparison of Alternate wetting and drying with normal transplantation

Treatment	Yield (q/ha)	% increase over Farmers Practice	Net returns (Rs./ha)	B:C Ratio
Alternate Wetting and Drying	72.62	3.74	89457	1:3.00
Farmers Practice (Continuous Flooding)	70.00	-	83250	1:2.84

Table: 5 Performance of Rice under SRI and normal transplantation

Year	SRI (Yield/ha)	Normal transplantation (Yield/ha)	% increase over normal transplantation
2004-05	71.25	60.00	15.78
2005-06	78.00	62.00	21.00
2006-07	79.50	62.25	27.71
Mean	76.25	61.41	24.16

Cheralu *et al.* (2006) reported SRI, drum seeding and broadcasting are efficient alternstives to increase the rice production as requires less water less seed and reduces cost of cultivation. Despite of increased cost of cultivation through transplantation by labour, untimely planting, planting with over aged seedlings and others, it is practiced by many of the farmers due to lack of awareness on recent developments of cost reduction technologies in rice cultivation to farming communities. Earlier studies indicated differential response of varieties to different cultivation methods indicating requirement of different ideotypes for different situations or cultivation methods.

References

Ali RA, N Iquabal, MU Saleem, and M Akhbar. 2012. Effect of different planting methods on economics, yield and grain quality of rice. International journal of Agricultural and Applied Sciences, 4(1): 28-34.

Cheralu C, L Jalapathi Rao and M Sreedhar. 2006. An experience with SRI in Warangal district of Andhra Pradesh. In: National symposium on system of rice intensification (SRI) – Present status and future prospects, Nov. 17-18. 117.

Mahapatra PC, M Din, BC Parida, S Pate and P Pand Mishra. 2012. Effect of mechanical planting and weeding on yield, water use efficiency and cost of production under modified system of rice intensification. Indian journal of Agricultural Sciences, 82(3): 280-283.

Parameshwari YS, A Srinivas, T Ramesh Prakash and G Narendar. 2014. Agricultural Reviews, 35(1): 74-77.

Venkataravana NGV, G Prabhakara Reddy and R Mahender Kumar. 2020. Indian Journal of Pure and Applied Biosciences, 8(4): 612-630.

ICSCI 2022/T3/53

Bracketing potential production zones and optimum sowing window for higher seed yield of Pigeonpea in Telangana using CROPGRO– Pigeonpea model

B. Balaji Naik, G. Sreenivas and D. Devkumar

Agro Climate Research Centre, PJTS Agricultural University, Rajendranagar, Hyderabad, E-mail: balajinaikbanoth789@gmail.com

Introduction

In India, the cultivation of legumes forms an integral part of the rainfed production systems; however, their productivity over the years has remained low and unstable. In Telangana, the pigeonpea was traditionally cultivated under rainfed situations over a wide range of agro-ecosystems. The yield levels are highly variable and largely governed by prevailing environmental conditions. Weather parameters like rainfall, temperature and solar radiation play a vital role in crop growth and development under rainfed situations (Goswami *et al*., 2006). Various constraints limiting crop yields in these regions need to be identified to develop suitable adaptation strategies for bridging the gap between the actual and potential yield of Pigeonpea. Further conducting research at each location on complex variables is laborious and time-consuming. The crop simulation models help in the estimation of crop growth and development under complex and varied environments (Priscilla *et al.*, 2021). Therefore, the present investigation aimed to calibrate and validate the CROPGRO-Pigeonpea model thereby identification of suitable areas and optimum sowing window for the cultivation of Pigeonpea in Telangana state.

Methodology

The present investigation aimed to identify suitable areas and optimum sowing windows for the cultivation of Pigeonpea in Telangana state using the DSSAT CROPGRO-Pigeonpea model. For calibration and validation of the CROPGRO-Pigeonpea model, two years' field experiment with WRG 65 cultivar was conducted under rainfed and supplemental irrigated conditions as main plots with 4 dates of sowing as subplots replicated thrice under split-plot design during *kharif* 2016-17 and 2017-18 at Agro Climate Research Centre, PJTS Agricultural University, Rajendranagar, Hyderabad. After satisfactory calibration and validation of the model, the *Seasonal* module of the model employed using mandal-level soil data and 32 years of historical weather data (1988 to 2020) acquired from NBSSLUP and Telangana State Development Planning Society, respectively for identification of suitable area and optimum sowing window. The mandal level results were average to district level and summarized the results in this paper.

Results

The seasonal output of the CROPGRO- Pigeonpea model considering the risk of crop failure, higher chances of success to achieve sustainable crop yields, and the median values, the optimum sowing window was identified for each district and presented in Table 1.

Table.1 District level optimum sowing window for Pigeonpea cultivation in different Agro Climatic Zones of Telangana during *kharif*

Northern Telangana Zone	Central Telangana Zone	Southern Telangana Zone

District	Opt. Sowing window	District	Opt. Sowing window	District	Opt. Sowing window
Adilabad	7 Jul -14 Jul	Bhadradri Kothagudem	7Jul - 21 Jul	Jogulamba Gadwal	14 Jul- 28 Jul
Jagtial	1 Jul – 21Jul	Jangoan	1 Jul - 21 Jul	Mahabubnagar	14 Jul -28 Jul
Kamareddy	7Jul - 21 Jul	Jayashankar Bhupalpalli	7Jul - 21 Jul	Medchal	1 Jul- 28 Jul
Karimnagar	1 Jul - 14 Jul	Khammam	7Jul - 21 Jul	Nagarkurnool	14 Jul-21 Jul
Asifabad	1 Jul - 14 Jul	Mahabubabad	7Jul - 28 Jul	Nalgonda	1 Jul- 14 Jul
Mancherial	7Jul - 28 Jul	Medak	1 Jul - 28 Jul	Narayanpet	7Jul - 21 Jul
Nirmal	1 Jul - 14 Jul	Mulugu	7Jul - 28 Jul	Ranagareddy	24 Jun- 21 Jul
Nizamabad	17Jun - 1 Jul	Sangareddy	24 Jun - 14 Jul	Suryapet	1 Jul -14 Jul
Peddapalli	1 Jul - 21 Jul	Siddipet	24 Jun - 14 Jul	Vikarabad	24 Jun 7Jul
Rajanna Sirisilla	24 Jun -14 Jul	Warangal R	1 Jul - 21 Jul	Wanaparthi	1 Jul - 21 Jul
		Warangal U	1 Jul - 21 Jul	Yadadri	7 Jul -14 Jul

Further, the crop phenology and seed yield between different Agro Climatic zones of Telangana was compared and presented in Table 2. The results indicated that the Northern Telangana zone needs 92 days and 68 days for anthesis and 173 days and 140 days for physiological maturity when the crop is sown early on 10 June and late on 28 July, respectively. Further, the maximum yield of 1827 kg ha^{-1} was recorded with early 1 July sowing, and the lowest yield of 1573kg ha^{-1} was recorded with early sowing of 10 June. In Central Telangana Zone, 92 days and 65 days for anthesis and 173 days and 138 days for physiological maturity are needed when the crop is sown early on 10 June and late on 28 July, respectively. Further, the maximum yield of 2057 kg ha^{-1} was recorded with 7 July sowing, and the lowest yield of 1621 kg ha^{-1} was recorded with early sowing on 10 June. In Southern Telangana Zone**,** 89 days and 64 days for anthesis and 171 days and 136 days for physiological maturity are needed when the crop is sown early on 10 June and late on 28 July, respectively. Further, the maximum yield of 1966 kg ha^{-1} was recorded with 1 July sowing and lowest yield of 1734 kg ha^{-1} was recorded with early sowing of 10 June.

Table.2 Simulated phenology and seed yield of pigeonpea influenced by sowing dates in different Agro Climatic zones of Telangana

Date of sowwing	Anthesis			Physiological maturity			Seed yield (kg/ha)		
	NTZ	CTZ	STZ	NTZ	CTZ	STZ	NTZ	CTZ	STZ
10 - Jun	93	92	89	172	173	171	1573	1621	1734
17 - Jun	88	88	85	167	168	165	1707	1848	1861
24 - Jun	84	84	81	162	162	160	1798	1987	1942
01 - Jul	81	79	77	157	157	154	1827	2043	1966
07 - Jul	77	76	74	153	152	150	1818	2057	1958
14 - Jul	74	72	70	148	147	145	1784	2050	1926
21 - Jul	71	69	67	144	142	140	1740	2010	1852
28 - Jul	68	65	64	140	138	136	1683	1949	1760
Minimum	68	65	64	140	138	136	1573	1621	1734
Maximum	93	92	89	172	173	171	1827	2057	1966

Conclusion

Among the zones, Northern Telangana Zone needs 3 and 4 days more to complete the crop cycle as compared to Central Telangana Zone and Southern Telangana Zone, respectively. The sowing window differs from district to district within and between the zones. Southern and Central Telangana zones were found more potential in terms of recording higher seed yield.

References

Goswami B, GS Mahi, and US Saikia. 2006. Effect of few important climatic factors on phenology, growth and yield of rice and wheat - a review, Agricultural Reviews, 27(3): 223 – 228.

Priscilla NK, KK Ayisi and BM Petja. 2021. Challenges and opportunities in crop simulation modelling under seasonal and projected climate change scenarios for crop production in South Africa, Agriculture & Food Security, 10(10): 1-24.

ICSCI 2022/T3/55

Screening of rice germplasm for sodicity tolerance in association with soil amendment

B. N. Tripathi, P. K. Singh,* Devendra Singh and Y. K. Singh
Chandra Shekhar Azad University of Agriculture & Technology, Kanpur-208002 U.P., India
E-mail: pk_singh65@yahoo.com

Introduction

India is the world's second-largest producer and the largest exporter of rice where the crop is grown in an area of about 43.86 million hectares across a variety of climate, and soil and water conditions, rice production increased from 53.6 million tons in 1980 to 120 million tons in 2020-21. West Bengal and Uttar Pradesh are the top rice producing states in the country. Sodic soils are particularly widespread in India, where they cover some 3.6 million ha (Singh, 1998) and greatly affect the rice productivity especially asian rice (*Oryza sativa*) are more susceptible to salt stress particularly at seedling stage (Khan and Panda, 2008). Therefore, there is an urgent need to develop salt tolerant varieties for sustaining the rice productivity in the salt affected soils. Such soils can be managed in two ways viz. either by growing a crop variety tolerant / resistant to a particular soil or by ameliorating the soil through the application of soil amendments.

Methodology

Keeping these points in view, a trial was conducted in split plot design with three replications during Kharif 2018 at Seed Multiplication Farm, Bojha, C.S. Azad University of Agriculture & Technology, Kanpur to screen 24 germplasm for tolerance to sodicity and higher rice productivity under three levels of gypsum application {(0, 50 and 100% gypsum recommendation (GR)] in addition to the recommended dose of NPK. The soil texture of the experimental site was clay loam with 10.0 pH and 0.96 dS/m EC. Three levels of gypsum recommendation were placed in main plot whereas 24 rice germplasm were placed in sub plot for evaluation and statistical analysis.

Results

The results revealed significant differences among rice genotypes for all the yield and yield parameters when cultivated under natural sodic conditions. Gypsum application @ 50% GR and 100% GR were found to increase the number of panicles/sq m and panicle weight of the genotypes evaluated as compared to the treatment without gypsum. Gypsum application increased panicle production by 31%-65% and panicle weight by 26% - 42%. The highest number of panicles (554/ sq m) was produced in CSAR 1604 after application of gypsum at 100 % GR and the genotype DRR Dhan 40 produced panicles with the highest weight (1.90 g). Ismail *et al.* 2022 have also observed that gypsum application positively enhanced rice varieties growth parameters, photosynthetic pigments, relative water content, grain yield, yield attributes and crop water productivity under salt affected soil conditions.

Application of gypsum in conjunction with recommended dose of NPK significantly influenced the grain yield. Grain and straw yields at 50% GR and 100% GR increased over control (without gypsum amendment) by 65%-127%, respectively (Table 1). The highest grain yields of 4.61 t/ha, 4.58 t/ha, 4.54 t/ha, 4.47 t/ha and 4.46 t/ha was observed with DRR Dhan 46, CSR 23, DRR Dhan 42, DRR Dhan 45 and

DRR Dhan 43, respectively under recommended NPK + 100% GR fertilization. Straw yield (5.25-5.44 t/ha) also followed similar trends as grain yields. Significant interaction effects between genotypes and gypsum application was observed as both grain and straw yields of genotypes were highest with recommended dose of NPK with 100% GR application. The genotypes with highest yields in unamended sodic soils were DRR Dhan 46 (2.21 t/ha), CSR 36 (2.19 t/ha), DRR Dhan 42 (2.18 t/ha), DRR Dhan 45 (2.14 t/ha) and DRR Dhan 43 (2.09 t/ha).

Gypsum application and varietal differences contributed to the differences in nutrient uptake Gypsum applied at 50% GR and 100% GR rates in addition to the recommended doses of NPK increased nitrogen uptake (69.38 and 96.03 kg/ha, respectively), phosphorus uptake (16.78 and 23.89 kg/ha, respectively) potassium uptake(69.94and 96.89 kg/ha, respectively) and zinc uptake (134.92 and 189.12 g/ha, respectively) compared to the control that received only NPK fertilization (N, P, K and Zn uptake of 41.22, 9.38 and 41.48 kg/ha and 80.56 g/ha, respectively). The genotype DRR Dhan 46 at 100% GR application, exhibited the highest N, P and K uptake with values of 111.27 kg N/ha, 28.10 kg P/ha, 110.18 kg K/ha and 215.41 g Zn/ha.

Table 1: Grain and straw yield (t/ha) of 24 rice germplasm under sodic soil ameliorated with three levels of gypsum recommendation at Kanpur during Kharif 2018.

Variety	Grain yield (t/ha)				Straw Yield (t/ha)			
	T1*	T2	T3	Mean	T1*	T2	T3	Mean
DRR Dhan-40	1.98	3.28	4.41	3.22	2.33	3.58	5.21	3.79
DRR Dhan-41	1.94	3.15	4.36	3.15	2.28	3.66	5.14	3.69
DRR Dhan-42	2.18	3.46	4.54	3.40	2.56	4.08	5.36	4.00
DRR Dhan-43	2.09	3.35	4.46	3.30	2.46	3.94	5.25	3.88
DRR Dhan-44	2.00	3.28	4.41	3.23	2.35	3.79	5.20	3.78
DRR Dhan-45	2.14	3.40	4.47	3.34	2.53	4.00	5.28	3.94
DRR Dhan-46	2.21	3.47	4.61	3.43	2.58	4.09	5.44	4.04
HRI-196	1.56	2.79	3.65	2.67	1.84	3.26	4.31	3.14
HRI-197	1.69	2.59	4.00	2.76	1.99	3.34	4.71	3.35
27 P 36	1.72	2.88	3.77	2.79	2.03	3.38	4.47	3.30
27 P 63	1.81	3.01	4.27	3.03	2.13	3.54	5.04	3.50
27 P 22	1.56	3.10	4.35	3.01	1.84	3.64	5.13	3.54
28 P 09	1.78	2.95	4.20	2.97	2.10	3.46	4.94	3.50
TI- 93	1.65	2.80	3.86	2.77	1.94	3.29	4.55	3.26
B/V-243	1.74	2.95	4.18	2.96	2.05	3.47	4.92	3.48
B/V-344	1.48	2.57	4.32	2.53	1.74	3.02	4.18	2.98
CSR-43	1.84	3.07	4.32	3.08	2.17	3.61	5.08	3.62
CSR-23	1.93	3.13	4.58	3.13	2.28	3.68	5.10	3.68
CSR-36	2.19	3.45	4.29	3.41	2.55	4.05	5.38	3.99
CSAR-17817	2.07	3.04	4.15	3.14	2.44	3.58	5.06	3.69
CSAR-1604	1.73	2.89	3.96	2.92	2.04	3.40	4.89	3.44
CSAR-1628	1.68	2.85	3.80	2.83	1.99	3.35	4.67	3.34
CSAR-17135	1.64	2.77	3.64	2.74	1.94	3.26	4.50	3.23
CSAR-1611	1.55	2.78	3.54	2.66	1.83	3.27	4.28	3.13
Mean	1.84	3.04	4.17	3.02	2.17	3.58	4.92	3.56
CD at 5%								
Main	0.03				0.03			
Sub	0.06				0.04			
Main x Sub	0.10				0.07			
Sub x Main	0.10				0.07			

*T1- No amendment, T2- 50% GR, T3- 100% GR

Conclusion

Five genotypes, DRR Dhan 46, CSR 23, DRR Dhan 42, DRR Dhan 45, DRR Dhan 43 produced the highest yields when supplemented with 100% GR (4.46 - 4.61 t/ha) whereas, under unamended native sodic soils the genotypes that produced the highest yields were DRR Dhan 46, CSR 36, DRR Dhan 42, DRR Dhan 45 and DRR Dhan 43 (2.09 t/ha - 2.21 t/ha). The choice of rice variety is critical because there are marked genotypic differences in sodicity tolerance. Therefore, we can conclude that four rice genotypes *i.e.* DRR Dhan 46, DRR Dhan 42, DRR Dhan 45 and DRR Dhan 43 were found to possess tolerance to soil sodicity irrespective of soil amendment with gypsum and may be effectively used in salt stress breeding programme.

References

Ismail AOA, MMH Hamad, MM El- Hawary, and KI Gad. 2022. Effect of gypsum application on the behavior of some rice varieties under salt affected soil conditions, International Journal of Environment, 11(1): 23-40.

Khan MH, and SK Panda. 2008. Alterations in root lipid peroxidation and antioxidative responses in two rice cultivars under Nacl- salinity stress, Acta Physiologiae Plantarum, 30: 81-89.

Singh GB. 1998. Natural resource management for sustainable agriculture, In Fifty Years of Natural Resource Management Research in India (Eds G. B. Singh & B. Sharma), New Delhi: ICAR, 3–11.

ICSCI 2022/T3/56

Management of emerging pests through pest diversionary approaches in rice

Anandhi, P[1], **Senguttuvan, T**[2] **and K. Subrahmaniyan**[3]
*[1]Associate Professor, [2] Professor & Head, Dept. of Entomology, [3] Director
Tamil Nadu Rice Research Institute, Aduthurai- 612 101,
Tamil Nadu Agricultural University
Email: anandhi.aaidu@gmail.com

Introduction

A total of hundred and more species of insects recorded as pests in rice, five pests *viz.*, rice yellow stem borer (YSB), *Scirpophaga incertulas* (Walker), leaf folder (LF), *Cnaphalocrocis medinalis* (Guenee), brown plant hopper (BPH), *Nilaparvata lugens* (Stal) and gall midge (GM), *Orseolia oryzae* (Wood-Mason) are of important as their incidence has significant impact on rice yields across the Thanjavur rice ecosystems. Some less significant pests such as Hispa, Whorl maggot and Black bug *etc*. due to their suddenness of occurrence and spread, have resulted in panic actions by rice farmers to protect their crops at any cost. The above emerging pests were found in severe form (>45 %) in recent days in Cauvery delta region (AICRIP, 2015- 17). Due to misuse of chemical pesticides and large scale cultivation of susceptible varieties, this minor pest that was known as less important is becoming major problem in rice cultivation. Use of trap plants included in the push-pull strategy which is one of the techniques of pest control that is principled on non-toxic control component, so that it can be integrated with other methods that can suppress the development of pest populations. This strategy may also increase natural enemies, especially the role of Parasitoids and predators (Effendi, 2009). Hence, it is the need of the hour to formulate suitable pest diversionary approaches for the effective management of these emerging pests.

Materials and methods

The experiments were conducted at Tamil Nadu Rice Research Institute, Aduthurai during *rabi* 2019- 20. Experiments were laid out in Randomized Block Design (RBD) consisting eight treatments and three replications. The treatments v*iz*., T1- Azolla @ 25 kg/ha alone; T2. Lemon grass as bund crop alone; T3. Neem oil (3%) as Foliar Spray on 15, 30, 60 DAT; T4. Azolla @ 25 kg/ha + lemon grass as bund crop; T5. Lemon grass as bund crop + Neem oil (3%) as Foliar Spray on 15, 30, 60 DAT; T6. Azolla @ 25 kg/ha + lemon grass as bund crop + Neem oil (3%) as Foliar Spray on 10, 30, 60 DAT; T7. Chlorpyriphos 20% EC @ 1250 ml. ha-1 on 10, 30, 60 DAT and T8. Untreated check was imposed. Lemon grass were planted in the bunds to refuse black bug, aphids, grasshoppers, mites and whorl maggot, to make the target crop rice less attractive. Azolla were applied to reduce the multiplication of pests. The population of Hispa, Whorl maggot and Black bug will be made before and 1, 3, 7 and 14 DAT. Populations of the emerging pests in each of the 10 randomly selected plants per plot will be assessed. Cost benefit ratio was estimated by the formula of cost of produce / cost of cultivation + Cost of plant protection.

Results

Lemongrass as a mosquito repellent is relatively effective in repelling hispa, whorl maggot and black bug. Low whorl maggot incidence (9.33 %) recorded when Azolla water fern alone covers the water surface during the early vegetative stage and considerable reduction of hispa also noticed. However, black bug incidence response towards azolla is negligible. Lemongrass as a mosquito repellent is relatively effective in repelling hispa (60.00), whorl maggot (59.70) and black bug (78.20). Minimum Black bug noticed when neem oil 3% sprayed on 15, 30 and 45 days after transplanting. When all the treatments combined (Azolla @ 25 kg/ha + lemon grass as bund crop + Neem oil (3%) as Foliar Spray on 10, 30, 60 DAT) minimum pest incidence and maximum yield was noticed (5507 kg/ha.) when compared to control (4996 kg/ha.) Klien (2012) reported that genus Andropogon can refuse and lose the population of insects in the family pentatomidae. Viajante and Heinriches, 1985 also also supports the water attraction theory. Whorl maggot lay progressively fewer eggs per area as plant density increases. Females are first attracted to open water and secondarily to rice plants. If the water surface in the field is covered with a dense crop, whorl maggot overflies the field. Low whorl maggot incidence recorded when Azolla water fern covers the water surface during the early vegetative stage.

Table 1. Pest diversionary approaches for the management of emerging pests (Pooled observations 2019 & 2020) (Mean of three replications)

Treatment	% Hispa damaged leaves_50 DAT	% WM damaged leaves_50 DAT	% Black bug damaged leaves_70DAT	Yield kg/ha
Azolla @ 25 kg/ha	22.39 (25.07)	9.33 (17.37)	34.07 (35.54)	5096
Lemon grass as bund crop	13.73 (20.52)	9.91 (17.59)	6.76 (17.35)	5157
Neem oil (3%) as Foliar Spray on 15, 30, 60 DAT	10.26 (17.62)	8.38 (16.25)	6.6 (16.61)	5279
Azolla @ 25 kg/ha + lemon grass as bund crop	11.11 (18.90)	8.11 (16.25)	6.75 (14.41)	5230
Lemon grass as bund crop + Neem oil (3%) as Foliar Spray on 15, 30, 60 DAT	5.67 (13.95)	6.63 (14.64)	8.08 (16.1)	5473
Azolla @ 25 kg/ha + lemon grass as bund crop + Neem oil (3%) as Foliar Spray on 10, 30, 60 DAT	6.0 (13.67)	5.43 (12.1)	7.61 (15.46)	5708
Chlorpyriphos 20% EC @ 1250 ml/ ha on 10, 30, 60 DAT	5.01 (12.47)	2.0 (11.2)	4.39 (11.58)	5816
Untreated check	43.43 (41.03)	37.86 (37.35)	49.26 (44.56)	4199
CD (P = 0.05)	7.62	8.15	5.34	254.7

Conclusion

From the study it is concluded that Lemongrass as a mosquito repellent is relatively effective in repelling hispa, whorl maggot and black bug and low whorl maggot incidence recorded when Azolla water fern covers the water surface during the early vegetative stage and considerable reduction of hispa also noticed.

References

Effendi and B Suherlan. 2009. Strategi Pengendalian Hama Terpadu Tanaman Padi Dalam Perspektif Praktek Pertanian Yang Baik (Good Agricultural Practices), Journal Pengembangan Inovasi Pertanian, 2(1): 65-78.

Klein JT, RR Luiza and B Alone. 2012. Occurrence of diapause and the role of andropogon bicornis (Poaceae) Tussouks an The Seasonal Abundance and Mortality of Tibraca limbativentris (Hemiptera: Pentatomidae), Florida Entomologist, 95(4): 813-818.

ICSCI 2022/T3/57

Effect of Long Term Integrated Nutrient Supply System on Productivity, Profitability and Soil Fertility in Rice-Rice Cropping System

D. G. Jondhale[1], S. B. Bhagat[2], N. V. Mhaskar[3], A. V. Dahiphale[4] and T. J. Bedse[5]
[1,2,3, 5] Jr. Soil Scientist, Chief Agronomist, Jr. Scientis(Agronomy), [&] Biochemist, Regional Agricultural Research Station, Karjat, Dist Raigad, Maharashtra -410201, [4] Jr. Agronomist, Irrigation Scheme, Central Experimentation Scheme, Wakawali, Ratnagiri, Maharashtra
E-mail :jondhaless17@gmail.com

Introduction

The knowledge and judicious management of soil-water-nutrient interaction is one of the important component which affect the management efficiency aspects. There has been appreciable increase in agricultural production due to adoption of high analysis fertilizers, high yielding varieties, multiple cropping and other agricultural chemicals. Keeping this in view a permanent plot experiment on intsegrated nutrient supply system in cereal based crop sequence (Rice-Rice) was started in *kharif* 1986 at Regional Agricultural Research Station, Karjat, Dist. Raigad to study the effect of Rice- Rice system on production and productivity of rice and soil health and it is being continued at present. Rice is the main crop grown during *kharif* season in *Konkan* as it is receiving about 3000 to 3500 mm rainfall during *kharif* season. Thus, 'Rice-Rice' system is followed by farmers in command areas of irrigation projects in the region with application of less than recommended dose of nutrients mainly through inorganic sources. The data generated with long term fertilizer experiments in India indicated that continuous cropping without addition of nutrients resulted into depletion of these nutrients whereas fertilization and manuring helped to restore the soil fertility depletions (Nambiar *et al.*, 1992). Increased N, P and K uptake with organic sources of FYM was due to the priming effect such that organics on decomposition release organic acids which solubilise native i.e., fixed and non-exchangeable form of nutrients in soil solution at later stages of crop growth.

Methodology

The experiment was laid out in a randomized block design with four replications and 12 treatments comprising different rates of chemical fertilizers alone and in conjunction with FYM, rice straw and Glyricidia green leaf manure (GGLM) at 50% and 25% N substitution during *Kharif* and with 100% and 75% RDF in *Rabi*- hot weather. The recommended dose of fertilizers (RDF) for rice is 100:50:50 kg NPK ha^{-1} for *Kharif* rice and 120:50:50 kg NPK ha^{-1} for Rabi- hot weather rice, respectively. Treatment details are given in Table 1. Medium duration and fine grained rice variety Palghar-1 was grown during *Kharif* and early variety *Karjat* -3 having coarse grain type was grown during *Rabi*- hot weather season.

Results

The results revealed that to get higher yields and economic returns from *Kharif* rice and *Rabi*- hot weather rice system (Table 2) by improving soil fertility in terms of organic carbon and available NPK (Table 3) and sustaining productivity of rice under Rice-Rice cropping system, 50% RDF as inorganics (50:25:25 kg N, $P_2O_5$and K_2O ha^{-1}) be integrated with rest of 50 kg N (RDN) in the form of FYM or *Glyricidia* green leaf manuring during *Kharif* and 100% RDF be applied as inorganics (120:50:50 kg N, P_2O_5 and K_2O ha^{-1}) during *Rabi*- hot weather season.

Table 1. Treatment details

Tr. No.	*Kharif*	Tr. No.	*Rabi*
T_1	No fertilizers, no organic manures (UTC : 0)	T_1	No fertilizers, no organic manures (UTC : 0)
T_2	50 per cent recommended NPK dose through fertilizers (RDF :50)	T_2	50 per cent recommended NPK dose through fertilizers (RDF :50)
T_3	50 per cent recommended NPK dose through fertilizers. (RDF :50)	T_3	100 per cent recommended NPK dose through fertilizers. (RDF:100)
T_4	75 per cent recommended NPK dose through fertilizers (RDF :75)	T_4	75 per cent recommended NPK dose through fertilizers (RDF :75)
T_5	100 per cent recommended NPK dose through fertilizers (RDF :100)	T_5	100 per cent recommended NPK dose through fertilizers (RDF :100)
T_6	50 per cent recommended NPK dose through fertilizers + 50 per cent N through FYM (RDF :50 + FYM:50 N)	T_6	100 per cent recommended NPK dose through fertilizers (RDF :100)
T_7	75 per cent recommended NPK dose through fertilizers + 25 per cent NPK through FYM (RDF :75 + FYM:25 N)	T_7	75 per cent recommended NPK dose through fertilizers (RDF :75)
T_8	50 per cent recommended NPK dose through fertilizers + 50 per cent N through rice straw (RDF :50 + RS:50 N)	T_8	100 per cent recommended NPK dose through fertilizers (RDF :100)
T_9	75 per cent recommended NPK dose through fertilizers + 25 per cent N through rice straw (RDF :75 + RS:25 N)	T_9	75 per cent recommended NPK dose through fertilizers (RDF :75)
T_{10}	50 per cent recommended NPK dose + 50 per cent N through *Glyricidia* green leaf manure (GGLM)(RDF :50 + GGLM:50 N)	T_{10}	100 per cent recommended NPK dose through fertilizers (RDF :100)
T_{11}	75 per cent recommended NPK dose through fertilizers + 25 per cent N through GGLM(RDF :75 + GGLM:25 N)	T_{11}	75 per cent recommended NPK dose through fertilizers (RDF :75)
T_{12}	Farmer's practice (45:45:45 NPKkg ha^{-1}) (45:45:45:)	T_{12}	Farmer's practice (90:45:45 NPK kg ha^{-1}) (90:45:45)

Table 2: Mean grain yield of rice and economics as affected by various fertility levels under rice-rice cropping sequence (2020-2021)

Treatment	Mean grain yield (q ha^{-1})			Mean straw yield (q ha^{-1})			Gross returns (Rs. ha^{-1})			System Net returns (Rs. ha^{-1})	System B:C ratio
Kharif - Rabi	*Kharif* 2020	*Rabi* 2020-2021	*Total K+R*	*Kharif* 2020	*Rabi* 20-2021	*Total K+R*	*Kharif* (Grain + Straw)	*Rabi* (Grain + Straw)	Total K + R		
T_1	23.56	22.38	45.94	31.5	26.8	58.32	52355	48515	100870	-42440	0.70
T_2	36.49	37.90	74.39	49.0	43.3	92.41	81165	81634	162799	11011	1.07
T_3	39.96	49.62	89.58	51.9	56.6	108.64	88444	106843	195287	39184	1.25
T_4	43.51	47.30	90.81	56.9	53.5	110.46	96385	101740	198125	42298	1.27
T_5	50.35	54.04	104.4	64.9	62.8	127.78	111292	116669	227962	67695	1.42
T_6	50.81	55.08	105.8	67.5	64.0	131.57	112814	118891	231706	50439	1.28
T_7	45.30	47.46	92.75	59.6	54.5	114.14	100426	102275	202701	34192	1.20
T_8	43.57	50.53	94.10	57.9	59.1	117.06	96744	109169	205913	27246	1.15
T_9	40.81	45.77	86.58	53.7	54.1	107.85	90481	99026	189507	22298	1.13

T_{10}	50.78	53.64	104.4	65.5	62.2	127.84	112254	115779	228033	63516	1.39
T_{11}	44.39	46.51	90.89	58.3	54.5	112.83	98378	100507	198884	38750	1.24
T_{12}	33.57	36.68	70.26	44.1	44.0	88.18	74426	79530	153956	3925	1.03
CD at 5%	1.72	3.65	3.76	2.64	4.45	5.26					

Table 3: Effect of different treatments on chemical properties of soil after harvest of *Rabi* rice

Treatments **K - R**	**pH (1:2.5)**	**E.C. (dSm^{-1})**	**O.C. (%)**	**Av.N (kg ha^{-1})**	**Av.P_2O_5 (kg ha^{-1})**	**Av. K_2O (kg ha^{-1})**
T_1= UTC:0 **-0**	6.72	0.247	1.08	203.84	25.65	261.41
T_2= RDF:50 **-50**	6.70	0.250	1.18	223.28	30.08	305.09
T_3= RDF:50 **-100**	6.68	0.252	1.20	232.06	30.78	306.10
T_4= RDF:75 **-75**	6.65	0.263	1.22	231.44	31.01	308.11
T_5= RDF:100 **-100**	6.75	0.263	1.29	242.73	32.18	319.87
T_6= RDF:50+FYM:50N - **100**	6.79	0.259	1.33	244.61	33.11	321.22
T_7= RDF:75+FYM:25N – **75**	6.76	0.256	1.27	239.59	31.71	315.17
T_8= RDF:50+RS:50N – **100**	6.76	0.260	1.31	242.73	32.41	321.22
T_9= RDF:75+RS:25N – **75**	6.74	0.265	1.25	237.08	31.24	315.50
T_{10}= RDF:50+GGLM:50N **-100**	6.80	0.269	1.32	242.73	32.64	320.88
T_{11}= RDF:75+GGLM:25N- **75**	6.79	0.265	1.26	237.08	31.48	313.82
T_{12}=FP 45+45+45 **- 90+45+45**	6.74	0.255	1.12	217.01	28.68	311.14
CD at 5 %	NS	NS	0.09	4.65	1.08	5.05
Initial values	7.05	0.27	1.25	213.00	29.85	294.88

Thus, on system basis 50 per cent saving in fertilizer cost to be applied to *Kharif* crop (50 kg N, 25kg P_2O_5 and 25 kg K_2O out of 220 kg N, 100 kg P_2O_5 and 100 kg K_2O ha^{-1} $year^{-1}$) can be achieved with this INSS treatment using FYM or *Glyricidia*, grown on field bunds, as it recorded similar productivity level to that of application of recommended dose of nutrients through fertilizer *(*100:50:50 kg NPK ha^{-1} to *Kharif* and 120:50:50 kg NPK ha^{-1} to *Rabi*- hotweather rice) during both the seasons.

Conclusion

In North Konkan Coastal Zone of Maharashtra, to get higher yields and economic returns from kharif rice and rabi-hot weather rice system, 100 per cent RDF through inorganics be applied to both the crops. However, to improve soil fertility and sustain productivity of rice under 'rice- rice' cropping system, 50% RDF as inorganics (50, 25, 25 kg N, P_2O_5 and K_2O ha^{-1}) be integrated with 50% N either in the form of FYM or *Glyricidia* green leaf mannuring during *kharif* and 100% RDF as inorganic (120, 50, 50 kg N, P_2O_5 and K_2O ha^{-1}) during *rabi* season**.**

References

Nambair KKM and AB Ghosh. 1984. Highlights of research of long-term fertilizer experiment in India. LTFE Research Bulletin No.1 IARI, New Delhi.

ICSCI 2022/T3/58

Combining ability studies in maize (*Zea mays* L.) under different water regimes

Jaishreepriyanka R[1] and Shyam Sundar Mandal[2]
[1] Ph.D. Scholar, Department of Genetics and Plant Breeding, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu 641003, India.[2] Junior Scientist-cum-Assistant Professor, Department of Plant Breeding and Genetics, Bihar Agricultural College, Bihar Agricultural University, Sabour, Bhagalpur 813210, Bihar, India.
E-mail: jondhaless17@gmail.com

Introduction

Maize (*Zea mays* L.) is one of the most important food crops that represents as the staple food of many developed and developing countries. It can also be processed and value-added to various processed products. It is greatly preferred by the farmers for its versatility and good yield potential, making it as a potential crop for crop improvement works. Being predominantly cultivated as a *kharif* crop in India, maize faces drought and waterlogging stresses during *kharif*. Waterlogging stress affects the reproductive stage of the crop and results in yield loss. However, tolerance to waterlogging is found to be present in the crop and improvement of maize for waterlogging tolerance could be a good scope. For progressive research in stress tolerance, it is necessary to understand the morphological and genetic variability in the crop. The information on the general and specific combining ability effects can be studied using Line × Tester mating design, which was given by Kempthorne (1957). The design is widely used in quantitative studies on maize, to determine the nature and magnitude of gene action and inheritance characteristics, which are the important prerequisites in breeding for stress tolerance. The present investigation was framed to study the combining ability in maize under waterlogging and optimal water conditions.

Methodology

Ten lines were selected and crossed with three testers in line × tester design in *rabi*, 2018 at the experiment field of Maize Section, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India. In *kharif*, 2019 the 30 crosses and parents are evaluated with two checks under both optimal and waterlogging conditions. The details of the lines, testers and checks used in the investigation are presented in Table 1. For waterlogging environment, waterlogging treatment is given by maintaining stagnant water for seven days once during knee-high stage and once during tasseling stage of the crop. The parents, hybrids and the checks are studied for 13 morphological traits including days to 50 per cent tasseling (days), days to 50 per cent silking (days), anthesis – silking interval (days), days to 75 per cent brown husk (days), plant height (cm), ear height (cm), cob length (cm), cob girth (cm), number of rows per cob, number of grains per row, test weight (g), shelling percentage (%) and grain yield at 15% moisture (kg ha^{-1}) under both optimal and waterlogging conditions. Analysis of Variance of the characters was done as per standard statistical procedure for randomized complete block design as given by Panse and Sukhatme (1978) and the line × tester analysis was done using the method suggested by Kempthorne 1957. The analysis for GCA and SCA was carried out following Singh and Chaudhary (1979).

Results

From the analysis of variance for combining ability, it can be observed that there is presence of both additive and non-additive gene actions in the inheritance of the traits studied. The SCA variances were found to be greater than the GCA variances for the traits plant height, ear height, cob length, cob girth, number of rows per cob, number of grains per row, test weight, shelling percentage and grain yield at 15% moisture under both optimal and waterlogging condition, indicating the preponderance of non-additive gene action for the inheritance of these traits. These observations were in agreement with those of Archana *et al*. (2018), Ahmed *et al*. (2017).

The GCA and SCA effects were found to be having both significantly positive and significantly negative values for various traits studied in the investigation. Based on the gca effects observed, L_1 and T_2 were found to be a good combiner for earliness, while L_8 and T_1, were found to be good combiners for grain yield under both optimal and waterlogging conditions. Based on the sca effects, $L_6 \times T_3$ and $L_2 \times T_3$ were found to be good cross combinations for earliness under optimal conditions, while none of the combinations showed significant negative sca effects for earliness traits. However, the crosses $L_1 \times T_2$, $L_2 \times T_3$, $L_3 \times T_3$, $L_5 \times T_3$, $L_6 \times T_3$, $L_7 \times T_1$, $L_9 \times T_1$ and $L_{10} \times T_1$ were found to be good cross combinations for grain yield under both optimal and waterlogging conditions.

Table 1. Details of lines, testers and checks

S.No.	Code	Pedigree	Source
1	L_1	(CML451-B*4//CML451-BBB/ZEWBc1F2-216-2-2-B-2-B*4-1-B-1-BB///CML451-B*4//CML451-BBB/CML444-1-BB)/(CML451-B*4//CML451-BBB/LaPostaSeqC7-F86-3-1-2-1-B*6///CML451-B*4//CML451-BBB/DTPWC9-F24-2-3-1-3-2-1-2-B*4)-B-3-2-BBB1-B	
2	L_2	((CML451-B*4//CML451-BBB/LaPostaSeqC7-F18-3-2-2-3-B*7///CML451-B*4//CML451-BBB/DRB-F2-60-1-1-1-BBB-3-B)-BB/(LPSC7-F96-1-2-1-1-BBB*//OFP39)-6-1-1-1-2BB)-B-11-BB-B2-B	
3	L_3	(POP501C5#9/GEMS-0053)-B-9-2-1-1-BB	
4	L_4	(HSBC1F1-12)DH10-B-#-BBB	CIMMYT, Hyderabad
5	L_5	(CLQRCYQ44-B*8/[(CTS013082/P3011F2-5-3-1-3-B*4/Nei402011)-BB/G17C3H883-1-BB-3-3-B)-BBB-1-B-B	
6	L_6	(POP-501C5#2/GEMS-0009)-B-15-3-1-1-BBB	
7	L_7	(AMDROUT1(DT-Tester)C1F1-36-B*5/(CML451/LH82//CML451)-B-8-1-1-1-B)-B-3-B-B1-B	
8	L_8	((CML466/CML165-B//CML466)-BB-9-B*4/(CML465/CML165-B//CML465)-BB-36-B*5)-B-10-B-B1-B	
9	L_9	(AMDROUT2C2-17-B*4/POP502C5#4/GEMN-0159)-B-19-3-1-1-B)-B-3-2-B1-B	
10	L_{10}	((CA34505xCA00302)-B-2-1-B-1-B(T)/ZEWBC1F2-216-2-2-B-2-B*4-1-B-1-BB)-B-B1-B-2-BB1-B	
11	T_1	CLO2450	CIMMYT, Hyderabad
12	T_2	CM501	IIMR, Ludhiana
13	T_3	BML-7	ANGRAU, Hyderabad
14	C1	SHM 1	BAU, Sabour
15	C2	DHM 117	ANGRAU, Hyderabad

Conclusion

The good general combiner lines observed in the study, may be used in hybridization programmes for maize improvement. The best cross combinations observed in the study, may be forwarded for multi-location testing and Front Line Demonstration, and then promising crosses can be released as hybrid. Stable genotypes observed under waterlogging condition, may be utilized in deriving high yielding hybrids for waterlogging tolerance. The variability detected in the genotypes in the study, may be utilized for the exploitation of heterosis. Good hybrids may also be used for development of good inbred lines.

References

Ahmed S, S Begum, MA Islam, M Ratna and MR Karim. 2017. Combining ability estimates in maize (*Zea mays* L.) through line × tester analysis, Bangladesh Journal of Agricultural Research, 42(3): 425-436.

Archana KA, PH Kuchanur, PH Zaidi, SS Mandal, B Arunkumar, A Patil, MT Vinayan and K Seetharam. 2018. Combining ability and heterosis in tropical maize (*Zea mays* L.) under heat stress, Journal of Pharmacognosy and Phytochemistry, 7(6): 1026-1031.

Kempthorne O. 1957. An introduction to statistics, John Wiley and Sons. Inc. New York. 468- 471.

Panse VG and PV Sukhatme. 1969. Statistical methods for agricultural workers. ICAR. New Delhi.

Singh PK and RD Choudhary. 1997. Biometrical Methods, In. Quantitative Genetic Analysis, Kalayani Publishers, New Delhi, 178-185.

ICSCI 2022/T3/59

Influence of Diversification of rice based cropping systems on yield, economic returns and soil health in North Konkan Coastal zone of Maharashtra

S. B. Bhagat[1], D. G. Jondhale[2],N.V.Mhaskar[3], A. V. Dahiphale[4] , and T. J. Bedse[5]
[1]*Chief Agronomist,* [2]*Jr. Soil Scientist,*[3]*Jr. Scientis(Agronomy),*[4]*ECF Agronomist* [5]Biochemist, *Regional Agril. Research Station, Karjat, Dist Raigad, Maharashtra*
E-Mail: sbbhagat1791@gmail.com

Introduction

Continuous cultivation of rice for longer periods with low system productivity, and often with poor crop management practices,results in loss of soil fertility due to emergence of multiple nutrient deficiency (Dwivedi *et al*., 2001) and deterioration of soil properties, crop yields in high productivity areas.Continuous adoption of rice-rice cropping system has led to deterioration of soil quality resulting in a serious threat to its sustainability in high rainfall zone of North Konkan, Maharashtra. Therefore, crop diversification with wider choice in the production of a variety of crops is being promoted to restore the soil fertility. Crop diversification has beenrecognized as an effective strategy for achieving the objectives of food security,nutrition security, income growth, poverty alleviation, employment generation,judicious use of land and water resources, sustainable agricultural developmentand environmental improvement (Hedge *et al*., 2003) growing non paddy crops during post rainy season has special reference for efficient utilization of irrigation water, labour and other inputs for higher productivity, profitability and food security and to maintain soil health. Therefore, the present investigation was carried out to find out most productive, resource-use-efficient and remunerative cropping system for this region.

Methodology

A field experiment was conducted at Model Agronomic Experiment Farm, Karjat Dist. Raigad, Maharashtra on medium black soil to evaluate the production potential, sustainability, economics and soil fertility of 10 cropping systems based on rice.The crops in sequences after *Kharif* rice included existing crops *Viz.*, okra , field bean, soil health crop cowpea, greengram, family nutrition sesame +blackgram, groundnut+ long yard bean, fodder crops oat, rice bean income generation sweetcorn and cucumber followed by *Kharif* rice with four replications in Randomized Block Design during 2020-2021.

Results

Total rice equivalent yield (TREY) of Rice-Cucumber was the highest (282.35 q ha^{-1}) followed by 'Rice-Okra' sequence (239.38 q ha^{-1}). Rice-Cucumber crop sequence secured maximum and numerically higher gross returns (Rs. 5,27,438/- ha^{-1}), net returns (Rs. 2,82,755/- ha^{-1}) and B:C ratio of 2.16 respectively. 'Rice-Sweet corn' crop sequence stood second (Rs. 1,77,544/- ha^{-1}) in case of net returns and B:C ratio (2.07) (Table 1). Organic carbon (1.18%) was significantly higher and identical in Rice – Cowpea system, Rice- Groundnut + Long Yard Bean systems and remained at par with Rice – Field bean, Rice-Greengram, Rice-Sesame + Black gram. Maximum and significantly higher available nitrogen (248.37 kg ha^{-1}) and P_2O_5 (28.21kg ha^{-1}) was observed under 'Rice- Cowpea' crop sequence except, Rice – Field bean, Rice-Greengram, Rice- Sesame + Black gram, Rice-Okra and Rice- Groundnut + Long Yard Bean systems. Significantly the highest available K_2O content (254.35 kg ha^{-1}) of soil was observed due to 'Rice-Sweet corn' system which was at par with Rice- Cucumber' (Table 2).

Table 1: Mean grain/pod/fruit/fodder/cob yield and monetary returns from various crop sequences

Treatment	Mean Yield (q ha-1)		Rabi crops REY (q ha-1)	System REY (q ha-1)	Total gross returns (Rs.ha-1) (K+R)	Net returns (Rs.ha-1) (K+R)	B:C ratio
	2020	2020-21	2020-21	2020-21			
Rice- Okra	39.28	112.80	193.65	239.38	447164	173733	1.64
Rice- Field bean	40.22	9.07	51.09	98.43	183858	56654	1.45
Rice- Cow pea	43.84	10.42	46.73	98.93	184804	60404	1.49
Rice- Green gram	32.07	11.55	64.39	101.60	189787	70123	1.59
Rice-Sesame + Black gram	42.02	6.43	46.18	96.04	179404	61698	1.52
Rice-Groundnut + LYB	25.12	19.79	92.41	125.19	233847	64522	1.38
Rice- Oat	44.19	395.11	63.45	115.75	216213	95837	1.80
Rice- Rice bean	45.10	188.67	60.60	114.16	213244	93890	1.79
Rice- Sweet corn	44.79	153.37	131.05	183.69	343129	177544	2.07
Rice- Cucumber	47.25	176.35	227.04	282.35	527438	282755	2.16
CD (P=0.05)	2.28	--	9.16	8.90			

Selling rates (Rs.q^{-1})

Crop	Rice grain	Okra (Fruits)	Field bean	Cow pea	Green gram	Sesame	Black gram	G'nut (Dry pods)	Long yard bean	Oat (GF)	Rice bean (GF)	Sweet corn	Cucumber
Grain	1888	3200	10000	8000	10000	13000	10000	8000	2400	300	600	1200	3200
Straw	250	25	200	200	200	25	200	200	200	-	-	400	25

Table 2: Effect of different treatments on chemical properties of soil after harvest of *Rabi* crops.

Treatment	pH (1:2.5)	E.C. (dSm^{-1})	O.C. (%)	Av. N (kg ha^{-1})	Av. P_2O_5 (kg ha^{-1})	Av. K_2O (kg ha^{-1})
Rice- Okra	6.82	0.23	1.11	231.44	26.81	239.57
Rice- Field bean	6.81	0.22	1.15	233.95	27.28	236.88
Rice- Cow pea	6.88	0.22	1.18	248.37	28.21	233.86
Rice- Green gram	6.85	0.21	1.15	247.12	27.98	232.51
Rice-Sesame + Black gram	6.80	0.21	1.16	244.61	27.75	226.95
Rice-Groundnut + LYB	6.83	0.21	1.18	240.22	27.51	231.50
Rice- Oat	6.84	0.21	1.10	227.05	25.65	229.49
Rice- Rice bean	6.83	0.21	1.12	228.93	25.88	227.14
Rice- Sweet corn	6.81	0.22	1.07	221.40	24.25	254.35
Rice- Cucumber	6.88	0.21	1.10	225.16	24.95	251.66
CD (0.05)	NS	NS	0.04	18.44	2.03	8.36
Initial values	**7.01**	**0.30**	**0.97**	**217.28**	**24.00**	**240.12**

Conclusion

‘

Rice-Green gram’, Rice -Groundnut + Long Yard Bean, ‘Rice-Field bean’ Rice-Sesame + Black gram, Rice-Field bean, Rice-Sweet cornand Rice-Cucumber systems were the most productive, sustainable and remunerative cropping system to maintain soil fertility.

References

Dwivedi BS, AK Shukla, VK Singh and RL Yadav. 2001. Results of participatory diagnosis of constraints and opportunities (PDCO) based trials from the state of Uttar Pradesh. In: Subba Rao, A., Srivastava, S. (Eds.), Development of Farmers’ Resource-Based Integrated Plant Nutrient Supply Systems: Experience of a FAO–ICAR–IFFCO Collaborative Project and AICRP on Soil Test Crop Response Correlation. IISS, Bhopal, India, 50–75.

Hegde DM, S Prakash Tiwari and M Rai. 2003. Crop diversification in Indian Agriculture, Agricultural Situation in India, August, 2003, 351-354.

Fujisaka S, L Harrington and P Hobbs. 1994. Rice–wheat in South Asia: systems and long-term priorities established through diagnostic research, Agricultural Systems, 46(2): 169–1

CSCI 2022/T3/61

Evaluation of aerobic rice genotypes for yield and water productivity under low and high fertilizer levels

Amit Kumar*, ***Rakesh Kumar, Mahaveer Singh, Sumit Saini, Ashish Jain, Sukham Madaan, O. P. Lathwal and Mangat Ram***

Chaudhary Charan Singh Haryana Agricultural University (CCSHAU),
Rice Research Station Kaul, (Kaithal), Haryana 136021

Introduction

Rice is the major food crop of Kharif season in north–western part of Indo-Gangetic Plain in India including Haryana where it is commonly grown by transplanting method of establishment under lowland conditions. But transplanted lowland rice culture requires a large amount of water for maintenance of submergence and labour for transplanting operations. In these areas ground water is used as a primary source of irrigation to meet the high water requirement of the crop which has resulted into serious depletion of groundwater resources. Direct seeded rice (DSR) grown under unpuddled and un-flooded conditions (aerobic rice) is a resource conservation and climate resilient technology as it not only helps in saving water but also labour and hence can be a good alternative to the conventional transplanted rice (PTR) . But there is dearth of rice genotypes suitable for aerobic conditions and the yield of presently available lowland rice genotypes has been found to reduce under direct seeded aerobic conditions (Kumar and Ladha, 2011) because of possible water stress. The extent of the yield reduction may vary with the cultivar grown and its duration (Joshi, 2016). Therefore, there is need to identify rice cultivars suitable for direct seeded aerobic conditions to mitigate or at least to minimize the yield reduction under water deficit conditions. In view of this, the present field experiment was conducted to evaluate various rice cultivars under direct seeded aerobic conditions.

Methodology

The field experiment was conducted during *kharif* season of 2021-22 at CCSHAU Rice Research Station, Kaul, Haryana on a clay loam soil which was alkaline in reaction (pH 7.9), low in available N (160 kg N/ha), medium in available P (16 kg P/ha) and high in available K (320 kg K/ha). The treatments of the experiment consisted of two fertilizer levels viz. 50% and 100% of recommended dose of fertilizers (RDF) and five rice genotypes, including advance breeding lines and popular varieties, which were laid out in split plot design with three replications keeping the fertilizer levels in main plots and genotypes in sub-plots. In RDF, only N and P were supplied through urea and single superphosphate, respectively whereas K was not applied as the soil was high in K. The crop was sown in the field during 3rd week of June on well prepared flat seed bed in rows 20 cm apart. The field was irrigated immediately after sowing to provide soil moisture for germination. Thereafter, the crop was irrigated (50 mm each) at 5 days after disappearance of ponded water from the soil surface. All other recommended agronomic and plant protection practices were followed to raise the crop.

Results

Yield attributes (number of panicles/m^2 and grain weight/panicle) and grain yield of aerobic rice, when averaged over the genotypes, increased significantly when the fertilizer level was increased from 50% to 100% RDF (Table 1). Among the rice genotypes, HURS 18-2-IR98976-20-1-2-2 exhibited the highest number of panicles/m^2 whereas YRH 2027, though at par with RCPR 63-IR 97034-21-2-1-3 in respect of 1000-grain weight, possessed the highest 1000-grain weight and the heaviest panicle. Genotype HURS 18-2-IR98976-20-1-2-2 was found to be the most promising under aerobic conditions as it gave the highest grain yield (5582 kg/ha), significantly out yielding the other genotypes. The other genotypes, however, yielded at par with the local varieties. Flowering (50% flowering) in all the elite lines occurred earlier than HKR 47 with YRH 2027 (Hybrid) being the earliest in flowering.

Table 1: Yield attributes and grain yield of aerobic rice as influenced by fertilizer levels and genotypes.

Treatment	Days to 50% flowering	No. of panicles/m^2	1000- grain weight (g)	Grain weight /panicle (g)	Grain yield (kg/ha)
Fertilizer levels					
50% of RDF	91	176	25.7	2.81	4411
100% of RDF	91	208	25.9	2.93	5647
CD (p=0.05)	-	19	NS	0.07	935
Cultivars					
RCPR 63-IR 97034-21-2-1-3	92	192	27	2.85	5008
YRH 2027 (Hybrid)	82	158	28.7	3.46	4962
HURS 18-2-IR98976-20-1-2-2	90	222	24.5	2.73	5582
HKR 47 (Local Check)	102	192	25.1	2.71	4843
HKR 48 (Local Check)	89	196	23.7	2.60	4750
CD (P=0.05)	-	18	2.1	0.16	358

The irrigation water applied and total water requirement was minimum in genotype YRH 2027 but the highest water productivity was obtained with HURS 18-2-IR98976-20-1-2-2 (Table 2) obviously due to its higher grain yield.

Table 2. Water requirement and water productivity of aerobic rice as influenced by fertilizer levels and genotypes

Treatment	Irrigation water applied (mm)	Total water requirement (mm)	Water productivity (kg/mm)
Fertilizer levels			
50% of RDF	960	1640	2.69
100% of RDF	960	1640	3.44
Cultivars			
RCPR 63-IR 97034-21-2-1-3	970	1650	3.03
YRH 2027	870	1550	3.20
HURS 18-2-IR98976-20-1-2-2	970	1650	3.38
HKR 47 (Local Check)	1070	1750	2.77
HKR 48 (Local Check)	920	1600	2.97

Conclusion

It can be concluded from the results of the present field experiment that rice genotype HURS 18-2-IR98976-20-1-2-2 was found to be the most promising under aerobic conditions as it gave the highest grain yield (5582 kg/ha) as well as water productivity.

References

Joshi, R. 2016. Management interventions to enhance water productivity in dry seeded rice (Oryza sativa L.). *Intern. J. Agric. Environ. Biotech*. 9: 69-83.

Kumar, V. and Ladha, J.K. 2011. Direct seeding of rice: Recent developments and future research needs. *Adv. Agron*. 111: 299-391.

ICSCI 2022/T3/62

Diversity analysis for gall midge resistance and yield attributes in rice (*Oryza sativa* L.)

B. Srinivas, P. Gonya Nayak, B. Laxmi Prasanna, P. Madhukar, S. Omprakash and M. Uma Devi

Regional Agricultural Research Station, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Polasa, Jagtial, Telangana, India – 505 529

Introduction

India is the world's second largest producer of rice cultivated in 43.86 m.ha. with production of 120 m.t. It is the major staple food for the people of the country across the states. The production levels are 2.39 t/ha which is low when compared to China (6.71 t/ha) and Vietnam (5.57 t/ha). Apart from improper management practices and use of inferior quality seed, various biotic and abiotic factors causing severe yield losses. Asian Rice Gall Midge, *Orseolia Oryzae* (Wood-Mason) is one of the major pests after stem borer and plant hoppers causing yield losses in 30-70 per cent of total rice area (Mathur *et al.* 1984). Out of 7 biotypes identified specific to different locations, biotype 3 is specific to Northern Telangana Zone. Screening and evaluation diverse lines at hot spot locations results in identification of genotypes with high yield and pest resistance. The main objective of this study is to identify the genotypes with gall midge tolerance and other desirable agronomic characters through diversity analysis for their further evaluation to release as varieties and also to use as donors in breeding programmes.

Methodology

About 30 rice genotypes were evaluated during *kharif*, 2021 in two replications with spacing of 15x15 cm and plot size of 7.02 m^2 at Regional Agricultural Research Station, Jagtial, PJTSAU, Telangana state, India located at 18°50'20.24" N latitude, 78°56'54.20" E longitude and 249 m above mean sea level, part of Northern Telangana. The data was recorded on 10 random plants from each entry and replication for effective bearing tillers/m^2, plant height (cm), panicle length (cm) and number of grains/panicle. Days to 50% flowering and yield (kg/ha) were estimated on whole plot basis and random sample was used to record 1000 grain weight (g). Incidence of gall midge was recorded as per cent tillers affected with silver shoots (SES, IRRI, 2002) on 10 random hills and averaged. Multivariate analysis was done as per Mahalanobis D2 statistic described by Rao (1952).

Results

The analysis of variance revealed presence of significant amount of variability in 30 genotypes studied for 8 characters. Of all the traits studied, huge difference between PCV and GCV was observed for per cent gall midge incidence revealed the huge role of environment. High heritability coupled with high genetic advance was observed for number of grains/panicle and per cent gall midge incidence indicated the role of additive genes and hence selection in negative direction for gall midge incidence is desirable. Based on D^2 values, 30 genotypes were grouped into 7 clusters with the highest number of genotypes allotted to cluster I (13) followed by cluster II (11) and cluster VI (2) and single genotype is allotted to remaining each of 4 clusters. The highest inter cluster distance was observed between clusters III and VI followed by clusters I and VI and clusters III and VII. Crossing between genotypes from these clusters would yield early duration segregants with fine and coarse type grains. JGL 41240 (Cluster IV) could be the good source for development of dwarf varieties as dwarf stature enables lodging resistance. Consumer preference towards super fine rice is increasing and hence use of RNR 15048 (Cluster VII) in breeding programme could fulfill the present day consumer needs. Segregants with long duration, more number of grains/panicle and gall midge resistance can be obtained from the crosses between cluster V and VI genotypes. But, short duration varieties with gall midge resistance is the need of hour for Telangana state because long and medium duration varieties does not fit under late sowing situations as late sowings increases gall midge incidence. Genotypes from clusters I, II, III, V and VI can be used breeding programme for development of early varieties with gall midge resistance. Present experimental material is rich source of diversity for the trait days to 50% flowering as it contributes 50.11% to the total divergence among all the traits studied.

Table 1: Average intra (Diagonal) and inter cluster distances for 7 clusters

	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI	Cluster VII
Cluster I	35.90	116.74	61.18	56.27	69.77	455.37	243.63
Cluster II		30.54	234.07	110.38	105.31	198.76	84.41
Cluster III			0.00	107.45	140.08	698.06	421.96
Cluster IV				0.00	110.62	368.51	246.06
Cluster V					0.00	307.97	117.06
Cluster VI						34.40	80.85
Cluster VII							0.00

Table 2: Cluster means and per cent contribution of each trait towards total divergence

	Days to 50% flowering	No. of effective bearing tillers/m2	Plant height (cm)	Panicle length (cm)	1000 grain weight (g)	No. of grains/panicle	Yield (kg/ha)	% gall midge incidence
Cluster I	89	303	117.8	26.2	26.71	165	6812	22.12
Cluster II	96	325	131.0	25.4	24.01	155	6463	12.82
Cluster III	86	352	104.8	23.5	26.96	114	5344	30.59
Cluster IV	94	293	97.9	25.2	30.90	133	7190	28.61
Cluster V	89	275	118.5	25.5	18.76	264	5779	0.79
Cluster VI	104	320	116.6	24.0	17.08	268	6836	12.95
Cluster VII	97	269	127.1	25.9	13.51	248	5587	14.10
% contribution of character	50.11	0.23	14.71	5.06	12.41	12.87	2.76	1.84

Conclusion

Screening at hot spot location resulted in identification of gall midge tolerant genotypes (JGL 41274, JGL 41607, JGL 41608 and JGL 41652). Development of early varieties with gall midge resistance which are suitable for late sowing conditions for Telangana is possible using the present genetic material.

References

Mathur KC, S Rajamani. 1984. Orseolia and rice: Cecidogenous interactions. Proceedings: Animal Science. 93: 283–292.

Rao, CR, 1952. Advance Statistical Methods in Biometrical Research. John Wiley and Sons, New York.

ICSCI 2022/T3/63

Residue management using microbial culture in rice-based cropping systems *of coastal deltaic region of Karaikal*

L. Aruna[1], K. Surekha[2] and M. B. B. Prasad Babu[2]
[1] PJN College of Agriculture and Research Institute, Karaikal, UT of Puducherry, India
[2] IIRR, Rajendira nagar, Hyderabad, India
E-mail: marunassac@gmail.com

Introduction

India at present finds itself amid a paradoxical situation of prodigious production of rice and wheat (food grains) for meeting the country's food security needs, co-existing with increasing problem of residue disposal. In India, huge quantities of crop residues (about 371 million tons) are produced annually of which paddy residues constitute 51–57%. The disposal of paddy residues has become a big problem, mainly due to the use of combine harvester and narrow time gap (one to three weeks) between paddy harvesting and planting of next crop, resulting in farmers preferring to burn the residues in-situ. Burning biomass pollutes environment by depleting air quality, emitting greenhouse gases (GHGs) besides being deleterious to soil microbes (Mandal *et al*., 2004; Lohan *et al*., 2018).

Straw is the only organic material available in significant quantities to most rice farmers and about 40 percent of the nitrogen (N), 30 to 35 percent of the phosphorus (P), 80 to 85 percent of the potassium (K), and 40 to 50 percent of the sulfur (S) taken up by rice remains in vegetative plant parts at crop maturity. The major impact of straw removal is on the soil K balance where complete straw removal over several cropping seasons without replenishing soil K with mineral fertilizer is likely to lead to increased incidence of K deficiency (Dobermann and Fairhurst, 2002). Thus, proper residue management is of utmost important as it contains plant nutrients and improves the soil-plant-atmospheric continuum. The major components of rice straw are hemicelluloses, cellulose, lignin and water- soluble polysaccharides The rate of decomposition was positively correlated with cellulose, while negatively to amount of lignin and polyphenol content in residues. Microbial consortium, capable of producing hydrolytic enzymes responsible for the degradation of the polysaccharides in plant cell wall results in faster decomposition. Therefore, the trial was initiated to study the role of microbial culture in decomposition of crop residues in turn on rice productivity in rice-based cropping systems.

Methodology

To study the influence of rice residue on rice crop productivity, a trial was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, UT of Puducherry with eight treatments *viz*., application of recommended dose of fertilizers (RDF), rice residues to supply 100% N with and without the addition of Pusa Decomposer, residues in combination with either chemical fertilizer or green leaf manure (GLM) to supply the 100% N requirement with and without the addition of Pusa Decomposer along with a control in three replications. The experimental soil was neutral, non- saline, medium in organic carbon status with sandy loam texture. The fertility status was low, high and medium with respect to available nitrogen, phosphorous and potassium.

Results

Application of 100% N through RDF registered highest grain yield (4.17 t ha^{-1}) which was on par with combined application of rice residues with N fertilizer (4.14 t ha^{-1}), rice residues with GLM and PD (3.86 t ha^{-1}) and rice residues with N fertilizer and PD (3.67 t ha^{-1}). The control produced the lowest grain yield (3.13 t ha^{-1}). The results proved that the crop residues can be deployed along with microbial culture to substitute half of the recommended nitrogen without yield penalty. The biodegradation of the lignocellulosic material had been enhanced by pusa decomposer yielding in comparison with RDF. No significant difference with respect to straw yield among the treatments, however numerically higher straw yield was recorded in the treatment combination of residues with GLM and PD (13.83 t ha^{-1}).

The significant effect of residue application on nutrient uptake was only with N and the highest N uptake was observed in rice residues with N fertilizer (120 kg ha^{-1}) that was on par to rice residues with GLM and PD (110 kg ha^{-1}) and RDF (97 kg ha^{-1}) treatments.

Conclusion

Supplementing half of the recommended N through rice residues (50% N) and remaining (50% N) either through fertilizer or GLM with microbial culture yielded at par with each other and on par with RDF (100% N) in terms of grain yield. The results showed that the crop residues along with Pusa decomposer can be deployed to substitute half of the recommended nitrogen without yield penalty.

References

Dobermann A and TH Fairhurst. 2002. Better Crops International, 16: 7 – 11.

Gathala M, JK Ladha, V Balyan, YS Saharawat, V Kumar and PK Sharma. 2011. Effect of Tillage and Crop Establishment Methods on Physical Properties of a Medium-Textured Soil Under 7-Year Rice-Wheat Rotation, Soil Science Society of America Journal, 75(5): 1-12.

Jat ML, YS Saharawat and R Gupta. 2011. Conservation Agriculture in Cereal Systems of South Asia: Nutrient Management Perspectives, Karnataka Journal of Agricultural Sciences, 24(1): 100-105.

Lohan SK, HS Jat, AK Yadav, HS Sidhu, ML Jat, M Choudhary, JK Peter and PC Sharma. 2018. Burning Issues of Paddy Residue Management in North-West States of India, Renewable and Sustainable Energy Reviews, 81: 693-706.

Mandal KG, AK Misra, KM Hati, KK Bandyopadhyay, PK Ghosh and M Mohanty. 2004. Rice Residue-Management Options and Effects on Soil Properties and Crop Productivity, Journal of Food, Agriculture and Environment, 2: 224-231.

ICSCI 2022/T3/64

Quantification of methane emission from paddy field in medium black soil of konkan region

T. J. Bedse[1], D.G. Jondhale[2], P.B. Vanve[3], A.V. Dahiphale[4], B. D. Waghmode[5] and S.B. Bhagat[6]
Regional Agriculture Research Station, Karjat, District Raigad.
Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli 415712, Maharashtra, India
E-mail: -tusharjbedse@gmail.com

Introduction

The methane is considered as second most significant greenhouse gas after CO_2 causing 20–30% of global warming effect. Considering last three-decade methane showed trend of continuous increment in the global atmospheric concentration. In year 1983 atmospheric CH_4 concentration was 1625.4 ppb and found up to 1893.4 ppb in 2021 (Anonymous, 2021). Methane exhibit '28 times' more potential for global warming than the carbon dioxide, because which perceives more capacity to entraps radiation on molecular basis.

In Maharashtra particular Konkan region large area under rice cultivation. Rice cultivation facing major problem of methane gas emission under anerobic condition. In rice field Methanogenesis and Methanotrophy are the fundamental processes in relation to production, emission and mitigation of methane (Nazaries *et al.*, 2013). Thus, the present experiment was undertaken to study the effect of different nutrient and mitigation sources responsible for methane gas emission in rice crop.

Methodology

The field experiment was conducted at Regional Agricultural Research Station, Karjat. The experiment was laid out in Factorial Randomize Block Design. Rice (*Oryza sativa* L.) variety Karjat-3 was selected for the experiment during the *Kharif* season of the year, 2020-21. The experiment consists of 16 total treatment combinations which is comprised the four nutrient sources (R0: absolute control, R1: RDF through chemical fertilizer, R2: FYM @ 10 t/ha and R3: RDF through KAB briquettes) and four mitigation sources (M0: absolute control, M1: Ortho silicic acid 0.08% @15 kg/ha through soil application, M2: Rice husk biochar @ 5t ha^{-1}, and M3: Azolla @ 1 t/ha) and one absolute control treatment in both the sources.

Results

Effect of nutrient sources

The effect of various nutrient sources in quantification methane flux at different growth stages is presented in the Table. The methane flux at panicle initiation stage was observed from 4.35 to 5.40 mg m^{-2} hr^{-1}. Application of Konkan Annapurna Briquette showed significantly lowest (4.35 mg m^{-2} hr^{1}) methane flux and which was found superior over the remaining treatments. Whereas, the highest methane flux (5.40 mg m^{-2} h^{-1}) was reported from the R_2 treatment, i.e. FYM 10 ha^{-1}. At the grain filling stage, the methane flux was in the range of 3.01 to 3.76 mg m^{-2} hr^{-1} and the highest flux (3.76 mg m^{-2} hr^{-1}) was observed by application of R_2 treatment i.e FYM 10t/ha. The application of Konkan Annapurna Briquette

R_3-treatment showed significantly lowest methane flux (3.01 mg m^{-2} hr^{-1}) from the submerged paddy (Table 1). It was found significantly lowest as compared to other treatments. Application of the different nutrient sources showed non-significant effect on the methane flux at harvest stage of the rice. However, the methane flux ranged from 0.99 to 1.25 mg m^{-2} hr^{-1} at harvest.

Table 1: Effect of application of different sources on methane flux (mg $m^{-2}hr^{-1}$) at different growth stages

Treat ments	Panicle Initiation					Grain filling					At harvest				
	R_0	R_1	R_2	R_3	Mean	R_0	R_1	R_2	R_3	Mean	R_0	R_1	R_2	R_3	Mean
M_0	5.23	5.11	5.56	4.71	5.15	3.53	3.69	4.14	3.25	3.65	1.50	1.14	1.26	1.01	1.23
M_1	4.14	4.62	4.91	3.93	4.40	2.92	3.53	3.12	2.92	3.12	0.81	0.93	1.05	1.18	0.99
M_2	4.62	5.39	5.92	4.26	5.05	2.96	3.16	3.77	2.76	3.16	1.22	1.26	1.18	0.85	1.13
M_3	4.95	5.56	5.19	4.5	5.05	3.00	3.41	4.02	3.12	3.39	0.65	1.01	1.50	0.93	1.02
Mean	**4.74**	**5.17**	**5.40**	**4.35**	**4.91**	**3.10**	**3.45**	**3.76**	**3.01**	**3.33**	**1.05**	**1.09**	**1.25**	**0.99**	**1.09**
	R	M	RXM			R	M	RXM			R	M	RXM		
S.E.±	0.012	0.015	0.027			0.028	0.037	0.064			0.023	0.029	0.051		
C.D.@0.05	0.035	0.045	0.079			0.083	0.107	0.185			NS	NS	NS		

Effect of mitigation sources

At the panicle initiation stage methane flux range between 4.40 to 5.15 mg m^{-2} hr^{-1} The M_1 treatment i.e. Ortho silicic acid 0.08% @15 kg ha^{-1} reported significantly lowest methane flux (4.40 mg m^{-2} hr^{-1}) over rest of the treatments. The highest methane flux (5.15 mg m^{-2} hr^{-1}) was noticed in the treatment M_0 indicating absolute control. At grain filling stage of the rice methane flux ranged from the 3.12 to 3.65 mg m^{-2} hr^{-1}). The application of the Ortho silicic acid 0.08% @15 kg/ha silica found to be significantly lowest (3.12 mg m^{-1} hr^{-1}) methane emission which was at par with the treatment M_2 i.e Rice husk biochar @ 5t ha^{-1}. The highest emission activity (3.65 mg m^{-2} hr^{-1}) was noticed in the control (M_0) treatment. Application of the different mitigation sources showed non-significant effect on the methane flux at harvest stage of the rice. However, the data of methane flux ranged from 0.99 to 1.23 mg m^{-2} hr^{-1} at harvest.

Interaction Effect

Data regarding the interaction effect at panicle initiation stage indicated that methane flux from the medium black soil was varied from the 3.93 to 5.92 mg m^{-2} hr^{-1}. Significantly superior mitigation of the methane (3.93 mg m^{-2} hr^{-1}) was reported by the application of ortho silicic acid 0.08% @15 kg/ha in combination with Konkan Annapurna Briquette (34:14:6 N:P_2O_5:K_2O) over rest of the treatments. The highest methane flux at the panicle initiation stage recorded by the R_2M_2 treatment comprising of application of the FYM 10t/ha with Rice husk biochar @ 5t ha^{-1}

The interaction effect between nutrient sources and the mitigation sources at grain filling stage observed that methane flux from medium black soil was varied from the 2.76 to 4.14 mg m^{-2} hr^{-1}. Significantly superior mitigation of the methane (2.76 mg m^{-2} hr^{-1}) was reported by the application of Rice husk biochar @ 5t ha^{-1} in combination with Konkan Annapurna Briquette (34:14:6 N:P_2O_5:K_2O) over rest of the treatments. The highest methane flux at the grain filling stage recorded by the R_2M_0 treatment comprising of application of the FYM 10t/ha with absolute control treatment. At harvest stage the interaction effect between nutrient sources and mitigation sources did not reached the level of significance. The data in relation to the methane flux after harvest stage of rice was ranged from the 0.65 to 1.50 mg m^{-2} hr^{-1}.

Conclusion

From this study it is revealed that significantly superior mitigation of the methane gas emission was reported by the application of ortho silicic acid 0.08% @15 kg/ha in combination with Konkan Annapurna Briquette (34:14:6 $N:P_2O_5:K_2O$).

References

Anonymous, (2021) https://noaa.gov

Nazaries L, J Colin, Murrell, P Millard, L Baggs and BK Singh. 2013. Methane, microbes and models: fundamental understanding of the soil methane cycle for future predictions, Environmental Microbiology, 15(9): 2395–2417.

ICSCI 2022/T3/65

Effect of foliar application of fertilizers on yield attributes, yield and economics of chickpea (*Cicer arietinum* L.)

Sharad Jadhav
Email: sharadsssjadhav882@gmail.com

Introduction

Chickpea (*Cicer arietinum* L.) popularly known as Gram or Bengal gram is most important and premier pulse crop of India. In 2017-18, chickpea was cultivated in about 106 Lha. The country harvested a record production of more than 111 Lakh tones at the ever-highest productivity level of 1056 kg ha^{-1} Anonymous. (2018) [3]. Chickpea is an important source of protein in diet and particularly important in vegetarian diet, also it is being used increasingly as a helpful source of zinc and foliate. In India, chickpea cultivation is being restricted mainly to rainfed areas or under residual moisture, lack of nutrient management, low harvest index and poor management of pest and diseases are main reason to low productivity. Foliar application of water-soluble fertilizers has good effect on growth, yield, and quality of crops (Patel and Patel, 1994) [8]. Application of nutrients through foliar spray along with soil application has several advantages in supplementing the nutritional requirement of crops. Retention of flower is possible through foliar application of nutrients as well as growth regulators during flower initiation and pod development stages along with soil application of nutrient (Chaurasia *et al*., 2005) [4].

Methodology

The field experiment was carried out during 2020-21 at experimental farm of Cotton Research Scheme, VNMKV Parbhani. The experiment was laid out in Randomized block design with eight treatments and three replications. There was eight treatments *viz*, T1 is RDF (No spray), T2 is RDF + 1% urea spraying, T3 is RDF + 1% DAP spraying, T4 is RDF + 1% 19:19:19 (N,P,K) spraying, T5 is RDF + 1% 00:52:34 (N,P,K) spraying, T6 is RDF + 13:00:45 (N,P,K) spraying, T7 is RDF + 1% 13:40:13 (N,P,K) spraying and T8- control (no RDF, no spray). Foliar application of fertilizers (1%) done at flowering and pod development stage. The treatments were allotted randomly in each replication. The recommended dose of fertilizer (25:50:25 NPK kg ha^{-1}) was applied at the time of sowing through Urea, SSP and MOP. The recommended cultural practices and plant protection measures were properly taken time to time. Five plants from all treatment were selected and labeled. These plants were used for measuring yield attributes.

Results

Effect of Foliar application of fertilizers on yield attributes

Data regarding mean number of pods $plant^{-1}$, seed weight $plant^{-1}$ and seed index (g) as influenced by various foliar application of fertilizers are presented in Table 1. Significantly maximum (83.78) number of pods $plant^{-1}$ was recorded by the T4 - RDF + 1% 19:19:19 (NPK) spraying at flowering and pod development as compared to all other treatments. The significantly higher seed weight $plant^{-1}$ (8.80 g) obtained in the T4 - RDF + 1% 19:19:19 (NPK) spraying at flowering and pod development which was found at par with T7 - RDF + 1% 13:40:13 (NPK) spraying at flowering and pod development (8.20 g) and T5 - RDF + 1% 00:52:34 (NPK) spraying at flowering and pod development i.e. (8.10 g) however it was significantly superior over all other treatments. Seed index not influenced significantly due to Foliar application of fertilizers. Numerically highest seed index (8.53 g) was recorded with T5 - RDF + 1% 00:52:34 (NPK) spraying at flowering and pod development stage followed by T4- RDF + 1% 19:19:19 (NPK) spraying at flowering and pod development (8.42 g) and T7 - RDF + 1% 13:40:13 (NPK) spraying at flowering and pod development (8.27 g). Significantly lower mean number of pods plant^{-1} (63.33), seed weight plant^{-1} (5.30) and seed index (g) (7.20) recorded with T8 -Control (No RDF, No spray).

Effect of Foliar application of fertilizers on yield

Data in respect of the grain yield (kg ha^{-1}) straw yield (kg ha^{-1}) are presented in Table 2. Data revealed that revealed that T4 - RDF + 1% 19:19:19 (NPK) spraying at flowering and pod development resulted in significantly highest grain yield (1870kg ha^{-1}) and it was statistically at par with T7 - RDF + 1% 13:40:13 (NPK) spraying at flowering and pod development (1778 kg ha^{-1}) and T5 - RDF + 1% 00:52:34 (NPK) spraying at flowering and pod development (1767 kg ha^{-1}), but significantly higher than rest of treatments. T4 - RDF + 1% 19:19:19 (NPK) spraying at flowering and pod development produced higher straw yield (2805 kg ha^{-1}) and biological yield (4675 kg ha^{-1}) it was at par with T7 - RDF + 1% 13:40:13 (NPK) spraying at flowering and pod development (2665 kg ha^{-1}) and (4418 kg ha^{-1}) respectively. Significantly lowest grain yield (1150 kg ha^{-1}), straw yield (1815 kg ha^{-1}), biological yield (2965 kg ha^{-1}) recorded in T8 - Control (No RDF, No spray). These findings were in conformity with Takankhar *et al.*, (2017).

Table 1: Mean Number of pods, Seed weight plant^{-1} (g) and Seed Index (g) as influenced by different treatments

Treatment	No. of pod plant^{-1}	Seed weight plant^{-1} (g)	Seed Index (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T1 - RDF (no spray)	69.06	6.80	7.70	1493	2299
T2 - RDF + 1% Urea spraying	74.71	7.20	7.71	1570	2418
T3 - RDF + 1% DAP spraying	75.36	7.50	7.75	1630	2445
T4 - RDF + 1% 19:19:19 (NPK) spraying	83.78	8.80	8.42	1870	2805
T5 - RDF + 1% 00:52:34 (NPK) spraying	75.89	8.10	8.53	1767	2575
T6 - RDF + 1% 13:00:45 (NPK) spraying	72.75	7.20	7.84	1557	2351
T7 - RDF + 1% 13:40:13 (NPK) spraying	79.24	8.20	8.27	1778	2665
T8 - Control (No RDF, No spray)	63.33	5.30	7.20	1150	1815
S. E. (m) +	1.20	0.25	0.35	44.9	53.8
CD at 5%	3.62	0.76	NS	135.6	162.5
General Mean	74.26	7.38	7.93	1602	2422

Conclusion

The foliar application of 1% 19:19:19 (NPK) or 1% 00:52:34 (NPK) or 1% 13:40:13 (NPK) spraying at flowering and pod development stage along with RDF found beneficial and productive for improving growth, growth attributes, yield and yield attributes of chickpea. For higher GMR, NMR and B:C ratio foliar application of 1% 19:19:19 (NPK) or 1% 00:52:34 (NPK) or 1% 13:40:13 (NPK) along with RDF was found beneficial in chickpea.

References

Ali M, Shiv Kumar. Chickpea (*Cicer arietinum* L.) research in India, accomplishment and future strategies. Indian Journal of Agricultural Science. 2005;75(3):125- 133.

Anonymous. Pulses in India, Retrospect and Prospects, Min. of Agri. And FW (DAC and FW), GOI. 2018, pp. 15-16.

Chaurasia SN, Singh KP, Rai NM. Effect of the foliar application of water-soluble fertilizers on growth, yield and quality of tomato (*Lycopersicum esculentum* L.). Sri Lankan Journal of Agricultural Science. 2005; 42:66-70.

Gutte AV, Karinjikar PN, Takankhar VG, Asunewad A, Effect of foliar fertilizer application on growth and yield of soybean (*Glycine max* (L.) Merill) under rainfed condition. International Journal of Current Microbiology and Applied Science. 2018;18(6):2203-2207.

Patel JR, Patel ZG. Effect of foliar fertilization of nitrogen and phosphorus on growth and yield of summer green gram. Indian Journal of Agronomy. 1994;39(4):578-580.

Akankhar VG, Karanjikar PN, Bhoye SR. Effect of foliar nutrition on growth, yield and quality of chickpea (*Cicer arietinum* L.). An Asian Journal of Soil Science. 2017;12(2):296-299.

ICSCI 2022/T3/66

Evaluation of promising nitrogen fixing and phosphorous solubilizing bacterial isolates on growth of rice seedling

Bandeppa Sonth*, P.C. Latha, Amol S Phule, G. Rajani, K. Surekha, V. Manasa, M.B. Kalyani, M. D. Tuti, R. Mahender Kumar and R. M. Sundaram
Indian Institute of Rice Research, Hyderabad-110 012, India
E-mail: bgsonth@gmail.com

Introduction

Soil microbes play a crucial role in providing soil nutrients to crop especially N and P. Beneficial soil microbes such as free-living nitrogen fixing bacteria and phosphorous solubilizing rhizobacteria, which enhance nutrient uptake and photosynthesis in rice. Nitrogen and Phosphorus are the essential elements that are necessary for plant development and growth. Diazotrophic free-living bacteria contribute up to 20 kg N/ha/ year in cereal crop yields, and cereals rotational cropping systems with about 30-50% of the total nitrogen needs (Vadakattu and Paterson, 2006). Microorganisms that are able to solubilize phosphorus-bearing insoluble inorganic and organic compounds are termed as Phosphate solubilizing microorganisms (PSM). Phosphorus (P) makes up about 0.2% of a plant's dry weight. It is second only to nitrogen among mineral nutrients most commonly limiting the growth of crops (Azziz et al., 2012). P is a major limiting element despite being abundant in soils in both inorganic and organic forms, because it is in a form that the roots cannot absorb, the usual amount of phosphorus in soil is roughly 0.05% (w/w), however only 0.1% of this amount is usable by plants (Zhu et al., 2011).

Methodology

Soil samples were collected from different rice establishment methods, about 55 phosphate solubilizing bacteria (PSB) and 432 nitrogen fixing bacteria were isolated. Among these, seven nitrogen fixing and six PSB isolates were selected for evaluation (Bandeppa, 2020).

Results

Significant higher germination percentage was recorded in seed treatment with nitrogen fixing bacteria and the increase was to the tune of 12-28% as compared to untreated control. *Paenibacillus sonchi IIRRBNF1* was resulted in the highest germination percentage among all the cultures with ISM cultivar. Germination index was significantly higher in treated seeds of ISM (12.2 to16.3) over control (9.5). Seed treatment with *Stenotrophomonas sp. IIRRNF6* and *Paenibacillus sonchi IIRRBNF1* were showed the highest germination index with ISM cultivar. Seed vigour index was also significantly enhanced in treated seeds of ISM (1090 to 1590) over control (331.5). ISM seeds treated with *Paenibacillus sonchi IIRRBNF1* and *Rhizobium sp. IIRRNF7* exhibited higher seed vigour index. ISM cultivar was inoculated with PSB, germination percentage increased from 88% to 100% as compared to untreated control (80). Among the bacterial cultures, *B. paraflexus, B. aerius and B. oryzecorticus* recorded higher root length, shoot & root fresh weight, total fresh weight, shoot & root dry weight as compared to uninoculated control. Overall, all PGPBs treated seeds were enhanced the seed germination rate, vigour index and germination index compared to control.

References

Azziz G, N Bajsa, T Haghjou, C Taule, A Valverde and J Igual. 2012. Abundance, diversity and prospecting of culturable phosphate solubilizing bacteria on soils under crop–pasture rotations in a no-tillage regime in Uruguay. Applied Soil Ecology. 61: 320-326.

Babalola OO and BR Glick. 2012. The use of microbial inoculants in African agriculture: current practice and future prospects. Journal of Food Agriculture and Environment. 10(3&4): 540–549.

Bandeppa S, PC Latha, S Phule Amol, G Rajani, KV Prasad Babu, M Barbadikar Kalyani, C Chandrakala, MBB Prasad Babu, PK Mandal and RM Sundaram. 2020. Isolation, identification and characterization of efficient free-living nitrogen-fixing bacteria from rice ecosystem, Journal of Rice Research. 12(2): 38-44.

Vadakattu G and J Paterson. 2006. Free-living bacteria lift soil nitrogen supply. Farming Ahead. 116: 40.

Zhu F, L Qu, X Hong and X Sun. 2011. Isolation and characterization of a phosphate solubilizing halophilic bacterium Kushneria sp, YCWA18 from Daqiao Saltern on the coast of yellow sea of China, Evidence Based Complementary and Alternative Medical. 2011: 1-7.

ICSCI 2022/T3/67

Nutrient response trial on selected AVT-2 Biofort rice cultures under optimum and low input management at Warangal

U. Nagabhushanam, R. Shravan Kumar, Y. Hari, , G. Neelima, B. Satish Chandra, Ch. Damodara Raju and R. Uma Reddy
Regional Agricultural Research Station, Warangal

Introduction

Rice is an important food crop all over the world. Humans have been modifying crops for favorable traits since agriculture was invented thousands of years ago. But conventional breeding takes multiple generations and cannot be used to improve on only one specific trait. Genetic engineering and genome editing are precise technologies that can streamline the breeding process and introduce rice traits that cannot be significantly improved through conventional breeding.

Biofortification is the process of improving the nutritional quality of food crops. this can be achieved through agronomic practices, conventional breeding or biotechnology-based approaches like genetic engineering and genome editing. Biofortification through agronomic methods requires physical application of nutrients to temporarily improve the nutritional and health status of crops and consumption of such crops improves the human nutritional status (Cakmak and Kutman (2017)). Micronutrient biofortification through agronomical practices is an alternative strategy to reduce the iron and zinc deficiency in rice grain. Biofortification of rice plants by foliar spray of iron was an effective way to promote iron concentration in rice grains (He et al (2013)). Foliar application of zinc has been reported as an effective agronomic practice to promote rice grain zinc concentration and zinc bioavailability (Fang et al (2008)). Biofortification of staple crops such as rice is intended as a sustainable, cost-effective and food-based means of delivering target micronutrients to populations who do not have access to or cannot afford diverse diets and other existing interventions such as fortified foods and supplementation. Hence, the present investigation is taken up.

Methodology

A field experiment was conducted at 'B' block of Regional Agriculture Research Station, Warangal during *Kharif*, 2020. The experiment was laid out in Split-plot design, consisting of two main plot treatments fertilizer gradients (50% NPK/ha and 100%NPK/ha) and two bio-fortified rice cultures viz., C1- IET-27984 C2- IET-28714 and checks: C3-BPT-5204C4-IR-64C5-WGL-739C6-WGL-915 with three replications. All the agronomic practices were followed as per the recommendations of PJTSAU.

Results

In evaluation of performance of AVT-2 bio-fort rice cultures under varied fertilizer levels, crop performance was better and registered significantly higher grain yield under 100%RDF (6216 kg/ha) as compared to 50%RDF (5683 kg/ha). Among the AVT-2 bio-fort rice cultures C1- IET-27984, C2- IET-28714, C3- BPT-5204 and C4- IR-64 recorded comparable grain yields. However, C5- WGL-739 and C6-WGL-915 recorded significantly higher grain yield as compared to AVT-2 bio-fort rice cultures and other two checks.

Table 1: Growth, yield attributes of AVT-2 bio-fort rice cultures as influenced by different fertilizer levels during *Kharif*, 2021

Main plot treatments (Fertilizer levels)	Plant height(cm)	No. of tillers/hill	No. of panicles/hill	Panicle length(cm)	Panicle weight(g)
50% RDF	115	8.68	8.42	27.3	4.42
100% RDF	118	9.53	9.41	27.9	4.82
SEm±	0.68	0.13	0.29	0.22	0.10
CD (P=0.05)	NS	0.86	NS	NS	NS
Sub plot treatments (AVT-2 bio-fort rice Cultures)					
C1- IET-27984	118	8.98	8.70	30.2	3.61
C2- IET-28714	108	10.0	9.90	26.0	3.74
C3- BPT-5204	109	9.51	9.19	24.8	3.76
C4- IR-64	96.9	10.7	10.2	25.5	2.50
C5- WGL-739	125	9.25	9.54	26.4	6.05
C6- WGL-915	142	6.12	5.96	32.9	8.07
SEm±	1.80	0.33	0.28	0.43	0.30
CD (P=0.05)	5.37	0.99	0.84	1.30	0.89

Table 2. Yield attributes and yield (t/ha) of AVT-2 bio-fort rice cultures as influenced by different fertilizer levels during *Kharif*, 2021

Main plot treatments	Days to 50% flowering	Test weight(g)	Grain yield(Kg/ha)	Straw yield(Kg/ha)
50% RDF	106	23.9	5683	5928
100% RDF	107	24.1	6216	6425
SEm±	0.23	0.05	72.0	60.2
CD (P=0.05)	NS	NS	471	394
Sub plot treatments (AVT-2 bio-fort rice Cultures)				
C1- IET-27984	106	23.1	5333	5533
C2- IET-28714	112	27.7	5800	6033
C3- BPT-5204	114	14.2	5766	5963
C4- IR-64	95	28.4	5033	5263
C5- WGL-739	104	21.5	6833	7050
C6- WGL-915	107	29.2	6933	7220
SEm±	0.24	0.21	300	292
CD (P=0.05)	0.72	0.64	893	870

Conclusion

The present investigation, cotton cultivars AVT-2 bio-fort rice cultures C1- IET-27984, C2- IET-28714 performed better and recorded comparable grain yields with C3- BPT-5204 and C4- IR-64, has to be encouraged so as to obtain higher nutritional security.

References

Saltzman A, Birol E, Bouis HE, Boy E, De Moura FF, Islam Y. 2014. Biofortification: progress toward a more nourishing future. Glob Food Secur 2(1):9–17

Cakmak I, Kutman UB.2017. Agronomic biofortification of cereals with zinc: a review. Eur J Soil Sci 69:172–80.

He W, Shohag MJ, Wei Y, Feng Y, Yang X. 2013. Iron concentration, bioavailability, and nutritional quality of polished rice affected by different forms of foliar iron fertilizer. Food Chem 141(4):4122–6.

Fang Y, Wang L, Xin Z, Zhao L, An X, Hu Q. 2008. Effect of foliar application of zinc, selenium, and iron fertilizers on nutrients concentration and yield of rice grain in China. J Agric Food Chem 6(56):2079–84.

ICSCI 2022/T3/68

Alterations in the yield features of mustard varieties under various planting dates

Sushan Chowhan[1*] and Majharul Islam[2+]

[1]Senior Scientific Officer, Adaptive Research and Extension Division, Bangladesh Institute of Nuclear Agriculture (BINA), Sub-station, Ishurdi, Pabna-6620, Bangladesh

[2]Scientific Officer, Soil Science Division, BINA, BAU campus, Mymensingh-2202, Bangladesh

Introduction

Oil seed crops are important in Bangladesh's agricultural productivity. Among the principal oil crops, mustard outnumbers sesame, groundnut, sunflower, soyabean, and linseed. *Sarisha* is rape seed or mustard seed in bengali. Some of the major reasons for low yield of mustard are- lack of available soil moisture during the sowing time (Alam et al., 2014), late or early sowing and unfavorable weather conditions, lack of quality seeds of modern varieties and improper agronomic management including reluctancy of minor fertilizer (micro nutrient) application in soil (Chowhan and Islam, 2021). Presently, mustard covers just 3% of the total land area; nevertheless, there is huge potentiality to increase this area over 20% by exploiting the fallow areas in between the two crop patterns (Aman- boro rice). But prospective production is a major concern in this regard, as cultivating short duration mustard cultivars may need some extra care, management and overall proper sowing time is a prime factor (Chowhan, 2022). Adequate seed yield of mustard is contingent upon appropriate planting time; therefore, shift in the winter pattern (early/late) also remarkedly influences mustard growth and yield. Taking account into this situation, we aimed to reveal the influence of sowing intervals on the seed yield of some modern mustard cultivars.

Methodology

Field experimentation was conducted in *Rabi* (winter) season of 2019 at BINA, Sub-station farm, Magura. Land preparation was according to the procedures described by Chowhan and Nahar (2022). Fertilizers were applied considering low soil analysis interpretation level with yield goal 2.0±0.2 t/ha and applied on soil in accordance with Ahmmed *et al.* (2018). Whole of P, K, S, Zn, B and half of N were applied as basal dose; while remaining half of N was top-dressed at 22 days after seedling emergence (DAE) with light irrigation. Unit plot size was 1.5 m × 2.0 m; where line to line and plot to plot distance was 30 cm each. Seeds were line broadcasted at the rate of i.e. 10,000 m^2. Factorial randomized complete block design (RCBD) with 3 replicates was applied for experimentation. Distance between replications were 1m. Details of the factors and treatment are pointed below—

Factor A: Variety (6)-

C_1 = Binasarisha-4,	C_2 = Binasarisha-9,	C_3 = Binasarisha-10,
C_4 = BARI Sarisha-14,	C_5 = BARI Sarisha-16	C_6 = BARI Sarisha-17

Factor B: Sowing dates (3)-

*Present address: PhD fellow, Graduate School of Science and Engineering, Saitama University, 255 Shimookubo, Sakura Ward, Saitama, 338-8570, JAPAN.

+Present address: PhD fellow, Department of Soil Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur-1706, BANGLADESH

T_1 = 31-10-2019, T_2 = 10-11-2019, T_3 = 20-11-2019.Seed yield (t/ha), stover yield (t/ha), biological yield (t/ha), harvest index (HI%) and crop duration (days to maturity) was recorded after final crop cutting. Seeds harvested from individual plots were weighed (adjusting 10% moisture content). Stover yield (t/ha) was calculated through sun drying. HI (%) (Chowhan *et al.* 2018) and biological yield (Chowhan *et al.* 2017) as per the following way—

- HI (%) = {Economic (grain) yield ÷ biological yield} × 100
- Biological yield (t/ha) = seed yield + straw yield

Obtained data were analyzed statistically with ANOVA (analysis of variance) technique by Statistix 10 and the mean differences were adjudged by LSD test at 5% level of probability

Results

It was noticed that with planting time effect higher seed, stover, biological yield and HI was attained with sowing time T_2 and T_3. But T_3 had the late crop maturity. Contrary, varietal effect exhibited the superior seed, stover and biological yield of BARI Sarisha-16 (C_5). HI (%) was most in BARI Sarisha-17 (C_6). Binasarisha-4 (C_1) matured most late compared to other varieties (Figure 1). Interaction effect of planting time and varieties (Table 1) exposed that BARI Sarisha-16 planted at 31st October attained highest seed yield; which was statistically similar with 10th and 20th November planting. Stover and biological yield was also highest in BARI Sarisha-16 but with 10th November sowing. Most HI was gained with BARI Sarisha-14 on 10th November sowing. In case of maturity, Binasarisha-4 planted on 31st October had the delayed maturity among the treatment combinations

Table 1: Interaction effect of planting time and variety on the yield and duration of mustard.

Treatment combinations	Seed yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	HI (%)	Days to maturity
$T_1 \times C_1$	1.55 b-e	3.59 d	5.14 bc	30.06 e-h	100.67 a
$T_1 \times C_2$	0.85 fg	2.90 ef	3.75 efg	22.91 hi	92.33 de
$T_1 \times C_3$	0.65 g	1.89 hij	2.54 h	25.20 ghi	72.67 i
$T_1 \times C_4$	1.05 efg	1.75 ij	2.80 h	36.75 cde	77.00 h
$T_1 \times C_5$	2.31 a	5.82 b	8.13 a	27.66 f-i	98.00 abc
$T_1 \times C_6$	1.36 c-f	1.86 hij	3.23 fgh	41.76 abc	84.33 fg
$T_2 \times C_1$	1.51 b-e	4.34 c	5.86 b	25.97 ghi	95.67 bcd
$T_2 \times C_2$	1.62 bcd	3.62 d	5.25 bc	31.03 efg	91.00 e
$T_2 \times C_3$	0.98 fg	2.00 hi	2.98 gh	32.07 efg	75.67 hi
$T_2 \times C_4$	1.20 def	1.48 j	2.69 h	44.96 a	84.33 fg
$T_2 \times C_5$	2.00 ab	6.70 a	8.71 a	22.88 hi	99.00 ab
$T_2 \times C_6$	1.57 b-e	2.30 gh	3.87 def	40.69 a-d	84.33 fg
$T_3 \times C_1$	1.84 abc	3.63 d	5.47 b	33.64 def	98.00 abc
$T_3 \times C_2$	1.91 ab	3.27 de	5.19 bc	36.94 b-e	95.00 cd
$T_3 \times C_3$	1.14 d-g	3.08 ef	4.22 de	27.09 f-i	82.00 g
$T_3 \times C_4$	1.35 c-f	1.70 ij	3.05 gh	44.22 ab	82.33 g
$T_3 \times C_5$	1.94 ab	6.83 a	8.77 a	22.10 i	99.33 a
$T_3 \times C_6$	1.99 ab	2.62 fg	4.61 cd	43.21 abc	87.33 f
$LSD_{0.05}$	0.53	0.47	0.80	7.39	3.54
Level of significance	*	*	*	*	*
SEm	0.25	0.24	0.39	3.63	1.74
CV	21.29%	8.75%	10.16%	13.61%	2.40%

Figures in a column having different letter (s) differ significantly at 5% level of probability according to LSD

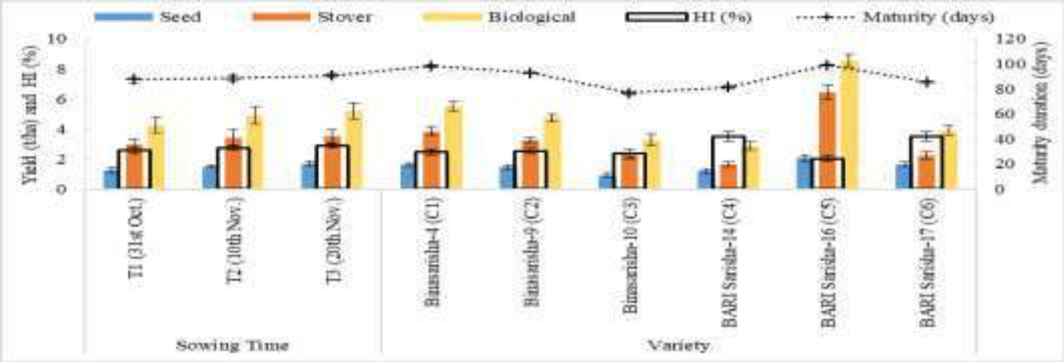


Figure 1: Effect of sowing time and variety on yield, harvest index and crop duration

Conclusion

Our current data demonstrate that yield exhibited an upward trend in late sowing; which implies that ideal mustard sowing period may have altered from October to November. Furthermore, cultivars, BARI Sarisha-16, BARI Sarisha-17, and Binasarisha-4 produced the better yield in delayed planting.

References

Ahmmed S, M Jahiruddin, S Razia, RA Begum, JC Biswas, ASMM Rahman, MM Ali, KMS Islam, MM Hossain, MN Gani, GMA Hossain and MA Satter. 2018. Fertilizer recommendation guide-2018. Bangladesh Agricultural Research Council (BARC), Dhaka. pp. 1-223. ISBN: 984-500-029-1.

Alam MM, F Begum, and P Roy. 2014. Yield and yield attributes of rapeseed mustard (*Brassica*) genotypes grown under late sown condition. Bangladesh Journal of Agricultural Research, 39(2), 311-336. https://doi.org/10.3329/bjar.v39i2.20434

Chowhan S and M Islam. 2021. Zinc effects yield of mustard (*Brassica campestris* L.) under zero tillage. Asian Journal of Soil Science and Plant Nutrition, 7(4), 83-91. https://doi.org/10.9734/ajsspn/2021/v8i130126

Chowhan S. 2022. Scope of mustard cultivation for meeting edible oil crisis due to russia ukraine war. Acta Scientific Agriculture 6 (12), 32-33.

Chowhan S and K Nahar. 2022. Evaluating the role of fertilizer and seed soaking on direct seeded aus rice varieties. Acta Scientific Agriculture. 6 (2), 02-17. https://doi.org/10.31080/ASAG.2022.06.1093

Chowhan S, R Gupta, MM Islam and SN Begum. 2018. Evaluation of NERICA rice mutant in jhum cultivation. International Journal of Agronomy and Agricultural Research, 12(2), 24-31.

Chowhan S, MR Haider, AFMF Hasan, MI Hoque, M Kamruzzaman and R Gupta. 2017. Comparative on farm performance of five modern rice varieties with two local cultivars. Journal of Bioscience and Agriculture Research, 13(1), 1074-1086. https://doi.org/10.18801/jbar.130117.131

ICSCI 2022/T3/69

Weed flora in Acid Saline *Pokkali* rice ecosystem of Kerala

Deepa Thomas and Jeen Shaji [1]
Rice Research Station, Kerala Agricultural University, Vyttila, Kerala- 682019, India,
E-mail: deepa.thomas@kau.in

Introduction

Pokkali is a versatile rice -fish system of cultivation, producing naturally organic rice along the water-logged coastal regions of Kerala. *Pokkali*, the most saline tolerant rice variety has proved its dominance as international donor of SalTol gene. The weed flora of *Pokkali* rice fields is different from that of other rice ecosystems. Diverse weed flora including aquatic and semi-aquatic weeds appears in low saline phase, when rice is cultivated, but they dry up and get decomposed in the high saline phase. With time, significant deviations have been reported in the climatic parameters like mean rainfall and number of rainy days and soil parameters like pH and EC. As a result, the weed flora has also undergone changes.

Methodology

Pokkali system of rice cultivation is unique by virtue of its versatile, traditional cultural practices. The soils of *pokkali* fields are rich in organic matter and basically acidic, but during summer months, the ingress of salt make them saline and hence soil is characterised as acid saline. Field preparation was initiated during the month of April by strengthening the bunds and maintaining water channels around the field for easy water movement. Field got drained during low tide and sluices were set for controlling water levels. When the soil became dry, soil was heaped to form mounds of about one metre base and half a metre high. The mounds were then allowed to dry and weather. With the onset of the monsoon during June, salt over the mounds got washed away and the top of the mounds became free of salts. Mounds act as *in-situ* nursery and on these mounds, pre-germinated seeds were sown. The seedlings were transplanted 25 days after sowing by dismantling the mounds into pieces with a few seedlings intact. Since the organic matter content was high, no nutrients were supplemented. No plant protection measures were adopted. Harvesting was done in October by cutting the panicles alone leaving the stubbles behind to form fish feed. Two level stratified surveys were conducted during *Kharif* 2017 to 2022 in *Pokkali* growing areas of Kerala. Two padasekharams (group farming units) from each block were selected for surveying. Weed vegetation parameters like frequency, density, relative frequency and relative density were worked out for weeds seen in the actual rice fields as suggested by Wentworth *et al*. (1984).

Results

Cyperaceae family dominated in the ecosystem with more number of species. A wide variety of weeds were observed including grasses, broad leaf weeds, sedges and fern. The weed flora observed in Pokkali ecosystem are listed in Table 1. With 75% frequency, *Diplachne fusca* was identified as the predominant weed in the area. *Eleocharis dulcis* was another major weed having a frequency of 39%. *Echinochloa crus-galli*, a dominant weed reported in earlier weed survey was found confined to very few locations and the frequency got reduced from 80 % to 12.5 %. Sedges like *Cyperus difformis* and *Fimbristylis miliacea* dominated on mounds during nursery stage, but disappeared after transplanting and were seen restricted to the bunds.

Table 1. Weed flora observed in Pokkali ecosystem

Field	Diplachne fusca, Echinochloa crus-galli, Eleocharis dulcis, Cyperus difformis, Sphenoclea zeylanica, Monochoria vaginalis, Sphaeranthus africanus, Pistia stratiotes, Hydrilla verticillata, Eichhornia crassipes and Nymphaea nouchali.
Bunds and sides of bunds	Digitaria ciliaris, Chloris barbata, Panicum repens, Fimbristylis miliacea, Kyllinga monocephala, Fuirena umbellata, Schoenoplectus lateriflorus, Cyperus exaltatus, Cyperus javanicus, Ludwigia parviflora, Sphaeranthus africanus, Mollugo pentaphylla, Phyllanthus niruri, Alternanthera sessilis, Alternanthera philoxeroides Scoparia dulcis, ,Hygrophila schulli, Cleome burmanii, Ipomoea sp., Digitaria sanguinalis, Lindernia sp. Acrostichum aureum, and Exoecaria agallocha, Vernonia cinerea, Ageratum conyzoides
Water channels	Salvinia molesta, Nymphaea nouchali, Ceratopteris thalictroides, Hydrilla verticillata, Najas graminea. Rhizophora mangle, Hygroryza aristata

Typha sp. which was not reported in *pokkali* ecosystem, was seen in the water channels of two locations since 2020. In addition, *Sphenoclea zeylanica* was observed as an emerging weed in more density with notable morphological adaptations. *Alternanthera sessilis* and *Alternanthera philoxeroides* were seen abundantly on the bunds, growing into the sides of the fields. Floating ferns like *Najas graminea*, *Ceratopteris thalictroides* and *Hydrilla verticillata* caused problems to aeration in the water in fields. Occurrence of flash floods resulted in the entry of aquatic plants to the field like pistia which drastically affected the growth and tillering of rice. *Eichhornia* was found floating in between the crops and also in the side channels of the field. This was a major menace to the ferries in these areas. When compared to the previous reports and surveys in *Pokkal*i ecosystem, the study could identify more number of weeds in the ecosystem. Tomy *et al*. (1984) had reported the presence of 14 species of weeds in the *Pokkali* field. In another survey by Vidya (2003)18 weeds were present in the *Pokkali* ecosystem, with intense being *Diplachne fusca* (Frequency - 85%, density - 17.17). In the present study, more diverse weed flora was observed. The average frequency (75 %) and density (9.83) of *Diplachne fusca* has decreased over years. Echinochloa crus-galli, a dominant weed reported in earlier weed survey was confined to a very few locations and the frequency was seen to have reduced from 80% to 12.5%. The frequency of *Eleocharis dulcis* has however reduced from 45 % to 39 % in the present study. In *Pokkali* ecosystem, over years, distribution and variation in the intensity of precipitation patterns remained much more uncertain.

Conclusion

The study could identify more number of weeds in the ecosystem, when compared to the previous reports and surveys. *Diplachne fusca* and *Eleocharis dulcis* were the major weeds. *Echinochloa crus-galli*, a dominant weed reported in earlier weed survey was found confined to very few locations. In addition, *Sphenoclea zeylanica* was observed as an emerging weed with notable adaptations. Floating ferns like *Najas graminea* and *Hydrilla verticillata* caused problems to aeration in the water in fields.

References

Tomy PJ, TU George and S Jose. 1984. Pokkali cultivation in Kerala, Technical Bulletin, 10: 1-20.

Vidya AS, CT Abraham and T Girija. 2004. Weed spectrum of Pokkali lands: The salt marsh rice ecosystem of Kerala, Indian Journal of Weed Science, 36(1/2): 157- 159.

Wentworth TR, JS Conn, WA Skroch and Jr E Mrozek. 1984. Gradient analysis and numerical classification of apple orchard weed vegetation, Agriculture, Ecosystems and Environment, 11 (3): 239-251.

ICSCI 2022/T3/70

Studies on nutrient management in transplanted rice for higher production

Denesh GR[1], Ramakrishna Reddy[2] and Savitha HR[3]
[1,2,3] Professor (Agronomy) & Scheme Head, M.Sc. Student, Junior Soil Chemist
AICRP on Rice, Zonal Agricultural Research Station, V. C. Farm, Mandya, University of Agricultural Sciences, Bangalore, Karnataka 571 405, India
E-mail: grdenesh@rediffmail.com

Introduction

Rice productivity varies between states of India as well as between different countries as due to divergence in climate and management practices adopted. Rice respond well to fertilizer usage and its management, as up to 40% of its yield increase. Thus an optimum and balanced supply of nutrients is necessary to achieve higher production. With the advent of high yielding varieties, the usage of higher doses of fertilizer in balanced manner is inevitable to exploit their full potential particularly under irrigated condition (Mangala Rai, 2006). On the other hand, under use of nutrients depress the scope of optimum production potential to a larger extent (Singh *et.al.* 2001). Keeping these facts in vision, the present investigation was undertaken to find out the effect of different nutrient management practice on rice production.

Methodology

A field experiment was conducted during *Kharif* 2020 and 2021 for two seasons at ZARS, V.C. Farm, Mandya, having geographical location situated at coordinates 12^0 57’ N Latitude and 76^0 82’ E Longitude, with an Altitude of 757.10 m above mean sea level. The soil of the experimental site was sandy loam in texture with a pH 7.99. The organic carbon content was medium (0.76%) with the electrical conductivity of 0.31 dS m^{-1}. The soil was low in available nitrogen (242.8 kg ha^{-1}), high in available phosphorus (74.90 kg ha^{-1}) and medium in available potassium (290.25 kg ha^{-1}). The experiment was laid out in Randomized Complete Block Design with nine treatments replicated thrice. The treatments comprised of fertilizer levels of 100, 125 and 150% recommended dose of fertilizer (RDF) alone, 100% RDF with FYM or micronutrient spray or 19:19:19 spray, fertilizer application as per STCR for 7.5 t ha^{-1} targeted yield in comparison with farmer application dose (Table 1). The cultivar used was MTU-1001.

The 21 days aged seedlings were used for transplanting in the puddled plot having bunds on all the side with the row spacing of 20 cm and plant to plant spacing of 10 cm. Inorganic fertilizers viz., urea, single super phosphate and muriate of potash were used to supply nutrients as per treatments. The recommended dose of fertilizer (RDF) used was 100N: 50 P_2O_5: 50K_2O kg/ha as per UASB package of practice. Farm yard manure was used as organic source of nutrient and was incorporated in one of the treatment (T_2). Phosphorus fertilizer was applied entirely as basal dose. Potassium fertilizer was applied in 2 splits viz., 50% at the time of sowing as basal and remaining 50% as top dressing at 50 days after transplanting (DAT). Nitrogen was applied in 3 splits viz., 50% at the time of sowing as basal and remaining fertilizers was applied as top dressing in two equal splits of 25% each at 30 & 50 DAT. The micronutrients mixture (Zn 3%: Mn 1%: B 0.5%: Fe 2 %) of 0.3% spray solution was used in T_5 treatment at 35 DAT, while 19:19:19 fertilizer spray solution of 2% was used at 35 & 55 DAT in T_8 treatment. The spray volume of water used was 500 lit./ha. Whereas, fertilizer doses in Soil Test and Crop Response (STCR) targeted yield treatment was worked out by using following equations as reported by Basavaraja *et al.* (2016) for the zone 6 of Karnataka.

F.N. = 5.165725T-0.798696 S.N-0.96678 O.M ($KMnO_4$-N)
$F.P_2O_5$=0.934433 T-0.3137514 $S.P_2O_5$ – 0.54028 O.M (Olsen's – P_2O_5)
$F.K_2O$ = 1.866216 T-0.3437135 $S.K_2O$-0.62769 O.M (NH_4OAC-K_2O)
Where,
T = Targeted yield (q ha^{-1})
F.N = Nitrogen supplied through fertilizer (kg ha^{-1})
$F.P_2O_5$ = Phosphorous supplied through fertilizer (kg ha^{-1})
$F.K_2O$ = Potassiun supplied through fertilizer (kg ha^{-1})
S. N, S. P_2O_5 and S. K_2O are initial soil available N, P_2O_5 and K_2O (kg ha^{-1}), respectively.

Results

Application of 150% RDF recorded higher mean panicles $meter^{-2}$ (322.50) followed by 125% RDF (318.17) and 100% RDF + FYM @ 10 t/ha (310.42) as compared to rest of the nutrient management practices, except Farmer's application dose (325.75). The higher mean paddy grain yield was recorded with 150% RDF (6.30 t ha^{-1}) followed by 125% RDF (5.95 t ha^{-1}) and 100% RDF + 2% 19-19-19 fertilizer spray at 35 and 55 DAT (7.79 t ha^{-1}) as compared to rest of the nutrient management. While, Farmer's application dose recorded 6.11 t ha^{-1} of similar paddy grain yield in the experiment (Table 1).

Table 1: Yield and yield components of transplanted rice as influenced by nutrient management practices, Kharif 2020 and 2021, V.C. Farm, Mandya

Treatment		Panicles /m2			Grain yield (t/ha)			Straw yield (t/ha)		
		Kharif 2020	Kharif 2021	Mean	Kharif 2020	Kharif 2021	Mean	Kharif 2020	Kharif 2021	Mean
T_1	100% RDF	310.67	287.50	299.09	5.32	5.32	5.32	7.87	7.17	6.60
T_2	T1 + FYM @ 10 t/ha	301.67	319.17	310.42	5.67	5.79	5.73	7.72	7.66	6.73
T_3	125% RDF	316.33	320.00	318.17	6.00	5.90	5.95	9.06	7.93	7.51
T_4	150% RDF	320.00	325.00	322.50	6.48	6.11	6.30	9.88	7.97	8.09
T_5	T1 + 0.3 % Micronutrient spray at 50-55 DAT	313.33	303.33	308.33	6.09	5.44	5.77	8.35	7.32	7.06
T_6	T1 + Eco-Agro spray @ 3.33 ml/lit. at 25, 40 & 55 DAT	298.67	313.33	306.00	5.52	5.69	5.61	8.11	7.36	6.86
T_7	STCR approach for 7.5 t/ha targeted yield (193 N:46P_2O_5:39K_2O kg/ha)	297.33	316.67	307.00	5.51	5.89	5.70	9.34	7.94	7.52
T_8	T1 + 2% 19-19-19 Fert. Spray at 35 and 55 DAT	305.33	313.33	309.33	5.93	5.65	5.79	9.16	7.34	7.48
T_9	Farmer's dose (150N:30P_2O_5:75K_2O kg/ha)	317.33	334.17	325.75	6.26	5.95	6.11	9.41	7.89	7.76
S.Em±		5.11	14.37	NA	0.18	0.42	NA	0.48	0.19	NA
CD (P=0.05)		15.32	NS	-	0.54	NS	-	1.45	0.57	-

RDF = Recommended dose of fertilizer (100:50: 50 N:P_2O_5:K_2O kg/ha); DAT = Days after transplanting; FYM = Farm yard manure

Similarly, application of 150% RDF recorded higher mean paddy straw yield (8.09 t ha^{-1}) followed by 125% RDF or STCR approach for 7.5 t/ha targeted yield treatments (7.51 to 7.52 t ha^{-1}) as compared to rest of the treatments, except with Farmer's application dose (7.76 t ha^{-1}). The increased yield in the former treatments could be credited to the additional usage of 25 to 50 Kg N ha^{-1}, 12.5 to 25 kg P_2O_5 ha^{-1}, and 12.5 to 25 kg K_2O ha^{-1} or with additional supply of FYM or foliar nutrition. This could cause for optimum uptake of plant for its need, thereby better photosynthetic activity as resulted in more number of productive tillers as recorded in this experiment and eventually resulted in higher grain and straw yield. The results obtained are in line with Raut *et al.* (2019) with increased fertilizer levels. Similarly, the higher paddy yield in Farmer's application dose was mainly due to additional usage of Nitrogen and potash fertilizer.

Conclusion

From this study it can be inferred that, no doubts on rice for responding higher dose of inorganic fertilizer nutrient management up to 150% RDF, but was significantly at par with 125% RDF or 100% RDF + 2% 19-19-19 fertilizer spray at 35 and 55 DAT during both *Kharif* 2020 and 2021 seasons. Hence, 125% RDF or 100% RDF + 2% 19-19-19 fertilizer spray at 35 and 55 DAT can be recommended for practical implication to obtain higher paddy grain and straw yield in transplanted rice.

References

Basavaraja PK, MH Saqeedulla, P Dey and SS Prakash. 2016. Fertilizer prescription equations for targeted yield of rice (*Oryza sativa* L.) and their validation under aerobic condition, International Journal of Agricultural Sciences, 8(4): 1003-1008.

Mangala Rai. 2006. Influence of organic manure, bio-fertilizer and nitrogen levels on nutrient uptake, soil properties and yield of rice, Indian Journal of Fertilizer, 3: 45-50.

Singh R, S Singh and SK Agarwal. 2001. Analysis of growth and productivity of wheat in relation to levels of FYM and nitrogen, Indian Journal of Plant Physiology, 6: 279-83.

Raut SD, UV Mahadkar, VD Varnekar, LS Chavan, SB Dodke, MM Burondkar and JS Dhekale. 2019. Effect of age of seedling levels and methods of fertilizer application on growth, yield attributes and yield of rice (*Orza sativa* L.), International Journal of Chemical Studies, 7(5): 1641-1647.

ICSCI 2022/T3/71

Productivity and quality improvement in Pearl millet (*Pennisetum glaucum*) through integrated nitrogen management for nutritional security in India

Tharapureddi Bhargavi*, **K. Mosha, M. Martin Luther and P. Venkata Subbaiah**
**Department of Agronomy, Agricultural College, Bapatla, ANGRAU, Andhra Pradesh*
E-mail: bhargavitharapureddi12@gmail.com

Introduction

Pearl millet is a major cereal in the arid and semiarid regions of Asia and Africa. It is resilient to climate change due to its inherent adaptability to drought and high temperature, also tolerant to saline and acid soils and is well adapted to marginal lands with low productivity (Jukanti *et al.*, 2016). Pearl millet have better nutritional qualities (Protein (11.6g), Carbohydrate (67.5 g), Fat (5.0 g), Crude (1.2 g), Mineral (2.3 g), Ca (42 mg), P (296 mg), Fe (10.3 mg), Zn (3.10 mg) (National Academy of Agricultural Sciences, New Delhi (2018)) compared to other cereals this ensures nutritional security in the vulnerable regions.

Nutrient and moisture stresses are considered as the greatest constraints for productivity. Efficient nutrient management approaches are among key strategies to realize higher yields in rainfed regions. Long term application of high analysis chemical fertilizers resulted in reduced productivity and also soil health. Thus, for long-term ecological and economic sustainability in rainfed pearl millet there is a need to enhance soil organic carbon (SOC) and nutrient buffering capacity of soil by integrated nutrient management through increasing the use of organic sources such as farmyard manures (FYM), vermicompost and biofertilizers. Keeping above facts in view, the present investigation was carried out to compensate the high-cost nitrogen input with low cost input, like biofertilizers (*Azospirillum*) and organic manures for increasing the productivity of pearl millet.

Methodology

This experiment was conducted at Agricultural College Farm, Bapatla inkharif 2019 (Rana hybrid) 8 treatments with simple RBD replicated thrice, T_1: 100% STBN, T_2: 75% STBN + 25% FYM, T_3: 75% STBN + 25% vermicompost, T_4: 75% STBN + 25% FYM + *Azospirillum* @ 5 kg ha^{-1}, T_5: 75% STBN + 25% vermicompost + *Azospirillum* @ 5 kg ha^{-1}, T_6: 50% STBN + 50% FYM + *Azospirillum* @ 5 kg ha^{-1}, T_7: 50% STBN + 50% vermicompost + *Azospirillum* @ 5 kg ha^{-1} and T_8: 100% STBN + *Azospirillum* @ 5 kg ha^{-1}. The N contents in the organic sources were farmyard manure (FYM) 0.5% and vermicompost 1.5%.

The organic manures *viz.*, FYM and vermicompost were applied before fifteen days of sowing and *Azospirillum* @ 5 kg ha^{-1} was applied on the day of sowing. Soil test-based nitrogen @ 75 kg ha^{-1} was applied as per the treatments in 2 equal splits *i.e.*, ½ at basal and remaining ½ was top dressed at 40 days after sowing. As initial soil N status was low, additional 15 kg N (25%) apart from recommended dose of nitrogen (60 kg) was added. Single superphosphate and MOP were applied to all the plots uniformly to supply 40 kg P_2O_5 ha^{-1} and 25 kg K_2O ha^{-1}. The data on earheads m^{-2}, earhead length, grain yield, straw yield, protein content, nitrogen content and crude fibre content were recorded as per standard procedures Data were analyzed using ANOVA and the significance was tested by Fisher's (1950) least significance difference (p=0.05).

Results

Data on number of earheads m^{-2}, earhead weight, earhead length were recorded at harvest and remarkable improvement was observed due to combined application of sources of nitrogen. Highest number of earheads m^{-2}, length and weight of earhead was recorded in treatment which received 75% STBN through urea and 25% N through vermicompost along with *Azospirillum* @ 5 kg ha^{-1} (T_5) which was at a par with T_8 (100% STBN + *Azospirillum* @ 5 kg ha^{-1}). Maximum protein and nitrogen content in pearl millet grain was recorded with application of 75% STBN + 25% vermicompost + *Azospirillum* @ 5 kg ha^{-1} and it was on par with 100% STBN + *Azospirillum* @ 5 kg ha^{-1} treatment. And these treatments have been significantly superior over rest of the treatments. Lowest was observed with application of 50% STBN through urea and 50% N through FYM along with *Azospirillum* @ 5 kg ha^{-1}. The lowest crude fiber content was reported with the treatment T_5 and T_6 indicating improvement in seed quality by these treatments.

Significantly higher grain yield and stover yield was observed with application of 75% STBN through urea and 25% through vermicompost along with *Azospirillum* @ 5 kg ha^{-1}. This might be due to integrated application of nitrogen in which inorganic fertilizer make more availability of nitrogen, while vemicompost improves the soil properties, and also the NPK availability, which have promoted growth (Kumar *et al*., 2014). Use of bio-fertilizer (*Azospirillum*) led to higher availability of nitrogen as well as promoted the root growth.

Table.1 Yield and yield attributes of pearl millet as influenced by organic and inorganic sources of nitrogen

Treatments	No. of earheads m^{-2}	Earhead weight (g)	Earheads length (cm)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T_1: 100% STBN	21.00	41.25	21.10	2403	4491
T_2: 75% STBN + 25% FYM	20.67	40.59	20.43	2399	4476
T_3: 75% STBN + 25% vermicompost (VC)	22.00	42.86	21.53	2419	4804
T_4: 75% STBN + 25% FYM + *Azospirillum* @ 5 kg ha^{-1}	23.00	43.01	21.71	2527	4998
T_5: 75% STBN + 25% VC + *Azospirillum*	26.67	49.00	23.79	2955	5867
T_6: 50% STBN + 50% FYM + *Azospirillum*	18.67	37.38	18.42	2182	4241
T_7: 50% STBN + 50% VC + *Azospirillum*	20.33	40.50	20.20	2277	4322
T_8: 100% STBN + *Azospirillum*	24.67	47.18	23.57	2691	5590
CD (P = 0.05)	3.304	5.481	2.66	348	726

Table 2. Protein content (%), nitrogen content (%) and crude fiber content (%) in grain of pearl millet crop as influenced by organic and inorganic sources of nitrogen

Treatment	Protein content (%)	Nitrogen content (%)	Crude fiber content (%)
T_1: 100% STBN	10.14	1.62	3.17
T_2: 75% STBN + 25% FYM	10.02	1.60	2.17
T_3: 75% STBN + 25% vermicompost	10.25	1.64	2.22
T_4: 75% STBN + 25% FYM + *Azospirillum* @ 5 kg ha^{-1}	10.27	1.66	2.05
T_5: 75% STBN + 25% vermicompost + *Azospirillum*	11.34	1.82	1.57
T_6: 50% STBN + 50% FYM + *Azospirillum*	9.58	1.53	1.70
T_7: 50% STBN + 50% vermicompost + *Azospirillum*	9.89	1.58	1.97
T_8: 100% STBN + *Azospirillum*	11.01	1.76	2.80
CD (P = 0.05)	0.94	1.62	0.45

Conclusion

Pearl millet have a great potential for tackling the hidden hunger caused by micronutrient deficiencies. The results concluded that the application of vermicompost or FYM and Biofertilizers along with NPK enhanced the productivity of pearl millet over the application of only fertilizers. This also improves the grain nutrient and protein content while improving soil health, water holding capacity and root proliferation.

References

Jukanti AK, CL Gowda, KN Rai, VK Manga and RK Bhatt. 2016. Crops that feed the world 11. Pearl Millet (*Pennisetum glaucum* L.): an important source of food security, nutrition and health in the arid and semi-arid tropics, Food Security, 8(2): 307-329.

NAAS. 2018. Role of Millets in Nutritional Security of India, National Academy of Agricultural Sciences, New Delhi.

Kumar G, RS Kurothe, Brajendra, AK Vishwakarma, BK Rao and VC Pande. 2014. Effect of farmyard manure and fertilizer application on crop yield, runoff, soil erosion and soil organic carbon under rainfed pearl millet (*Pennisetum glaucum*), Indian Journal of Agricultural Sciences, 84(7): 816–823.

ICSCI 2022/T3/72

Use of Power of Moisture regimes and P Solubilizers for Phosphorus management in Rice Growing Soils

Ilakkia, K., L. Aruna*, R. Mohan and U. Bagavathi Ammal
PJN College of Agriculture and Research Institute, Karaikal, UT of Puducherry, India
**Email: marunassac@gmail.com*

Introduction

The world population is expected to reach 8.6 billion in 2030 with a significant increase in the developing countries like India, Pakistan, Indonesia, Philippines *etc*. (UN, 2017). India can easily feed its growing population plus produce rice for global exports if it can raise its farm productivity as that of other developing countries such as Brazil and China. One of the ways of attaining maximum yield is the balanced use of nutrients. Among major nutrients, the unique characteristic of P is its low availability due to slow diffusion and high fixation in soils. A significant fraction of fertilizer P is often fixed into insoluble forms through a range of soil – dependent reactions and results in low utilization by plants. As the fertilizer P has been added continuously more than the crop demand, it resulted in an accumulation in soil over time which is often referred as Non-labile P. It is, therefore, imperative and desired to reduce P fertilizer inputs and attempt to use non-labile P resources in agriculture. The amount of non-labile P in some soils are higher that it could be effectively mobilized and could reduce the inorganic fertilizer P requirement by 50 per cent (Owen *et al*., 2015).

Methodology

A pot culture experiment was carried out with farm soils of the Institute having four levels of P (*low labile and non-labile P, low labile and high non-labile P, high labile and low non-labile P, high labile and non-labile P*) to study the solubilization of soil P without external fertilizer application to ADT 45 rice crop under two levels of moisture regimes (*Continuous submergence and Alternate wetting and drying*) and two levels of P solubilizers (*With and without Phosphobacteria*). The post-harvest soil samples were analysed for P-fractions, among which, the NaCl-P and NaOH-P constitute labile pool of P and HCl- P constitutes the non-labile pool of P.

Results

The soil with low labile and high non-labile pool of P under alternate wetting and drying and in the presence of *Phosphobacteria* significantly recorded the highest grain (327.90 g pot^{-1}) and straw (292.96 g pot^{-1}) yield. The partial soil dryness during crop growth and solubilization of insoluble phosphorous by Phosphobacteria had resulted in increased grain yield by promoting faster remobilization of carbon, root enlargement, favorable redox *etc*. for maximum and balanced nutrient uptake. The P uptake by rice crop showed significant difference among the treatments only after panicle initiation stage of the rice crop and the magnitude of P uptake was more conspicuous in soils with high level of non-labile P irrespective of level of labile P bullying other ionic absorption leading to imbalanced nutrients. The alternate wetting and drying moisture regime and application of P solubilizers had proved their performance in increasing the P uptake in low labile soils conditions.

In post-harvest soil, the Olsen-P was found to be low in all the soils except soil having both high labile and non-labile P and indicated that more phosphorus would have been released to the solution and utilized by rice crop in other levels of P in soils. The P-solubilizers registered low Olsen-P in post-harvest soil may be due to the solubilization by *phosphobacteria* based on the crop demand. Fractionation studies of P in soils provide information regarding depletion or accumulation of P in soils. The NaCl-P was significantly influenced by P levels in soils while HCl- P was influenced by *phosphobacteria* while other two fractions (NaOH – P and Residual P) did not respond to the treatments. The HCl-P, a non-labile pool fraction was higher due to the production of phosphatase enzyme by *phosphobacteria* (Hilda and Fraga, 2000) and release of organic anions by production of siderophores.

Conclusion

From the study, it is concluded that P nutrient availability, solubilization, absorption and translocation within the plant is a factor driven phenomenon and alters the availability and absorption of other essential plant nutrients. The response of P solubilizers and moisture regimes like alternate wetting and drying to soils with low labile and high non-labile P and submergence to soils with high labile and non-labile P had concluded that the P solubility and availability as per demand of the crop is a factor driven phenomenon. Hence, it was suggested that due to continuous P fertilization over and above the demand of the crops, the labile and non- labile P status changes altering the other nutrient availability, plant growth and yield. It was high time to rethink the P fertilization rather mange its availability by agronomic practices like alternate wetting and drying along with P-solubilizer application to soils with low labile and high non-labile P and submergence without P solubilizers to soils with high labile and non-labile P

References

Hilda R and R Fraga. 2000. Phosphate solubilizing bacteria and their role in plant growth promotion. Biotechnology Advances, 17(4&5): 319-359.

Owen D, AP Williams, GW Griffith and PJA Withers. 2015. Use of commercial bio-inoculants to increase agricultural production through improved phosphorus acquisition, Applied Soil Ecology, 86: 41-54.

United Nations. 2017. The Sustainable Development Goals Report, United Nations: New York

ICSCI 2022/T3/73

Foliar nutrition for boosting crop productivity and nutrient use in bush vegetable cowpea

Krishnasree R K[1] and Dr. Sheeja K Raj[2]
[1]*Student,* [2]*Assistant Professor, College of Agriculture, Vellayani, Kerala Agricultural University, Thrissur, Kerala India, 680656*
E-mail: krishnasreerk@gmail.com

Introduction

Foliar application is a means of rapid correction of nutrient deficiencies as well as physiological disorders in crop plants. Foliar feeding is environment friendly because it avoids the accumulation of toxic concentration of nutrients in soil (Haytova, 2013). Cowpea enhances soil health by way of biological nitrogen fixation and beneficial effects on soil flora and fauna. It fits well into various cropping systems as pure crop or inter crop. Foliar nutrition serves as a means for economizing nutrient use in cowpea (*Vigna unguiculata* subsp. *unguiculata* (L.) Verdcourt).

Methodology

The experiment was conducted during *Rabi* 2020 at Coconut Research Station, Balaramapuram, Kerala, India with 13 treatments in 3 replications in a randomized block design. Cowpea variety 'Bhagyalakshmi' was raised in the inter row spaces of 60 years old coconut palms planted at a spacing of 7.6 m x 7.6 m having 70% light transmission. Seeds were dibbled at a spacing of 30 cm x 15 cm. Recommended dose of fertilizer (RDF) for cowpea is 20:30:10 kg/ha N:P:K. Water soluble NPK fertilizer (19:19:19) and NK fertilizer as KNO_3 (13.7% N and 46% K_2O), zinc sulphate heptahydrate (21% Zn) and solubor (20.9% B) were used for foliar application. The present study was formulated to identify the effect of foliar nutrition on yield and economics of cowpea.

Results

RDF + 0.5% 19:19:19 + 0.025% solubor at 45 DAS recorded significantly higher number of nodules per plant, RGR, pod yield per plant and net returns. Chatterjee and Bandyopadhyay (2017) pointed out that B is relatively immobile in plant and foliar application of B during the reproductive phase of the crop influenced flowering and pod setting and ultimately influenced pod yield. Foliar nutrition of macro and micro nutrients enhanced the total nodules from 4.3 to 23.7 numbers per plant. Das and Jana (2015) observed that active nodulation in pulses stopped at 45-50 DAS due to the decay and disintegration of nodules. Parmar et al. (1999) revealed that foliar application of nutrients enhanced the root growth and provided more sites for rhizobial infection leading to higher number of nodules per plant. Source-sink relationship in pulses altered due to synchronized flowering habit. Hence, supplemental nutrition through foliar feeding is highly beneficial. Foliar application of nutrients resulted in better nutrient availability and uptake which greatly influenced the overall health and vigour of the plant (Moorthy and Hanif, 2014). The lowest net return was recorded in RDF due to the lowest pod yield registered in the treatment.

Table 1. Response of foliar application of macro and micro nutrients on total number of nodules/plant, relative growth rate, RGR (mg g^{-1} day^{-1}), Pod yield and net returns

Treatment	Nodules/ plant	RGR (60 DAS to final harvest)	Pod yield/ plant (g)	Net returns (₹/ha)
RDF (½ N, full P and K basal and ½ N at 20 DAS)	4.3	9.28	60.38	32939
+ 0.5% 19:19:19 at 45 DAS	23.5	12.64	96.87	80262
RDF + 0.5% 19:19:19 at 45 & 60 DAS	16.7	9.60	74.83	46791
RDF + 0.5% 19:19:19 + 0.05% $ZnSO_4$ at 45 DAS	21.3	10.79	79.25	53213
RDF + 0.5% 19:19:19 + 0.025% solubor at 45 DAS	23.7	22.01	106.54	82651
RDF + 0.5% 19:19:19 + 0.05% $ZnSO_4$ + solubor 0.025% at 45 DAS	23.3	14.23	91.68	75982
RDF + 0.5% 19:19:19 + 0.05% $ZnSO_4$ + solubor 0.025% at 45 DAS + 0.5% 19:19:19 at 60 DAS	13.3	11.08	84.72	54248
RDF + 0.5% KNO_3 at 45 DAS	15.0	19.01	87.37	70416
RDF + 0.5% KNO_3 at 45 & 60 DAS	19.3	11.00	76.73	47525
RDF + 0.5% KNO_3 + 0.05% $ZnSO_4$ at 45 DAS	12.3	21.45	78.21	53036
RDF + 0.5% KNO_3 + 0.025% solubor at 45 DAS	17.3	15.90	98.86	73861
RDF + 0.5% KNO_3 + 0.05% $ZnSO_4$ + solubor 0.025% at 45 DAS	13.0	17.52	81.89	59203
RDF + 0.5% KNO_3 + 0.05% $ZnSO_4$ + solubor 0.025% at 45 DAS + 0.5% KNO_3 at 60 DAS	14.3	18.10	81.87	60572
SEm (±)	1.00	1.026	5.910	
CD (0.05)	2.93	3.014	17.352	

Conclusion

Foliar nutrition of macro and micro nutrients significantly influenced growth and yield of cowpea and hence promsing.

References

Chatterjee R and S Bandyopadhyay. 2017. Effect of boron, molybdenum and biofertilizers on growth and yield of cowpea (*Vigna unguiculata* L. Walp.) in acid soil of eastern Himalayan region, Journal of Saudi Society of Agricultural Sciences, 16(4): 332-336.

Das SK and K Jana. 2015. Effect of foliar spray of water-soluble fertilizers at pre flowering stage on yield of pulses, Agricultural Science Digest, 35(4): 275-279.

Haytova D. 2013. A review of foliar fertilization of some vegetable crops, Annual Review and Research in Biology, 3(4): 455-465.

Moorthy KV and AKAN Hanif. 2014. Effect of water soluble and conventional fertilizers on growth and yield of chillies, Jornal of Krishi Vigyan, 2(2): 28-30.

Parmar KD, TR Sharma, JP Sani and V Sharma. 1999. Response of Frenchbean (*Phaseolus vulgaris*) to nitrogen and phosphorus in cold desert area of Himachal Predesh, Indian Journal of Agronomy, 39(4): 578-580.

ICSCI 2022/T3/74

Enhancing the productivity of rice through organic farming

Anandha Krishnaveni, S[1], Umamageswari, C[*]. M. Raju * and K. Subrahmaniyan[3]
Tamil Nadu Rice Research Institute, Aduthurai- 612 101, Tamil Nadu Agricultural University
Email: agroveni@gmail.com

Introduction

The organic farming aims to maintain soil health and thus making soil capable of supplying all essential nutrients to crop for its proper growth and development. It also aims at sustaining and increasing the productivity of crop besides the quality organic food. In Tamil Nadu, Cauvery delta zone is called as the "rice bowl". In this zone, many farmers are cultivating rice cultivars, since ages through organic cultivation. In organic agriculture, the nutrition mainly supplied through bulky organic manures lik FYM, compost, poultry manure, green manures and crop residues etc. In India, it is estimated that around 700 m.t of agricultural wastes are available every year. but it is not properly used. This implies theoretical availability of 5 t of organic manure / ha arable land/ year, which is equivalent to about 100 kg NPK /ha/year (Tandon, 1997). But in reality, only a fraction is used at field level. There are several alternatives to supply soil nutrients from organic sources like vermicompost, biofertilizers *etc.* which has great scope to reduce the gap between nutrient demand and supply. The organic product Panchagavya has the potential to play an important role of promoting growth and providing immunity in the plant system. It is recommended for all crops, as foliar spray at 3 % level. The liquid organics Panchagavya, individually as well as in combination with other organic sources, proved their efficacy in promoting the growth and yield attributes of vegetables crops (Sarkar *et al*., 2014). The degree of efficiency of individual treatments varied, but panchagavya together were found to be best for enhanced utilization of leaf nitrogen, efficient photosynthetic activity and improved yields. SRI is an improved production technology in rice which helps in enhancing the productivity with less water. Hence, a study has been conducted to develop a climate resilient technology capsule for sustainable organic rice farming.

Methodology

Field experiments were conducted at Tamil Nadu Rice Research Institute, Aduthurai during *rabi* 2021-22. Experiments were laid out in Randomized Block Design consisting seven treatments with three replications. Treatments viz., T_1 - Modified SRI with RDF , T_2- Modified SRI with EFYM @ 750 kg/ ha + Neem cake @ 250 kg/ ha + Vermicompost @ 1t/ ha in two equal splits at AT and PI stages + Panchagavya 3% spray twice (15 days before and after flowering), T_3 - Green manure/ Green leaf manure application @ 6.25 t/ ha + Vermicompost @1t/ ha + Neem cake @ 250 kg/ ha + Panchagavya 3% spray twice (15 days before and after flowering), T_4 - T_2 + AWD using FWT, T_5 - T_3 + AWD using FWT, T_6: FYM @ 12.5 t/ha + RDF (Check), T_7-Green manure *in situ* incorporation + Panchagavya 3% spray (Farmers' practice). The variety CO-52 was used as test variety and biometric observations were recorded.

Results

The data on biometric observations were statistically analyzed and the results are given in Table 1. The performance of organic farming treatments during *Rabi* 2021-2022 indicated that Modified SRI +

EFYM @ 750 kg ha^{-1} + Neem cake @ 250 kg ha^{-1} + Vermicompost @ 1 t ha^{-1} in two equal splits at Active Tillering and Panicle Initiation stages + Panchakavya 3% spray twice (15 days before and after flowering) + AWD using FWT (T_4) recorded higher plant height (105.2 cm), productive tillers $hill^{-1}$ (18.9), grain yield (4889 kg ha^{-1}) and straw yield (7851 kg ha^{-1}) which is significantly superior to other organic farming treatments. Economic analysis of the treatment showed that the above said T_4 treatment recorded the highest BC ratio of 3.06 with net return of Rs. 85,321 /ha.

Table 1. Effect of organic farming practices on growth parameters, yield attributes and yield of rice

Treatment		Plant height (cm)	No. of productive tillers $hill^{-1}$	1000 grain weight (g)	DMP (kg ha^{-1})	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1:	MSRI+ RDF	108.8	19.7	13.8	12409	5543	8785
T_2:	MSRI+ EFYM+ Neem cake + Vermicompost + Panchagavya	104.4	18.3	12.5	9944	4815	7832
T_3:	GM/GLM+Vermicompost + Neem cake + Panchagavya	103.2	16.2	13.1	9482	4784	7520
T_4:	T_2 + AWD using FWT	105.2	18.9	13.5	11005	4889	7851
T_5:	T_3 + AWD using FWT	103.9	16.4	13.2	9737	4799	7761
T_6:	FYM + RDF (Check)	108.1	19.2	13.6	11442	5290	8420
T_7:	GM+Panchagavya (Farmers' practice)	102.5	15.1	13.3	9343	4723	7481
	CD (p= 0.05)	2.0	2.3	0.4	837	362	611

Conclusion

Among the organic farming practices, Modified SRI with EFYM @ 750 kg ha^{-1} + Neem cake @ 250 kg ha^{-1} + Vermicompost @ 1 t ha^{-1} in two equal splits at Active Tillering and Panicle Initiation stages + Panchagavya 3% spray twice (15 days before and after flowering) + AWD using field water tube is found to be the economically viable technology capsule for enhancing the productivity organic rice cultivation.

References

Sarkar S, SS Kundu and D Ghorai. 2014. Validation of ancient liquid organics - Panchagavya and Kunapajala as plant growth promoters, Indian Journal of Traditional Knowledge, 13(2): 398-403.

Tandon HLS. 1997. In Plant Nutrient Needs, Supply, Efficiency and Policy Iissues, NAAS, New Delhi. pp 15-28.

ICSCI 2022/T3/75

Response of direct seeded rice (*Oryza sativa* L.) to various pre and post emergence herbicides

Kommireddy Poojitha*[1], K. N. Kalyana Murthy[1], M.T. Sanjay[1] and G.N. Dhanapal[1]
University of Agricultural Sciences, GKVK, Bengaluru, Karnataka-560065
Email: pujithareddy.71@gmail.com

Introduction

Since the beginning of agriculture, weeds have been regarded as the maximum damaging biotic factor that reduces both the quantity as well as the quality of crops. The damage caused by weeds in direct seeded rice is often more serious due to aerobic soil conditions and successive emergence of weeds along with the crop plants for which chemical weed management by different pre and post emergent herbicides are recommended. Hence, an experiment is planned to analyze the response of direct seeded rice to different herbicides.

Methodology

An experiment was planned to assess the crop growth of direct seeded rice under various pre and post emergent herbicides during *Rabi*, 2020 at University of Agricultural Sciences, GKVK, Bengaluru. The experiment consisting of twelve weed management treatments (Table 1) replicated thrice were evaluated in RBD.

Table 1. Number of tillers per meter row length, dry matter accumulation per hill, grain and straw yield of direct seeded rice as influenced by different weed management practices at harvest

Treatment	Tillers/meter row length	Dry matter accumulation (g/hill)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1: Bensulfuron methyl + pretilachlor 6.6 GR @ 660 g a.i. ha^{-1} as pre-emergence	176.85	19.03	4793	6612
T_2: Pyrazosulfuron ethyl 10 WP @ 40 g a.i. ha^{-1} as pre-emergence	174.09	18.33	4652	6496
T_3: Oxadiargyl 80 WP @ 100 g a.i. ha^{-1} pre-emergence	170.50	17.94	4428	6346
T_4: Bispyribac sodium 10 SC @ 40 g a.i. ha^{-1} as post emergence	179.30	19.38	4980	6771
T_5: Quizalofop-p-ethyl 5 EC @ 37.5 g a.i. ha^{-1} as post emergence	148.34	14.32	3757	5875
T_6: Cyhalofop-p-butyl 10 EC @ 100 g a.i. ha^{-1} as post emergence	157.84	15.01	3831	5725
T_7: Metamifop 10 EC @ 100 g a.i. ha^{-1} as post emergence	161.99	17.26	4147	5969
T_8: *Leucas aspera* plant extract 10 % as post emergence	131.07	12.51	2067	4047
T_9: *Eucalyptus* leaf extract 10 % as post emergence	146.37	14.06	3297	5186
T_{10}: *Hyptis suaveolens* plant extract 10 % as post emergence	135.61	13.46	2627	4238
T_{11}: Hand weeding at 20 and 40 DAS	185.18	19.90	5064	6876
T_{12}: Unweeded control	83.53	6.06	674	1471
CD (p=0.05)	10.74	1.40	402	336

Results

Among various treatments, hand weeding at 20 and 40 DAS has recorded highest number of tillers per meter row length and total dry matter accumulation per hill at harvest and it was statistically on par with bispyribac sodium 10 SC 40 g a.i. ha^{-1} as post emergence and bensulfuron methyl + pretilachlor 6.6 GR 660 g a.i. ha^{-1} as pre-emergence. Grain and straw yield of direct seeded rice was significantly higher with hand weeding at 20 and 40 DAS (5064 and 6876 kg ha^{-1}, respectively) and it was on par with bispyribac sodium 10 SC 40 g a.i. ha^{-1} as post emergence (4980 and 6771 kg ha^{-1}, respectively) and bensulfuron methyl + pretilachlor 6.6 GR 660 g a.i. ha^{-1} as pre-emergence (4793 and 6612 kg ha^{-1}, respectively). Both bispyribac sodium and bensulfuron methyl + pretilachlor were broad spectrum herbicides which resulted in better weed control resulting in better growth and yield of direct seeded rice. The results are in accordance with Prakash *et al*. (2017) and Yogananda *et al.* (2017). The unweeded control recorded lowest plant growth parameters resulting in lowest grain and straw yield (674 and 1471 kg ha^{-1}) due to severe weed competition.

Conclusion

Application of bispyribac sodium 10 SC @ 40 g a.i. ha^{-1} as post emergence at 2-3 leaf stage and bensulfuron methyl + pretilachlor 6.6 GR @ 660 g a.i. ha^{-1} as pre-emergence were found to be efficient weed management practices for obtaining higher crop growth and productivity.

References

Yogananda SB, P Thimmegowda and GK Shruthi. 2017. Weed management effect on growth and yield of wet direct-seeded rice in Cauvery command area of Karnataka. Indian Journal of Weed Science, 49(3): 219-222.

Prakash J, R Singh, RS Yadav, Vivek, RB Yadav, BP Dhyani and RS Sengar. 2017. Effect of different herbicide and their combination on weed dynamics in transplanted rice. Research Journal of Chemical and Environmental Sciences, 5(4): 71-75.

ICSCI 2022/T3/76

DRRH-4, the first Public bred Aerobic and High-yielding hybrid for water-limited conditions

Senguttuvel P*, HariPrasad AS, Sundaram RM, Revathi P, Kemparaju KB, Sruthi K, Sadath Ali, Koteshwara Rao, Beulah P, Nagaraju P, Veerendra J, Gireesh C, Anantha MS, Suneetha Kota, Mahender Kumar RM, Sreedevi B, Sheshu Madhav M, Muthuraman P, Nirmala B, Gobinath R, SubbaRao LV, Aravind Kumar J, AVSR Swamy, Sai Prasad SV, Padmavathi G, Laha GS, Amtul Waris, Somasekhar N, Kannan C and MS Prasad
ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad-30
Corresponding author: senguttuvel@gmail.com, P.Senguttuvel@icar.gov.in

Introduction

Water-limited condition is hampering traditional methods of rice production. Other factors combined with water scarcity, labor, and also land shortage are threatening rice breeding and food security. To overcome this situation, modernization, and a change of emphasis are crucial in rice cultivation. Direct-seeded aerobic rice is a promising solution and a sustaining crop system.

Materials and Methods

Keeping in view of research priority to breed varieties and hybrids suitable for water saving technologies, Indian Institute of Rice Research, initiated the research programme on aerobic rice. The hybrid IIRRH 124 was nominated in aerobic trials of AICRP on rice during 2018-2021, and tested consecutively for three years in more than 25 locations across India.

Results

With concerted effort, world's first public bred Medium slender grained DSR adapted Aerobic Hybrid DRRH-4 was developed and notified (**S.O. 4065(E).**dt 31st Aug, 2022). The hybrid consistently out-performed the check varieties in AICRIP trials in Northern Zone (Zone II), North Eastern Zone (Zone IV), Central Zone (Zone V) and Western Zone (Zone VI) from 2018-2021 and recommended for Punjab, Odisha, Tripura, Chhattisgarh and Gujarat. It is a medium slender, medium duration (120days) hybrid that is high yielding and resistant to multiple biotic stresses like leaf and neck blast, gall midge and rice thrips and have moderate resistance to plant hoppers. The yield potential of this hybrid is 5.7 to 6.3 t/ha. DRRH 4 (IET 27937) has good hulling (79.2%), milling (71.3%), head rice recovery (62.8%) intermediate amylose content (24.6), alkali spreading value (4.0) and gel consistency (30mm).

	Year of Testing	**Season of Testing**	**No. of trials**	**Proposed hybrid IET 27937**	**National check CR Dhan 201**	**Zonal check**	**Local check**	**Hybrid check**	**Qual. Variety 1 (IET27951)**
Mean yield (Kg/ha) Zone II, Zone IV, Zone V and VI	I year (Aerobic)	Kh 2018	6	5761	4070	4757	4713	5138	4952
	II Year (Aerobic)	Kh 2019	8	4264	3862	3583	3986	4600	4699
	III Year (Aerobic)	Kh 2020	6	5081	3446	3573	3621	3504	3970
	IV Year (Aerobic)	Kh 2021	8	5211	3873	3949	4237	4765	3741
	Weighted average		28	**5030**	**3821**	**3937**	**4136**	**4528**	**4323**
	% increase or decrease over checks				**32**	**28**	**22**	**11**	**16**

Conclusion

Taking into all the parameters and performance this hybrid, DRRH-4 is well suited for both irrigated and aerobic conditions. This hybrid is a boon to the current agricultural and farming community, demanding climatic conditions as well as the urbanization of arable lands and speeding up the process by consuming less water and increasing mechanization.

ICSCI 2022/T3/77

Methods of rice (*Oryza sativa*. L) cultivation viz., System of rice intensification - SRI vs Normal Transplanting - NTP on water productivity and grain yield in rice-rice system

R. Mahender Kumar, K. Surekha, Ch. Padmavathi, N. Somashekhar, P. Raghuveer Rao, P.C. Latha, B. Sreedevi, M.S. Prasad, M.B.B. Prasad Babu, L.V. Subba Rao · P. Muthu raman, Subramaniam Gopalakrishnan * V. Vinod Goud* and R.M. Sundaram
Indian Institute of Rice Research, Rajendraagar, Hyderabad, Telangana, India 500 030
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, 502 324
Email:kumarrm21364@gmail.com

Introduction

Rice is the principal staple food for 65 % of the population of India and demand for rice is expected to rise due to increase in population (1.6 % per year), with reduced area of 40 million ha in the next 15–20 years. The projected demand has to be met in the background of declining land and water resource scarcity of labour and costly inputs. Concern over increasing water scarcity has led to the introduction of the concept of agricultural water productivity and an emphasis on interventions to achieve '**more crop per drop'**. Among these constraints water scarcity will pose a major threat to rice cultivation and all out efforts are needed to ensure production of more rice crop from every drop of water **(**Meredith Giordano, et al, 2021)

Hence, there is a need to increase the yield and productivity of rice cultivation using reduced inputs and resources to feed the burgeoning population. System of Rice Intensification (properly known as SRI) an alternative methodology for traditional flooded rice cultivation (Laulanie, 1993) developed in the 1980's in Madagascar offers some instructive insights in to "positive plant microbial interactions". SRI method reportedly enhances the yields of rice through synergy among several agronomic management practices.

Methodology

The studies were conducted at Indian Institute of Rice Research Farm located at ICRISAT Patancheru in sandy clay loam soils for three consecutive wet (kharif) and dry (rabi) seasons to investigate water saving potential, and grain yield by comparing the plants grown with different crop establishment methods (SRI – organic, SRI with organic and inorganic) vs Transplanted Rice (NTP with organic+ inorganic). SRI plots were maintained with alternative wetting and drying irrigation whereas NTP with flooded irrigation. Each treatment was bunded separately for water maintenance the inputs are similar for both the methods (fertilizer doses)

Results

The results of three years' studies (3 wet seasons and 3 dry seasons) clearly indicated superior performance of SRI over NTP on grain yield and water productivity. SRI method yielded 16-23 % higher grain yield with mean water saving to the tune of 18-32 % during wet and dry season as compared to NTP. The system productivity of SRI method was to the tune of 20 % and water productivity of 1.32 kg grain m^3 over normal transplanted method (0.82 kg grain m^3). Using intermittent irrigation, Thiyagarajan et al., (2002) reported a water saving of 50% over the traditional flooding without any adverse effect on grain yield and proved that SRI is not only seed saving but also water saving technology. The water saved for rice can be effectively used for increasing the area under rice or other irrigated dry crops in the cropping sequence for enhancing the system productivity. Hence, the better yields in SRI crop are due to its practices (young seedling, wider spacing, inter cultivation with weeder, saturation of soil without submergence and use of organics) taken together, create conditions in which beneficial for plant growth better tillering and yield attributes and yields.

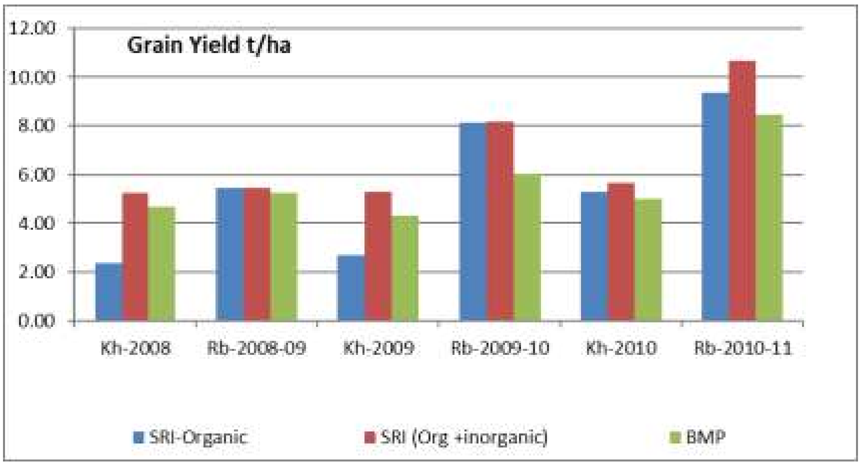


Fig.1. Grain yield as influenced by methods of crop establishment

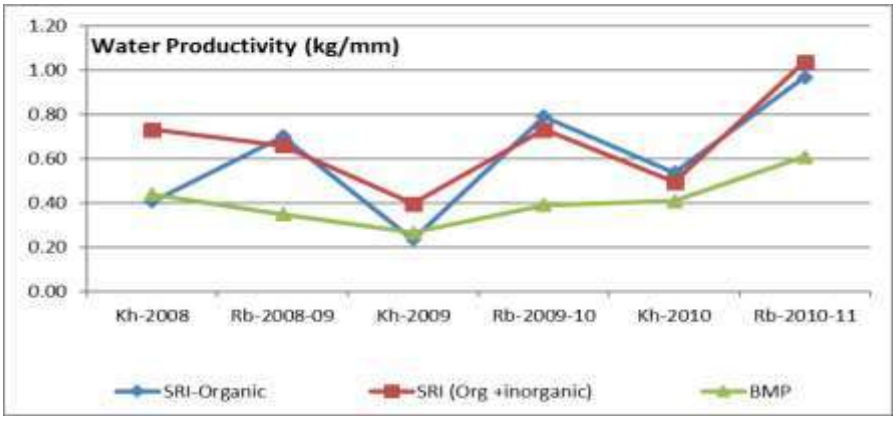


Fig.2. Water productivity as influenced by methods of crop establishment

The saving of the water to the extent of 39-45 % and 23 – 29.5 % accounts to nearly 2340 – 2700 US$ /ha and 1380 – 1740 US$ /ha during wet and dry seasons respectively. Hence SRI can greatly increase net benefits as it saves approximately 25-50% water over conventional flooded rice production thereby reducing production cost especially under water scarce conditions (Chapagain and Yamaji , 2010). Further collaborative research studies are useful in SRI to mitigate climate change effects (methane emissions) and for enhancing resource conservation and fine tuning the method for wide scale adoptability across the country.

References

Chapagain, T. and Yamaji, E. (2010) The Effect of Irrigation Method, Age of Seedling and Spacing on Crop Performance, Productivity and Water-Wise Rice Production in Japan. Paddy and Water Environment Journal, 8, 81-90.http://dx.doi.org/10.1007/s10333-009-0187-5

Meredith Giordano, Susanne M. Scheierling, David O. Tréguer, Hugh Turral & Peter G. McCornick (2021) Moving beyond 'more crop per drop': insights from two decades of research on agricultural water productivity, International Journal of Water Resources Development, 37:1, 137-161, DOI: 10.1080/07900627.2019.1576508

ICSCI 2022/T3/78

Impact of NPK fertilization of Finger millet (*Eleusine coracana* (L.) Gaertn) cultivars on SPAD values and its use for Leaf Colour Chart (LCC) development

B. Gangaiah[1] and Aparna, V[2]
[1]*Principal Scientist (Agronomy) and* [2]*Young Professional-II,*
ICAR- Indian Institute of Millets Research, Rajendra nagar, Hyderabad, Telangana 500 030,

Introduction

Finger millet (*Eleusine coracana* (L.) Gaertn), the nutri-cereal with highest productivity in India (1711 kg/ha) stands at third place in terms area (1.17 m ha) and production (2.0 m t) after pearl millet and sorghum (DES, 2022). Absence of major biotic (pests, diseases) pressures coupled with its drought adaptive capabilities makes it the inevitable choice of crop for cultivation by small and marginal farmers. Frontline Demonstrations of 2021-22 (135 demonstrations on 589 farmers' field in 8 states) on finger millet under the aegis of All India Coordinated Research Project on Small Millets (AICRP- SM) have indicated a grain and fodder yield gap of 31.68 and 34.50% over farmers practice. Selection of suitable finger cultivar coupled with need based fertilization could augment this yield gap to a major extent. As India is dependent on imports for P & K fertilizers, while N fertilizers are highly subsidized, an expenditure of 1.55 trillion rupees was incurred on fertilizer subsidy during 2021-22. This huge burden on economy needs to be reduced by enhancing the fertilizer use efficiency. In this direction, leaf colour charts (LCC) based N fertilization technology have been evolved for rice, wheat (Varinderpal Singh *et al.*, 2010) and maize (Vetsch and Randall, 2004). Nitrogen being a constituent of chlorophyll molecule, its deficiency in plant is reflected in loss of leaf greenness and associated decrease in leaf area, photosynthesis and biomass / grain production. Thus leaf greenness (cholorophyll) can be used as a plant nutrient status indicator. Traditional destructive chlorophyll content estimations done in the laboratories are made non-destructive using a simple instrument called 'SPAD meter' and based on threshold SPAD values, LCC were developed for farmers use as a crop fertilization tool. In this context, finger millet crop was selected for SPAD values measurement and also for its subsequent for LCC development.

Methodology

A field experiment was conducted during *kharif* season of 2022 in ICAR-Indian Institute of Millets Research, Rajendra nagar, Hyderabad (situated at 17^0 19' 40.9" N latitude $78^0$23'38.2" E longitude at an altitude of 542 m above mean sea level). The experimental sandy clay loam soil was moderately alkaline in reaction and low in organic carbon (0.42%) and available nitrogen (235 kg/ha) and medium in available phosphorous & SPAD values varied significantly among the finger millet cultivars, though the trend over observation time (37 DAS- flowering) was inconsistent. Finger millet cultivar 'PR 202' has consistently higher SPAD values than other varieties (Table 1). SPAD values of all cultivars at flowering too decreased as we move for top most flag leaf to the bottom leaf on account of translocation of nutrients especially N from bottom to the top leaves. Potassium (14.5 & 220 kg/ha). Temperature was optimum for growth of the crop. However, there was excess rain fall than the normal during the year. Twenty treatments formed by combination of 4 recommended dose of NPK fertilizers (0, 50, 100 and 150% in main-plot) and five finger millet cultivars (GPU 67, VL 376, PR 202, GPU 48 and GPU 28 in sub- plot) were evaluated in Split Plot Design with two replications. Crop was sown on 4th July 2022 in rows 30 cm apart with a plant to plant spacing of 10 cm. A recommended dose of fertilizer of 60:40:40 kg/ha $N:P_2O_5:K_2O$ was used in the study. Entire PK fertilizers as SSP and MOP along with 50% N as prilled urea was applied basal while rest of N was top dressed on 30 days after sowing as per treatment. SPAD values were recorded at fixed time (10 AM- 12 PM) under clear sun using SPAD-502, Spectrum Technologies, Inc, Minolta at weekly interval for the top most fully opened leaf since top dressing of N while at flowering, SPAD values were recorded for all the leaves from top to the bottom, however, data of flag leaf and bottom leaf was only given.

Results

SPAD value of top most fully opened leaf from 37-67 DAS and top most leaf and bottom leaf at flowering (Table 1) showed significant variations due to % recommended dose of NPK fertilizers (RDF), finger millet cultivar and their interactions.

NPK fertilization- SPAD values

Among the NPK fertilization treatments, un-fertilized control (no NPK) treatment has recorded markedly lower SPAD values than the treatments receiving NPK fertilizers right from 37 DAS to till flowering. The SPAD values increased significantly with increase in %RDF up to 100% at all stages. The SPAD values recorded by 0 and 50% RDF at 44 and 61 DAS) were not markedly different. At 67 DAS, 150% RDF has markedly higher SPAD values than 100%RDF. The SPAD values increased gradually from lowest values at 37 DAS to the highest at just before flowering stage. At flowering stage, flag leaf has the highest SPAD values and showed a decreasing trend as move from the top to the bottom leaf with bottom leaf recording the lowest values on account of translocation of nutrients especially N from lower to the top leaves.

Table 1. Finger millet cultivar SPAD values as affected by NPK fertilization

Treatment	SPAD value of fully opened top leaf at						Bottom leaf at flowering
	37 DAS	44 DAS	53 DAS	61 DAS	67 DAS	Flowering	
Fertilizer dose (NPK, % recommended)							
0	27.23	28.64	26.08	33.02	37.70	40.29	33.15
50	31.21	29.53	32.08	34.96	40.12	40.84	33.66
100	33.36	30.84	34.58	38.47	43.23	40.75	36.68
150	34.85	32.15	37.34	40.09	46.09	43.07	37.78
Mean	31.66	30.29	32.52	36.64	41.79	41.24	35.32
CD (P=0.05)	1.67	1.58	3.39	2.13	1.60	2.81	NS
Finger millet cultivar							
GPU 67	31.44	29.45	28.41	39.01	41.68	39.56	34.01
VL 376	29.80	30.19	35.88	35.47	42.23	38.84	36.65
PR 202	32.37	29.73	35.56	37.61	44.50	43.32	32.96
GPU 48	32.15	30.59	31.71	35.55	39.79	42.58	38.57
GPU 28	32.54	31.49	31.05	35.54	40.72	41.89	34.39
CD (P=0.05)	1.52	1.26	2.76	3.44	3.22	4.30	NS
Interaction	S	S	NS	NS	NS	S	NS

Finger millet cultivars -SPAD values

NPK fertilizer x Cultivar –SPAD values

Fertilizer and variety interaction effects on SPAD values was significant initially (37 & 44 DAS) became non-significant at all later stages except at flowering for flag leaf.

Conclusion

From the study, it is concluded that SPAD values of finger millet are vastly effected by NPK fertilization with important role from initial soil fertility. The leaf colour obtained under different levels of NPK fertilization is matched with green colour palette for leaf colour chart (LCC) development for finger millet crop as is done for other crops (rice, wheat and maize) for validation and subsequent use of farmers for efficient use of fertilizers.

References

DES (Directorate of Economics and Statistics). 2022. First Advance Estimates of Production of Foodgrains for 2022-23. Ministry of Agriculture and Farmers Welfare, Department of Agriculture and Farmers Welfare, Directorate of Economics and Statistics as on 21- 09-2022.

Varinderpal Singh, Bijay Singh, Yadvinder Singh, HS Thind and RK Gupta. 2010. Need based nitrogen management using the chlorophyll meter and leaf colour chart in rice and wheat in South Asia: a review. Nutrient Cycling Agroecosystems, 88: 361-380.

Vetsch JA and GW Randall. 2004. Maize production as affected by nitrogen application timing and tillage. Agronomy Journal, 96: 502–509.

ICSCI 2022/T3/79

Effect of varying levels and source of slow-release urea fertilizers on wet direct seeded rice (*Oryza sativa* L.)

K. Aruna[1]*, Mangal Deep Tuti[2], K. Bhanu Rekha[1], M. Yakadri and K. Surekha[2]
[1]College of Agriculture, PJTSAU, Rajendranagar-500030
[2]ICAR-Indian Institute of Rice Research, Hyderabad-500 030, Telangana, India
*Email:arunasree613@gmail.com

Introduction

Low nitrogen use efficiency (NUE) of rice has led to excessive and ineffective use of N fertilizer, which has caused serious soil degradation, ground water pollution and the emission of ammonia and greenhouse gases due to surface runoff, leaching into ground water and volatilization into the atmosphere (Peng *et al.*, 2010). Hence, the development of N-fertilizer-efficient technologies should be pursued, since they can allow rice growers to consistently achieve high grain yield and enhance NUE (Hamoud *et al.*, 2019). Controlled release urea (CRU) is helpful for decreasing the use of N fertilizer and saving time and labour inputs (Li *et al.*, 2017). Recently, slow release urea fertilizers such as silicon coated urea and cedar wood oil coated urea are developed at ICAR-IIRR laboratory and validation of the efficiency of these slow release urea fertilizers in field condition is very much essential.

Methodology

This trial was conducted at ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad in *kharif* 2022. It is in southern Telangana zone of semi-arid tropics. Soil texture was clay loamy and medium in available N. Treatments were laid in Randomized Block Design with 3 replications. Treatments were T_1: The recommended dose of nitrogen (Neem coated urea) (120 kg ha^{-1}); T_2 : Silicon Coated Urea (SCU) at 50% of RDN (60 kg ha^{-1}); T_3: SCU at 75% of RDN (90 kg ha^{-1}); T_4 :SCU at 100% of RDN (120 kg ha^{-1}); T_5 : SCU at 125% of RDN (150 kg ha^{-1}); T_6 : Cedar Wood Oil coated urea (CWO) at 50% of RDN (60 kg ha^{-1}); T_7 : CWO at 75% of RDN (90 kg ha^{-1}); T_8 : CWO at 100% of RDN (120 kg ha^{-1}); T_9 : CWO at 125% of RDN (150 kg ha^{-1}); T_{10} : Control with no application of urea fertilizer. Uniform dose of FYM, P_2O_5 and K_2O will be applied @ 10 t ha^{-1} @ 60 and 40 kg ha^{-1}, respectively to all treatments and in all treatments except T_{10} 25% of RDN will be applied as basal, 25% of RDN each at active tillering and 25% of RDN at panicle emergence and 25% of RDN at flowering stages in 3 split application.

Results

Plant height at active tillering stage was found to be the highest in plots received SCU at 125% of RDN (88.4 cm) followed by plots received CWO at 125% of RDN (85.3 cm). The lowest plant height was recorded in control plots (80.3 cm) where nitrogen was not applied. Similar pattern of plant height (the highest in SCU at 125% of RDN followed by CWO at 125% of RDN) was also observed at panicle emergence and flowering stages. The higher plant height might be due to optimum plant population, availability of nutrients and geometry of crop. Difference in plant height may be due to genotypes which may attributes to their inheritance genetic character of a variety and soil condition of crop as influenced by different doses of slow release urea fertilizer (SRUF).

Table 1. Plant height (cm) of rice as influenced by different dose of SRUF on rice crop

Treatment	Plant height (cm)		
	Active tillering	Panicle emergence	Flowering
T_1-Neem coated urea at 100% of RDN	82.3	84.3	96.0
T_2-SCU at 50% of RDN	80.3	80.6	90.6
T_3-SCU at 75% of RDN	80.9	82.5	91.5
T_4-SCU at 100% of RDN	81.6	85.6	94.6
T_5-SCU at 125% of RDN	88.4	92.5	102.2
T_6-CWO at 50% of RDN	81.1	81.4	90.1
T_7-CWO at 75% of RDN	82.2	86.7	95.7
T_8-CWO at 100% of RDN	83.7	89.9	101.8
T_9-CWO at 125% of RDN	85.3	93.6	105.9
T_{10}-Control	78.0	80.4	83.0
CD (p=0.05)	8.2	8.6	9.5

Conclusion

It was found that plant height responded positively to the increasing doses (from 50% to 125% of RDN) of both SRUF (Silicon coated urea and Cedar wood oil coated urea). Further, application of both SRUF at 125% of RDN produced more height in rice crop than that under neem coated urea at 100% of RDN.

References

Hamoud, Y.A., Guo, X., Wang, Z., Shaghaleh, H., Chen, S., Hassan, A and Bakour, A. 2019. Effects of irrigation regime and soil clay content and their interaction on the biological yield, nitrogen uptake and nitrogen-use efficiency of rice grown in Southern China. *Agricultural Water Management*. 213: 934–946.

Li, P. 2017. Reducing nitrogen losses through ammonia volatilization and surface runof to improve apparent nitrogen recovery of double cropping of late rice using controlled release urea. *Environmental Science and Pollution Research.* 24: 11722–11733.

Peng, S., Buresh, R.J., Huang, J., Zhong, X., Zou, Y., Yang, J., Wang, G., Liu, Y., Hu, R., Tang, Q. 2010.Improving nitrogen fertilization in rice by site specific N management. A review. *Agronomy for Sustainable Development*. 30: 649–656.

IICSCI 2022/T3/80

Comparative evaluation of Alternate wetting and drying conditions on water productivity of Drum seeded rice vs. Transplanted rice

Madhurya. D[1], Neelima. T. L[2], Madhavilata. A[3], Mahender Kumar. R[4]
[1]Department of Agronomy, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad-30
[2]Water Technology Centre, PJTSAU, Rajendranagar
[3]Agricultural Polytechnic, Malthummeda, PJTSAU
[4] AICRIP(Agronomy), Crop Production Section, ICAR-IIRR
Email: madhuryadakarapu9@gmail.com

Introduction

Water management in rice has gained importance in the recent times for sustainability and resource conservation cultivation. Alternate wetting and drying(AWD) of soil has been proved to improve water productivity without compromising the yields around the world. After establishment of rice, the use of safe AWD water management instead of continuous flooding reduces irrigation water requirement for all rice establishment methods. AWD is often omitted owing to its yield reduction along with irrigation. Using specifc form of AWD called "Safe AWD" that has been developed to potentially reduce water inputs by about 30%, while maintaining yields at the level of fooded rice.(Mote *et al.* 2022). Wet Direct seeded rice (W-DSR) technology has been noticed to be an alternative with benefits such as labour savings (40-45%), water savings (30-40%), energy savings (60-70%), and reductions in greenhouse gas emissions. (Yaduraju *et al*., 2021).

Methodology

A field experiment was conducted during *rabi* 2020-21 and 2021-22 at Agricultural College Farm, Professor Jayashankar Telangana State Agricultural University (PJTSAU) with twenty treatments laid out in strip plot design replicated thrice. The experimental soil is sandy clay in texture, pH 7.91, EC 0.90 dSm^{-1}, low in organic carbon and available nitrogen (142 kg ha^{-1}), medium in available phosphorous (40 kg ha^{-1}) and high in available potassium (270 kg ha^{-1}).The variety chosen for experiment is Tellahamsa (10754).The treatments consists of four main plots viz., M_1: Normal Transplanting; M_2: Direct seeded rice with drum seeder;M_3: Normal Transplanting with alternate wetting and drying at depletion of 5 cm; M_4: Direct seeded rice with alternate wetting and drying at depletion of 5 cm, and five nutrient management methods as subplots viz. N_1:100% RDF; N_2:75% RDN+25% N Biogas Slurry @ 2.5 t/ ha ;N_3:75% RDN+25% N *Azolla* Compost @1.8 t/ha ; N_4:75% RDN+25% N Vermicompost @ 3.1 t/ha ;N_5:75% RDN+ 25%N Poultry Manure @ 2.7 t/ha. Recommended dose of P and K (60:40) was applied equally to all the plots as basal. Well decomposed Organic manures which provide 25% of the recommended dose of nitrogen was incorporated in the soil 20 days before sowing and transplanting. Nitrogen is applied in splits i.e, 75% of the recommended dose of fertilizer was applied as 25% N at basal, 25% N at tillering, 25% N at Panicle initiation. Under continuous flooding, the crop was submerged to a depth of 2-5 cm of water, depending on the crop's growth stage. In alternate wetting and drying system (AWD) Bowman pipes were placed in the plots between the rows to a depth of 15 cm below the soil surface. Whenever water level inside the tube falls below 5 cm irrigation, field is irrigated.

Results

Normal transplanting with flooding recorded higher total water of 1542 mm. Normal Transplanting followed by direct seeded rice with flooding (1469 mm). Least quantity of water is applied under Direct seeded rice with alternate wetting and drying at depletion of 5 cm. (1233 mm). However, higher water use efficiency (WUE) and water productivity was reported in direct seeded rice with alternate wetting and drying at depletion of 5 cm (4.52 kg ha mm^{-1} and 0.46 kg m^{-3}) treatment which is on par with normal transplanting with alternate wetting and drying at depletion of 5 cm (3.99 kg ha mm^{-1} and 0.40 kg m^{-3}). The lowest WUE and water productivity was accounted with normal transplanting with continuous flooding, which recorded 3.30 kg ha mm^{-1} and 0.33 kg m^{-3} respectively. Low water consumption in AWD resulted in better use efficiency and productivity of water. Apart from water saving, Direct seeded rice with alternate wetting and drying required 2229 L water to produce one kg rice while normal transplanting required 3031 L of water to produce 1 kg rice.. WUE and Water productivity showed a significant linear relationship with grain yield. Highest grain yield was obtained with maximum water use efficiency and water productivity, which reports the resource use efficiency to produce yields similar to traditionally flooded condition. Nutrient management practices did not have any significant impact on water requirement of rice.

Conclusion

In the present study water saving under alternate wetting and drying in transplanted rice and direct seeded rice reported 9% and 10% increase in grain and straw yield, with 10.7 and 16.06% decrease in of water requirement over continues flooding. Adoption of wet DSR along with AWD helped in reducing the water required to produce 1 kg rice by 800 L. Supplementing inorganic fertilizers with organic fertilizers helped in improving the yield of the crop without any deleterious impact on the environment. Significant linear relationships help in understanding the fact "more rice with less water".

References

Mote, K., Rao, V.P., Ramulu, V., Kumar, K. and Devi, M.U., 2022. Performance of rice (*Oryza sativa* (L.)) under AWD irrigation practice—A brief review. *Paddy and Water Environment*, pp.1-21.

Yaduraju, N.T., Rao, A.N., Bhullar, M.S ., Gill, J.S., and Malik, R. K..2021. Direct-Seeded Rice (DSR) in India: New opportunities for Rice Production and Weed management in post COVID-19 pandemic period. *Weeds – Journal of Asian-Pacific Weed Science Society, Vol 3 (2).*

ICSCI 2022/T3/81

Spatial variability of rainfall and yields of maize in Siddipet district

G. Snigdha[1], Gumma Murali Krishna[2], P. Pranay[2], T.L. Neelima[1], K. Avil Kumar[1]
[1]*Water Technology Centre, PJTSAU, Rajendranagar, Hyderabad-500030*
[2]*International Crop Research Institutefor Semi-Arid Tropics, Patancheru, Hyderabad, India*
Email: snigdhaangel07@gmail.com

Introduction

Crop yield forecasting could be very useful in advanced crop planning, strategy creation, and management. The core objective of this study was to develop a method to integrate Remote Sensing (RS) data and APSIM-ORYZA model for rice yield estimation in Nalgonda district, Telangana. This study includes mapping of rice growing areas and execution of APSIM model, followed by integration of RS and crop simulation model for rice yield prediction and verification using government statistics. The results obtained from evaluating the model with simulated yield and observed yield in the farmers' fields showed linear regression of R^2 = 0.79, root mean square error (RMSE)=804 kg ha^{-1} and mean absolute error (MAE) =728 kg ha^{-1}. The overall spatially averaged model yield for the district showed 4925 kg ha^{-1} which is deviated by 2% from the average yield in the government statistics with 5024 kg ha^{-1}.

Methodology

The Nalgonda District lies in the southern part of Telangana region between 16º25' N& 17º50' N and 78º40' E & 80º05' E. The selected study areas were Telakantigudem village and Mallaram village from Kanagal and Kattangoor mandals, respectively of Nalgonda district, as shown in Fig. 1, which extrapolate the whole district with varying rainfall and soil conditions. The average annual rainfall of the district is 751 mm. The maximum and minimum temperatures are 40^0C and 17.7^0C respectively. The soil comprises red soil, black soil, alkaline soil, and alluvium. The red soil constitutes 85% of thearea. Net sown area of rice in Nalgonda in 2021 *kharif* was 142570 ha.

Results

Mapping of Rice growing areas:

The procedure for mapping rice for kharif season in Nalgonda district by combining Sentinel-1 and Sentinel-2 data has been adapted. GEE was used for satellite data processing and classification. VV and VH of Sentinel-1 and NDVI of Sentinel 2 were derived and was stacked. The stacked composite image was passed through a supervised classification by giving the training data which were pointed in Google earth were given and random forest classifier was used.

Execution of APSIM model for simulating rice growth and yield:

Rice transplant Aman was endorsed from the rice management toolbox to simulate transplanted paddy rice for *Kharif* season. Planting dates adopted to the model are based on the data collected from the farmers. The number of plants on hills (3), number of hills (25), number of plants per seed bed (1000), and the duration of the seedbed (25) were adopted for all the simulations. Split application of nitrogen was adopted based on the data recorded from the respective farmers at three stages of rice, at the time of transplanting, end of juvenile (DVS=0.4), and at the panicle initiation stage (DVS=0.65).

Table 1. Input variables and their source for major physiological processes simulated in APSIM-ORYZA

Simulation	Input variables and parameters	Source	Module
Phenology	Meteorological data: daily max. and min Temp, rainfall, solar radiation	Automatic Weather Station and NASA Power	'Oryza' module in APSIM
Soil water balance and soil nitrogen supply	Water availability in soil profiles	Default values in APSIM	'SoilWat2' module in APSIM
	Soil N supply is determined from the groundtruth data from the farmers	ISRIC	'Oryza' module in APSIM
Irrigation, fertilizer application and other field management	Irrigation (depth of ponding water), application levels of nitrogen fertilizer and transplanting dates	Farmers	Oryza module in APSIM
Physical and chemical properties of soil	Bulk density, pH, soil organic carbon, Electric conductivity, cation exchange capacity	ISRIC 2.0	Apsoil module in APSIM

For the soil water balance module, the inputs include soil bulk density, saturated water content, soil water at field capacity and wilting point in the soil layers that make up the profile, crop-specific parameters that determine root extension and crop's limit of water extraction. The input parameters for SOILN include pH, organic carbon, electric conductivity (EC), cation exchange capacity (CEC), and exchangeable sodium percentage, which were derived from the ISRIC 2.0 with 250m resolution (Table 1)

Evaluation of the model:

The model's performance was evaluated using both a graphical comparison of results and statistical analysis. The statistical measures included root mean square error (RMSE), root mean absolute error (MAE), standard deviation (SD), and coefficient of variation (CV) (Milesi and Kukunuri, 2022). RMSE is a good measure of how accurately the model predicts the response. It's the most important criterion for fit as the main purpose of the model is prediction. The RMSE and MAE were calculated using the Eqs.(1) and (2).

$$RMSE = \{\Sigma(Y_s – Y_o)^2 / n\}^{0.5} \quad (1)$$

$$MAE = \Sigma(Y_s - Y_o)/n \quad (2)$$

In the above cases, Y_s is the simulated yields, Y_o is the observed yields and n is the sample size.

Integration of Remote Sensing and Crop simulation

The maximum LAI of the model and the yield simulated was compared and based on the correlation, linear equation was used for deriving the spatial distribution of simulated yield over the Nalgonda district and zonal statistics were calculated. For constructing spatial distribution of yield map, the rice mask obtained from the classified crop map is used in which the noise was diminished by applying the threshold limit of above 0.4 NDVI value indicating the rice growing areas. The yield estimate of the model obtained was verified against the government statistics.

Results

The map obtained by supervised classification using random forest classification algorithm is shown in Fig 2. The Rice growing areas in Nalgonda district covered 155013.2ha. The overall accuracy of the classification showed 92% accuracy.

Model Evaluation:

The linear regression's coefficient of determination (R^2) value was 0.795, resulting in smaller differences between the simulated and observed yields. RMSE of the simulated yields was 804 kgha^{-1}, and an MAE value of 728 kgha^{-1}. All of these indications suggest that the model performed well while modelling the medium duration variety production in a transplanted rice eco-system during the *kharif* season of 2021.

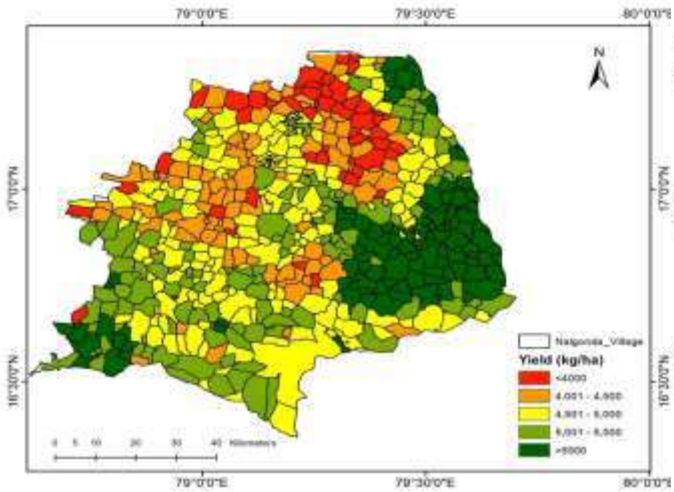


Fig 2. **Spatial extent of rice in Nalgonda district in *kharif* season**

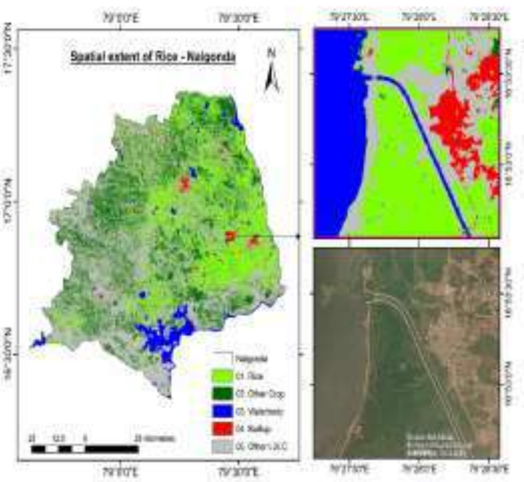


Fig 3. Spatial distribution of simulated yield at village level

Spatial distribution of yield and verification against government statistics:

For deriving remote sensing LAI, the comparisions were made between NDVI and ground LAI and model LAI and the simulated yields. The correlation (R^2) was 0.64. Based on the correlation between them, the linear equation (Eq.3) was used to derive the Remote Sensing LAI

$$LAI = 15.028 \times NDVI_{max} - 7.8835 \quad (3)$$

The spatial distribution of rice yield over the district was constructed as shown in Fig 3. The spatial distributed map of field LAI and model LAI showed the similarity in the distribution as they have good correlation. The spatial pattern of estimated yields corresponds to the availability of irrigation sources. The dark green colour with the middle right corner villages of the map (Fig 10) represented that there were relatively more areas with higher yields (>5500 kg ha^{-1}) since they are under the Nagarjunasagar canal command regions, and water for irrigation is readily available in absence of rainfall.

Conclusion

The major goal of this work was to create a method for estimating rice yield in the Telangana district of Nalgonda by integrating remote sensing data into the APSIM-ORYZA model. The results showed that the RMSE and MAE values obtained for the observed and simulated yield values were 804 $kgha^{-1}$ and 728 $kgha^{-1}$ respectively. The final result of the district was compared with the government's rice yield statistics to demonstrate the validity of the approach for yield estimation in Nalgonda district, Telangana. Results showed the higher yields in the areas which are under the Nagarjuna Sagar canal command area as the irrigation water is readily available in absence of rainfall. Based on the assimilation results, it is possible to conclude that the LAI assimilation approach can be applied successfully for rice yield prediction in the Nalgonda district. The overall findings of this study indicate that integrating remote sensing data with crop simulation model APSIM and weather factors has enormous potential to improve the efficiency and reliability of rice yield estimates at the regional scale.

References

Milesi, C. and Kukunuri, M., 2022. Crop yield estimation at gram panchayat scale by integrating field, weather and satellite data with crop simulation models. *Journal of the Indian Society of Remote Sensing*, *50*(2), pp.239-255.

ICSCI 2022/T3/82

Discrimination of rice ecosystem using Sentinel 1 SAR data in Jogulamba Gadwal district, Telangana

M. Bhargav Reddy[1], T. L. Neelima[2], P. Srikanth[3], M. Uma Devi[4] and C. S. Murthy[5]
[1]*College of post-graduation Studies-Agriculture Sciences, CAU, Imphal- 795004.*
[2]*WTC, PJTSAU, Rajendranagar, Hyderabad-30.*
[3]*Crop Monitoring & Assessment Division, AS & A Group, National Remote Sensing Centre, Balangar, Hyderabad,* [4] *PJTSAU, Hyderabad,* [5]*MNCFC, GOI*
Email: marambhargavreddy@gmail.com

Introduction

Rice is one of the most important food crops and more than 1/3 rd of the world's population depends for their daily calorific needs. Rice can be established by Direct seeding and Transplanting techniques. During the *kharif* season difficulty to get cloud free optical data led to the use of microwave data (SAR sensor) for crop area estimation. This study particularly is about the feasibility of using microwave data to discrimination the rice ecosystem. In this study, microwave in variable band combination helped discriminate the rice ecosystems and was found to be a viable technology.

Methodology

The location of the study area is Naouroji camp (minor village) between Mandoddi and China Thandrapad villages of Ieeja mandal of Jogulamba Gadwal district. The farmers cultivate direct seeded rice with the onset of monsoon and transplant rice in the low lying areas with the release of canal water. Rice crop was monitored by using the Sentinel-1A SAR data in the C band. The data collected from the satellite was pre-processed and the temporal backscattering values were extracted from stacked image according to satellite pass from the month of mid-July to the end of crop growth season i.e., the end of January. The emittance values were used for extracting the spectral profile in order to discriminate the crop ecosystems.

Results

The backscattering values for both the crop establishment methods were extracted and plotted for the entire crop growth period. There was little confusion in the interpretation because of the differences in the time of sowing or transplanting of the rice crop. However, (Gumma et al., 2015) reported that, clear differences could be noticed in the two rice cultures even if there is difference in the dates of sowings. In order to avoid this confusion, the crop growth stages were made to synchronize within each ecosystem to attain discrimination accordance with the satellite pass. The different stage of crop was divided to land ploughing, land preparation (flooding), establishment, tillering, maximum tillering, stem elongation, panicle initiation, heading, flowering, dough, maturity, and harvest. Direct dry seeding rice which was sown with the onset of monsoon showers during July second fortnight and transplanting was carried out with the release of the canal water during September first fortnight. So, the difference between transplanted and direct dry seeded rice was perceived. Paired t-test with equal variance was performed to study the significance of backscatter values in relation to the crop growth stage (Table 1). Data analyzed was interpreted by using the t table values with t-calculated value in order to find out their significant difference at 0.01 and 0.05 level of significance. The two-sample t test revealed that VV polarization gave good results and was able to differentiate the crop at land preparation, establishment, tillering, maximum tillering and stem elongation stages. VH also performed on par with VV and was able to discriminate the crop at land preparation, establishment and tillering. VV/VH was able to discriminate at maximum tillering and stem elongation stage of the crop.

Table 1: Statistical two sample T test of crop growth stage with SAR polarisations.

	Polarisation		
Stage of the crop	VV	VH	VV/VH
Land preparation	-2.69	-2.51	0.20
Land preparation (water Impounding)	3.32**	3.59**	0.47
Early establishment stage	0.83	3.05**	-1.52
Establishment stage	3.64**	4.56**	-1.55
Tillering	3.30**	3.17**	-0.26
Maximum Tillering	3.16**	-1.61	4.62**
Stem elongation	2.41*	-0.71	2.48*
Panicle initiation	-0.59	-1.02	0.59
Heading	-3.83	-3.83	-0.38
Flowering	3.23**	2.55*	1.124
Dough	3.69**	5.57**	-1.12
Maturity	3.57**	6.35**	0.20
T statistics **at 0.05 % LOS is 2.101, T statistics value *at 0.01 % LOS is 2.835			

Conclusion

It can be concluded that discrimination of rice ecosystems is possible. The two-sample t test revealed that VV/VH polarization could differentiate the rice crop at maximum tillering stage and stem elongation stage whereas VV and VH polarizations could differentiate at land preparation, establishment and tillering stage of the crop.

References

Gumma, M.K., Mohanty, S., Nelson, A., Arnel, R., Mohammed, I.A., & Das, S.R. 2015. Remote sensing-based change analysis of rice environments in Odisha, India. *Journal of Environmental Management.* 148: 31–41. doi: 10.1016/j.jenvman.2013.11.039.

ICSCI 2022/T3/83

Biochar: A climate smart technology for better soil physical properties, resource use and yield of yard long bean

Mariya Dainy M. S[1], and Usha P. B.[2]
[1]Soil Science and Agricultural Chemistry, Agronomic Research Station, Chalakudy, Kerala Agricultural University, Thrissur, Kerala, 680307, India
[2]Dept. of Soil Science and Agricultural Chemistry, College of Agriculture, Vellayani, Trivandrum, Kerala Agricultural University,695522, India
Email: mariya.dainy@kau.in

Introduction

Biochar is a carbon-rich product obtained when organic biomass is heated under zero or limited oxygen conditions. Biochar is a highly porous and stable material that can hold and release nutrients and water slowly, thus its application to soil can improve soil physical properties including porosity, bulk density, water holding capacity and aggregate stability there by increase soil fertility and crop yield. Tender coconut husk is a biowaste which accumulates as an organic waste on the roadsides causing environmental pollution. The present investigation was conducted to produce biochar from tender coconut husk to protect the ecosystem from pollution by reducing carbon dioxide emission there by serves as a mechanism of climate change mitigation and utilization of the produced biochar as a soil amendment for improving soil properties and yield of yard long bean.

Methodology

An experiment was conducted at College of Agriculture, Vellayani of Kerala Agricultural University, to investigate the efficacy of biochar from tender coconut husk for better resource use and enhanced crop production. Biochar was produced from tender coconut husk, characterized and tested in the field at different levels of application *viz.* 10 and 20 and 30 t ha^{-1} using yard long bean variety Vellayani Jyothika as the test crop during January to April 2013. Along with biochar, other commonly used organic manures namely Farm Yard Manure (FYM) and vermicompost, biofertilizers, Plant Growth Promoting Rhizobacteria (PGPR) and Arbuscular Mycorrhizal Fungi (AMF) were also tested in the field. The experiment was laid out in RBD with 9 treatments and 3 replications. The details of treatments with results are presented in Table 1. Physical properties of the soil such as porosity, bulk density, water holding capacity and per cent water stable aggregates were analyzed after the application of treatments. The soils of the experimental site belong to the family Loamy Skeletal Kaolinitic Isohyperthermic Rhodic Haplustult.

Results

Biochar produced from tender coconut husk was alkaline in nature with pH of 9.13, water holding capacity of 226.00 per cent, bulk density of 0.14 Mg m^{-3} and BET surface area of 157.93 m^2 g^{-1}. Biochar when applied @ 30 t ha^{-1} with NPK as per POP significantly increased the water holding capacity of the soil. The highly porous nature of biochar can retain water in small pores and thus increase water holding capacity (Asai *et al*., 2009). Porosity of the soil increased by 18.82 per cent by biochar application. Biochar influences soil porosity and thus soil water retentions by three mechanisms *viz.* direct pore contribution from pores within the biochar, creation of packing or accommodation pores between biochar and the surrounding soil aggregates and through improved persistence of soil pores due to increased aggregate stability. Bulk density of the soil was reduced by the incorporation of tender coconut husk biochar. Biochar, being a rich source of Ca and Mg, helps in supplying these nutrients to the soil, resulting in improved flocculation and stability of water stable aggregates. Busscher *et al*. (2011) indicated that increasing total organic carbon by the addition of biochar in soils could significantly decrease bulk density by influencing flocculation of soil micro-aggregates.

Table 1. Effect of treatments on physical properties of soil and yield

Treatments	Water Holding Capacity (per cent)	Porosity (per cent)	Bulk density ($Mg\ m^{-3}$)	Water Stable Aggregates (per cent)	Pod yield ($t\ ha^{-1}$)
Biochar @ 10 t ha^{-1} + NPK as per POP	28.66	45.53	1.34	55.13	13.04
Biochar @ 10 t ha^{-1} + NPK as per POP	29.96	46.77	1.32	58.54	16.59
Biochar @ 20 t ha^{-1} + NPK as per POP	36.57	50.39	1.29	64.89	17.88
Biochar @ 30 t ha^{-1} + NPK as per POP	45.64	54.10	1.23	78.30	18.70
Biochar @ 20 t ha^{-1} + 75% NPK as per POP	34.37	50.00	1.28	62.96	17.60
Biochar @ 10 t ha^{-1} + FYM @ 10 t ha^{-1}+75% NPK as per POP	31.00	47.58	1.30	60.12	16.92
Biochar @ 10 t ha^{-1} + vermicompost @ 5 tha^{-1} + 75% NPK as per POP	33.49	49.61	1.29	61.43	18.02
Biochar @ 20 t ha^{-1} + 2 % PGPR + NPK as per POP	41.89	53.03	1.24	77.75	20.12
Biochar @ 20 t ha^{-1} + AMF @ 200 g m^{-2} + NPK as per POP	38.26	53.31	1.24	70.13	18.30
CD (0.05)	0.595	0.848	0.023	0.799	0.260

Conclusion

Biochar produced from tender coconut husk can act a climate smart technology, reducing environmental pollution. As it can store more carbon in a stable form, it can as a slow-release organic material for water and nutrients. Because of the highly porous nature and other desirable physical properties it can be used as an amendment to improve soil physical properties and water relations, thereby increase the yield of yard long bean.

References

Asai, H., Samson, B. K., Stephan, H. M., Songyikhangsuthor, K., Homma, K., Kiyono, Y., Inoue, Y., Shiraiwa, T., and Horie, T. 2009. Biochar amendment techniques for upland rice production in northern Laos. Field Crops Research, 111: 81–84.

Busscher, W. J., Novak, J. M., and Ahmedna, M. 2011**.** Physical effects of organic matter amendment of a southeastern us coastal loamy sand. Soil Science, 176: 661–667.

ICSCI 2022/T3/84

Effect of silicon amendments for arsenic monitoring in rice

Rubina Khanam[1], Amaresh Kumar Nayak[1], Mohammad Shahid[1], Pedda Ghouse Peera Sheikh Kulsum[2]

[1]*ICAR-Crop Production Division, National Rice Research Institute, Cuttack-753006, Odisha, India*

[2]*C V Raman Global University, Bhubaneswar-752054, Odisha, India*

Email: erinakhanam@gmail.com

Introduction

Arsenic (As) poisoning has been claimed to affect 200 million people globally, either by drinking As-contaminated groundwater or through consumption of As-laced food crops, mostly rice (Oryza sativa L.) (Khanam et al., 2021). Being a class I carcinogen, As is linked to a wide range of human illnesses, including fatigue, chronic respiratory disease, liver fibrosis, cardiovascular disorders, skin cancer, and lung cancer Several attempts have been made by researchers to reduce As bioavailability and to restrict As accumulation in rice grains with different management options, viz agronomic, biotechnological, nanotechnological intervention or microbial supplementation. However, most of the studies on the reduction of As in the paddy-rice system were done in isolation taking one or two amendment (s) at a time with the simple objective of knowing its impact on As loading in grains without much insight of the factors and the mechanisms involved in its whole journey from soil to cooked rice to cause the problem. In this investigation, the interplays of the factors for mitigating arsenic (As) toxicity in rice was assessed using a contaminated paddy-rice system with seven amendment regimes involving $CaSiO_3$, SiO_2 nanoparticles, silica solubilizing bacteria (SSB), and rice straw compost (RSC).

Methodology

A pot experiment was conducted, having the capacity to hold 10.0 kg soil, in the net house of ICAR-National Rice Research Institute, Cuttack, India. Rice (var. IR 64) seedlings were raised in small pots with two-kilogram soil in the Rabi season of 2019− 20 and 2020−21. Watering was done as and when necessary, using 500 µg l^{-1} As treated water. Four types of organic and inorganic Si sources [silica solubilizing bacteria (SSB), rice straw compost (RSC), calcium silicate (CS) and SiO_2 nanoparticles (Si Np)] were used individually and in different combinations and doses (SSB+RSC, Si Np at 80 mg kg $soil^{-1}$, and Si Np at 40 mg kg $soil^{-1}$) totalling seven and with four replications.

Results

Tracing the translocation of As from soil-root-shoot-grain-polished to cooked rice, RSC and its combination with SSB was found as most effective in curbing As loading in rice grain (53.2%) (Fig. 1). The translocation of As from roots to shoot and subsequently from shoot to grains primarily governs by availability of transporters, vacuolar sequestration of As, production of phytochelatine, morpho-physiological characters of plants and competition between ions (i.,e As vs Si and As vs P) (Pan et al., 2020).The risk of dietary exposure to As was assessed by computing the average daily intake (ADI), hazard quotient (HQ) and incremental lifetime cancer risk (ILCR), and observed the ADI is reduced to one-third (0.24 µg kg^{-1} BW) under RSC+SSB treatments over control.

Table 1. The values of the estimated average daily intake (ADI, µg kg BW^{-1}), hazard quotient (HQ), incremental lifetime cancer risk (ILCR)

Treatments details	ADI[a]	HQ	ILCR[b]
Control	0.88	2.93	1.31
Silicate solubilizing bacteria (SSB)	0.50	1.66	0.75
Rice straw compost (RSC)	0.30	0.98	0.55
SSB + RSC	0.25	0.83	0.44
$CaSiO_3$	0.47	1.56	0.70
Si Np at RD	0.51	1.53	0.76
Si Np at 50% RD	0.57	1.92	0.86

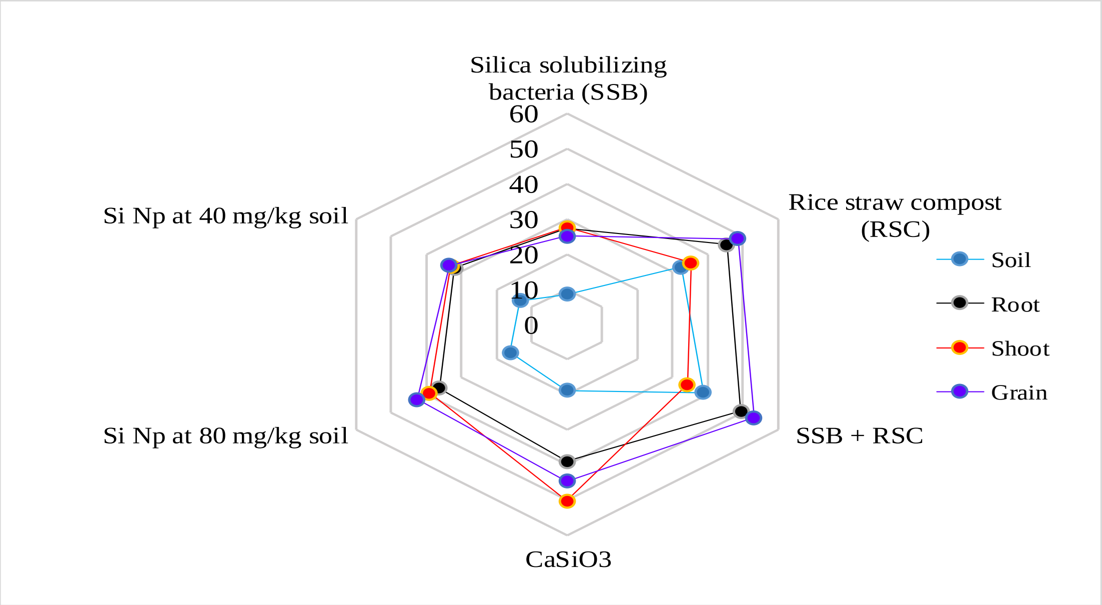


Fig. 1 Efficiency of the soil amendments (singly or in combinations) in causing reduction (% over the control) in arsenic contents in soil, root, shoot and grain at maturity.

Conclusion

Human exposure to As via rice continues unabated despite the management strategies proposed by various researchers at regular intervals. Our result results highlight that one or two elements from amendments applied may not directly reduce As accumulation in rice grain up to the desired level (HQ < 1), however, by changing the regulating factors in soil (pH, Soil As, Soil P, Soil Fe, S, Soil Si) and plant morpho-physiological characters can produce As benign rice grain.

References

Khanam R, Kulsum, PGPS., Debnath S, Roychowdhury T, Mandal B. 2022. Impact of Soil Amendment Regimes on Arsenic Exposure to Human Through Rice: Risk Assessment and Prediction for Remediation. Exposer and Health, 1-17.

Pan D, Yi J, Li F, Li X, Liu C, Wu W, Tao T.2020. Dynamics of gene expression associated with arsenic uptake and transport in rice during the whole growth period. BMC Plant Biol. 20.

ICSCI 2022/T3/87

Evaluation of Nitrogen Sources for Improving Rice Productivity and Nitrogen Use Efficiency

K. Surekha, D. V. K. N. Rao, R. M. Kumar, C. N. Neeraja, V. Manasa, R. Gobinath, Brajendra and R M Sundaram
ICAR-Indian Institute of Rice Research (IIRR), Hyderabad
Email: surekhakuchi@gmail.com

Introduction

Nitrogen is the key nutrient element required by rice in large quantities and its recovery efficiency is very low (25-40%) as it is subjected to various losses under flooded conditions. Nitrogen use efficiency is defined as the maximum economic yield per unit of N applied, absorbed or utilised by the plant to produce grain and straw (Dobermann 2007). However, the efficiency of applied N fertiliser primarily depends on the source of N and selection of right source of nitrogen fertiliser forms an important management strategy for improving nitrogen use efficiency. Considering this, some of the available nitrogen sources were evaluated for rice productivity and nitrogen use efficiency under field experiments at the Indian Institute of Rice Research, Hyderabad during wet and dry seasons of 2015-2017.

Methodology

Field experiments were conducted at the ICAR-Indian Institute of Rice Research, Hyderabad ($17^0 19''$ N latitude, $78^0 23''$ E longitude, 542 m altitude with mean annual precipitation of 750 mm) on a black clayey vertisol. The experimental soil characteristics were: slightly alkaline (pH 8.2); non-saline (EC 0.7l dS/m); calcareous (free $CaCO_3$ 5.01%); with CEC 44.1 C mol (p+)/kg soil and medium soil organic carbon (0.69%) content. Soil available N was low (228 kg/ha); available phosphorus was high (105 kg P_2O_5 /ha$_{);}$ available potassium was high (530 kg K_2O /ha). The experiment on direct seeded rice (DSR) was conducted during *kharif (wet season)* 2017 with five treatments viz; Control, RDF(Urea), Urea+ vermicompost (VC), Urea+gibberillic acid (GA3) and Urea+VC+GA3. In the transplanted rice, during *kharif* 2018 and rabi 2018-19 (dry season) five N sources (Urea; Neem coated urea, NCU; polymer coated urea, PCU; vermin-compost, VC and rice straw, RS) were tested at four N levels (N0, N50, N75 and N100 kg/ha). The data on yield parameters, grain yield, nitrogen use efficiency (NUE) and important enzyme activities were recorded at the end of the experiment.

Results

In transplanted rice, the yield parameters, panicles and grain number per panicle were maximum at 100 kg N/ha and 1000 grain weight was not influenced significantly in both seasons. The grain yield increase due to N application was by 22-45% in *kharif* and by 44-67% in *rabi*. Among the N sources, neem coated urea (NCU) and polymer coated urea (PCU) were superior to all other sources under transplanted conditions during both the seasons (Table 1). The coated ureas increased the grain yield over normal urea by 0.54 and 0.72 t/ha during wet and dry seasons, respectively, indicating higher response to N in dry season while complete organics recorded lower yield by 0.42-0.48 t/ha over urea. This could be due to their slow N release as indicated by comparatively less urease activity (by about 15%) and high N recovery efficiency (15-35%) with coated ureas (Zhang *et al*. 2018). Nitrogen use efficiency (NUE) as given by agronomic efficiency (AE) also followed the similar trend as that of grain yield trend with maximum values in coated ureas (26-33 kg grain yield increase/ kg N added) to minimum values with complete organic sources (15-16 kg grain yield increase/ kg N added) compared to urea with 21-25 kg grain yield increase/ kg N added.

Under direct seeded rice (DSR), GA3 spray along with RDF and vermi compost (VC) increased the plant height, panicle length, yield parameters, grain yield, N uptake and enzyme activities. Grain yield was maximum with urea+VC+GA3 (5.68 t/ha) and urea recorded the minimum (4.58 t/ha). Agronomic efficiency was also maximum with urea+VC+GA3 recording 21 kg grain yield increase/ kg N added and minimum with urea (13.8 kg grain yield increase/ kg N added).

Table 1: Influence of various N levels and Sources in transplanted and direct seeded rice

	Transplanted rice (2018)							Direct seeded rice (2017)		
N Levels (kg/ha)	Grain Yield (t/ha)		N Sources	Grain Yield (t/ha)		Nitrogen use efficiency		N Sources	Grain Yield (t/ha)	Nitrogen use efficiency
	Kharif	*Rabi*		*Kharif*	*Rabi*	*Kharif*	*Rabi*			
N-0	3.11	3.34	Urea	4.01	4.51	21.0	25.0	Control	3.20	-
N-50	3.82	4.80	Neem Coated Urea (NCU)	4.63	5.12	26.3	32.0	Urea	4.58	13.8
N-75	4.11	5.11	Polymer Coated Urea(PCU)	4.67	5.34	26.7	33.0	Urea+ vermicompost (VC)	5.24	17.0
N-100	4.50	5.60	Vermicompost	3.64	4.04	16.7	16.1	Urea+ GA3	4.76	15.6
			Paddy Straw	3.62	4.15	16.3	15.0	Urea+VC+GA3	5.68	21.0

Conclusion

Neem coated urea and polymer coated urea were superior with their slow N release nature and high N recovery efficiency under transplanted rice and in case of direct seeded rice, GA3 spray along with recommended fertiliser dose and VC increased the plant growth parameters and yield.

References

Dobermann A. 2007. "Nutrient use efficiency–measurement and management," in Proceedings of the International Fertilizer Industry Association (IFA) Workshop on Fertilizer Best Management Practices, 7–9 March 2007, Brussels, 1–28.

Zhang S G, T L Shen, Y C Yang, Y C Li, Y S Wan, M Zhang, Y F Tang and S C Allen. 2018. Controlled-release urea reduced nitrogen leaching and improved nitrogen use efciency and yield of direct-seeded rice. Journal of Environmental Management. 220: 191–197.

ICSCI 2022/T3/88

Influence of integrated phosphorus management on productivity and profitability of wet seeded rice-greengram cropping sytem

R. Nageswari[1]*, S. Anandha Krishnaveni[1], K.B. Sujatha[2], K. Chitra[1], V.Dhanushkodi[3] K. Dhanalaksmi[4] and Anita[3]

[1]Tamil Nadu rice Research Institute, Aduthurai,Thanjavur, [2]Tamil Nadu Agricultural University, Coimbtore-3, [3]Anbil Dharmalingam Agricultural College and Research Institute, Trichy and [4]Horticultural College and Research Institute(Women), Trichcy

*Corresponding Authors Email id: oryzanagtn@gmail.com

Introduction

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore, during samba (September – February) and summer (March – May) seasons of 2001-'02 and 2002-'03 with the objective of finding out the influence of integrated phosphorus management on the productivity and profitability of wet seeded rice- green gram cropping system.

Materials and Methods

The field experiments were laid out in split plot design with three replications. The main plot treatments were 100 per cent (P_1), 75 per cent (P_2) and 50 per cent (P_3) of recommended P. The sub plot treatments were, S_1 -Entire dose of P as single super phosphate (SSP) alone, S_2 - Entire dose of P as SSP + Phosphate solubilising bacteria(PSB), S_3 - Entire dose of P as rock phosphate (RP) alone, S_4 - Entire dose of P as RP + PSB, S_5 - 1/3 SSP +2/3 RP + PSB , S_6 - 1/2 SSP +1/2 RP + PSB, S_7 - 2/3 SSP +1/3 RP + PSB, S_8 - 1/3 SSP +2/3 RP alone ,S_9 - 1/2 SSP +1/2 RP alone and S_{10} - 2/3 SSP +1/3 RP alone. The soil was medium in available P content (16.2 kg/ha). The fertilizer treatments were imposed the wet seeded rice and green gram (Pusabold) was sown after the harvest of rice as residual crop without any fertilizer application. Growth and yield parameters of wet seeded rice and green gram were observed and the productivity and profitability of wet seeded rice - green gram cropping system were worked out. The results were analyzed using the statistical methods as suggested by Gomez and Gomez (1984).

Results and Discussions

Rice Equivalent Yield (REY)

The levels and sources of P significantly influenced the rice equivalent yield of wet seeded rice -greengram cropping system (Table 1). Application of 100 per cent of the recommended level of P(P_1) recorded significantly higher rice grain equivalent yield(REY) (8237 and 8383 kg ha^{-1} during 2001-'02 and 2002-'03, respectively) than that from other levels of P as reported by Saikia and Balasubramaniam (1998) and Hasan (1999). This was followed by application of 75 per cent of the recommended level of P(P_2) which recorded 7530 and 7637 kg ha^{-1} of REY during the first and second years respectively. Reduction of P level to 50 per cent (P_3) recorded the lowest grain equivalent yields.

Regarding the sources of P, application of entire dose of P as SSP + PSB (S_2) recorded higher rice equivalent yield (8108 and 8454 kg ha^{-1} during 2001-'02 and 2002-'03, respectively). Application of P as 2/3 SSP + 1/3 RP + PSB (S_7) also produced comparable REY during both the years. Application of RP alone recorded the lowest REY.Similar results were reported by Raju and Reddy(1999).

Table 1. Effect of levels and sources of P on rice equivalent yield (kg ha^{-1}) of wet seeded rice -green gram cropping system

Treatments	2001-02				Treatments	2002-03			
	P_1	P_2	P_3	Mean		*P_1*	P_2	P_3	Mean
S_1	8448	8104	7707	8086	**S_1**	860	8241	7720	8194
S_2	8813	7553	7957	8108	S_2	8856	8510	7997	8454
S_3	7998	7694	7311	7668	S_3	8147	7769	7165	7694
S_4	8081	7810	7414	7768	S_4	8380	7509	7683	7858
S_5	8070	7840	738	7764	S_5	8133	7880	7543	7852
S_6	8622	8106	7706	8145	S_6	8626	8265	7864	8252
S_7	8729	8271	7868	8289	S_7	8806	8438	8027	8424
S_8	7753	7588	7213	7518	S_8	8806	8438	8027	8424
S_9	7910	7676	7389	7658	S_9	8172	7821	7510	7834
S_{10}	7941	7995	7351	7762	S_{10}	8103	8149	7502	7918
Mean	8237	7864	7530	7877	Mean	8383	8032	7637	8017

	SEd	**CD (0.05)**			**SEd**	**CD(0.05)**
P	43	120		*P*	58	162
S	95	190		**S**	86	173
P at S	161	33		**P at S**	153	35
S at P	164	39		**S at P**	150	300

Profitability

The levels and sources of P markedly influenced the gross and net income of wet seeded rice-green gram cropping system. The treatment combination of P_1S_2 recorded the highest gross income of Rs.48036 and Rs. 47642ha^{-1}, during 001-0 and 2002-03, respectively. The net income also followed the same trend during both the years. The highest net income of Rs. 27,602 and 28,312 ha^{-1} were recorded during 2001-’02 and 2002-’03, respectively.

The highest benefit cost ratio (BCR) (2.63 and 2.68, during 2001-02 and 2002-03 , respectively) was observed with 100 percent level of P(P_1). Among the sources of P, application of entire dose of P as SSP + PSB (S_2) recorded higher rice equivalent yield (2.64 and 2.75 kg ha^{-1} during 2001-’02 and 2002-’03, respectively). The lowest BCR was observed with the treatment combination of 50 per cent of the recommended P(P3) applied through 1/3 SSP+ 2/3 RP alone(P_3S_3)

Conclusion

Hence, it is concluded that application of 100 per cent recommended P to rice as SSP + PSB or 2/3 SSP + 1/3 RP along with PSB application is the best integrated phosphorus management strategy for wet seeded rice -green gram cropping system for increasing the productivity and profitability.

References

Raju, R. and M.N. Reddy.1999. Effect of rock phosphate amended with phosphate solubilizing bacteria and farmyard manure in wet land rice (*Oryza sativa*). **Indian J. Agric. Sci., 69**(6): 451-453.

Saikia, M. and N.Balasubramaniam. 1998. Effects of irrigation and P fertilization on root growth and yield of wet seeded and transplanted rice. Oryza, 35(3):260-263.

Gome, K. A and a.a.Gome,1984.Statistical Procedures for agricultural research(2ed.), John wiley and Sons, NewYork,

ICSCI 2022/T3/89

Graded levels of potassium on production of hydrolytic enzymes in rice

K. Chitra[1]*, K Dhanalakshmi[2], K. Kavitha[3], N. Indra[3] N. Rajinimala[3], R. Nageswari [4] S. Anandha Krishnaveni[4], R. Rajeshwari[5] and T. Sivsankari Devi [6]

[1]Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore
[2]Department of Horticulture, Tamil Nadu Agricultural University, Coimbatore-[3]Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore
[4]Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore
[5] Department of Soil Science, Tamil Nadu Agricultural University, Coimbatore
[6] Department of Microbiology, Tamil Nadu Agricultural University, Coimbatore
E-mail: chitrapatho@gmail.com

Introduction

Rice is an important cereal crop, which is the primary food for half of the human population. The average annual production of rice in India is 2.8 t ha^{-1}.Rice crop suffers from a number of fungal, bacterial and viral diseases. Among the fungal diseases, sheath blight is a major disease caused by *Rhizoctonia solani* Kuhn. (*Thanatephorus cucumeris* (Frank) (Donk.). Several workers reported that potassium fertilization reduced the susceptibility of rice to diseases, hastened the maturity and increased the yield. Yamada (1959) reported that the deficiency of potassium and excess of nitrogen were responsible for the incidence of diseases like sheath blight, brown spot, blast and stem rot of rice.

Methodology

Modified Czapek's broth in which the carbon source was substituted by three per cent pectin for pectinolytic enzymes was prepared. Potassium chloride at 0, 25, 50, 75 and 100 kg ha^{-1} was incorporated. The pH of the medium was adjusted to 6.5 - 7.0, distributed in 50 ml quantities in 250 ml Erlenmeyer flasks, sterilized and cooled to room temperature. The flasks were inoculated with eight mm discs of the fungal growth and incubated at room temperature (28±1°C) for 15 days. At the end of incubation period, the biomass from the culture solution was removed by filtration under suction in a previously dried and weighed filter paper. The filter paper with biomass was dried, at 105°C for 25 hrs. and the dry weight was determined. The culture filtrates were centrifuged at 2100 rpm. for 30 minutes, examined microscopically for the presence of contaminating fungal spores and retained for the various enzyme assays.

Enzyme assay

Pectinolytic enzymes

(a) Polygalacturonase (PG) , (b) Polygalacturonase transeliminase (PGTE)

(c) Pectin trans-eliminase (PTE) Mahadevan, (1966),

Results

The production of Polygalacturanase (PG), Polygalacturanase transeliminase (PGTE) and Pectic Trans Eliminase (PTE) were measured and the results showed that, all the enzymes production reduced significantly in all the treatments with increasing levels of potassium when compared to control. The maximum and minimum inhibition was observed at 100-kg k2o ha^{-1} levels respectively. PG production was considerably inhibited in all the treatments. Maximum inhibition of 44.44 per cent was noticed in 100-kg k2o ha^{-1} when compared to control. Minimum inhibition of 14.37 per cent was noticed in 25 kg k2o ha^{-1} level. PGTE and PTE production also followed the same pattern, recording the maximum and minimum percentage of reduction of 73.33 and 26.66, 72.17 and 20.00 per cent respectively over control. (Alagappan 1992, Prabakar, 1991 and Murugesan, 1993).

Table1. Effect of graded levels of potassium on the in vitro production of Pectinolytic enzymes *by R. solani*

K_2O levels kg ha^{-1}	PG**	Percent decrease over control	PGTE***	Percent (-) decrease are control	PTE****	Per cent decrease (-) over control
0	30.6		7.5		11.5	
25	26.2	+14.37	5.5	+26.66	9.2	+20.00
50	22.1	+27.77	4.1	+45.33	7.1	+38.26
75	19.0	+37.90	3.0	+60.00	5.0	+56.52
100	17.0	+44.44	2.0	+73.33	3.2	+72.17
SE	0.3095		0.3093		0.2503	
CD (p=0.05)	0.8792		0.8792		0.7116	

References

Alagappan, K.R. (1992). Studies on the effect of potassium on the die-back and fruit rot disease of chillies incited by *Colletotrichum capsici*. M.Sc.(Ag.) Thesis, Annamalai Univ. India.

Mahadevan, A. (1966. Biochemistry of infection and resistance. Phytopathology Z, 90: 566.

Murugesan, R. (1993). Studies on the effect of potassium on blast disease of fingermillet incited by *Pyricularia grisea* (Cke). Sacc. M.Sc.(Ag.) Thesis, Annamalai Univ. India. on wilt incidence on muskmelon. Potash Newsl, 9: 3.

ICSCI 2022/T3/90

Effect of Geoxol.Com on yield and yield components of irrigated rice

Manasa V*, Surekha K, Gobinath R, Bandeppa S and Padmaja K
ICAR-Indian Institute of Rice Research, Hyderabad-500030, Telangana, India.
**E-mail: vakadamanasa@gmail.com*

Introduction

Intensive cropping coupled with imbalanced fertilization leads to deterioration in soil chemical, physical, biological properties and ultimately soil health. Despite the past gains in rice production through chemical fertilizers, recent observations of stagnant or declining yields have raised concerns about the addition of organic amendments for long-term sustainability of the crop production (Hussainy, 2020). Moreover, the physical environment of the soil influences the nature of the chemical and biological reactions in the soils which determine the availability of water, nutrients, oxygen and the mechanical support to the growing plants. Organic materials such as FYM and Vermi compost are traditionally being used by rice farmers. Although FYM supplies all major nutrients (N, P, K, Ca, Mg, S) as well as micronutrients (Fe, Mn, Cu and Zn) necessary for plant growth, the nutrient concentration in these manure is very less and need to apply in huge quantities which also attracts labour and transport cost. To overcome these constraints, a product “Geoxol.com” was developed by Privi Life Sciences as a viable alternative to Farm Yard Manure. It is compressed granulated geo competent organic manure consisting unique blend of ecofriendly, naturally derived and aseptically decomposed peat extract, low molecular weight organic acids, polysaccharides and animal biomass. Geoxol.com contains 15 %, carbon 1.50 %, 1% phosphorus and 0.5% potassium. Although there is a growing concern about the use of organics, application of organic manures alone as a substitute to inorganic fertilizers is not enough to maintain the present levels of crop productivity of high yielding varieties. Therefore, integrated nutrient management in which both organic manures and inorganic fertilizers are used simultaneously is the most effective method to maintain a healthy and sustainably productive soil (Singh, 2017). In view of these, Geoxol.com in combination with Inorganic fertilizers was tested in irrigated rice at Rajendranagar farm, Indian Institute of Rice Research, Hyderabad.

Methodology

Field experiment was conducted during *Rabi* 20-21 with graded doses of Geoxol.com, recommended doses of FYM @ 10 t/ha and Vermicompost @ 5 t/ha in combination with RDF (recommended dose of fertilizer) doses. The experiment was laid out in a Randomized complete block design with Chandra variety and replicated thrice. The experimental soil is a Vertisol with neutral pH 7.95, EC (0.79), medium organic carbon (0.56 %) low available nitrogen (181 kg/ha), high phosphorus (68 kg P_2O_5/ha) and high available potassium (510 kg K_2O/ha). The paddy crop was supplied with 100:40:40 kg N, P_2O_5 &K_2O ha^{-1} and all the recommended crop management practices and timely plant protection measures were adopted.

Results

The highest tiller number (390) and panicle number (315) were noticed in the plot, which received 60 kg/ha Geoxol.com along with recommended fertilizer dose. All the Geoxol.com treated plots, irrespective of the dose and FYM applied plot were on par with Geoxol 60 kg/ha with respect to tillers and panicles. Grain number per panicle varied significantly among the treatments and ranged from 85 to 109 with a mean of 100 grains per panicle (Table 1). Application of RDF + 40 kg/ha Geoxol.com recorded highest grains per panicle (109) which was on par with rest of the treatments except absolute control (85) and RDF (96). There was a significant increase in grain yield with application of Geoxol.com in different doses compared to only RDF application. Grain yield differed significantly among the treatments and ranged from 3450 to 6950 kg/ha with an average grain yield of 5873 kg/ha. The highest grain yield (6950 kg/ha) was observed in the treatment supplied with 60 kg/ha Geoxol.com in combination with RDF. Application of Geoxol.com @ 40 kg/ha (6800 kg/ha), 20 kg/ha (6523 kg/ha), FYM @ 10 t/ha (6392 kg/ha) recorded on par yields with 60 kg/ha Geoxol.com. Geoxol application resulted in yield increment to the tune of 17 - 36 % over only RDF application maximum being 60 kg/ha. The similar trend was noticed in straw yield of rice in which 60 kg/ha Geoxol.com in combination with RDF registered significantly higher straw yield (7858 kg ha^{-1}) and at par with all other treatments except absolute control (4053 kg ha^{-1}) and RDF (6585 kg ha^{-1}). Harvest index was statistically non-significant among the treatments.

Table 1: Effect of Geoxol.com on yield and yield parameters of rice

Treatments	Tillers/m^2	Panicles/m^2	Grains/ panicle	Grain Yield (kg/ha)	Straw yield (kg/ha)	Harvest Index
Absolute control	287	201	85	3450	4053	0.45
RDF	339	244	96	5130	6585	0.44
RDF + 10 t/ha FYM	371	280	104	6392	7737	0.45
RDF + Vermicompost	310	233	100	5702	6857	0.45
RDF + 10 kg/ha Geoxol.com	352	279	98	6040	7067	0.46
RDF + 20 kg/ha Geoxol.com	364	294	101	6523	7495	0.47
RDF + 40 kg/ha Geoxol.com	374	303	109	6800	7477	0.47
RDF + 60 kg/ha Geoxol.com	390	315	106	6950	7858	0.47
Mean	348	269	100	5873	6891	0.46
C.D (p = 0.05)	47.7	49.1	11.5	900	1144	NS
C.V (%)	7.74	10.3	6.54	8.67	9.39	7.36

Conclusion

The grain and straw yields recorded with 20 kg/ha Geoxol.com were on par with higher doses of Geoxol.com *Viz.,* 40 & 60 kg/ha application and FYM @ 10t/ha indicating application of RDF + 20 kg/ha geoxol.com was sufficient to achieve higher yields which saves input cost and ultimately resulting in higher benefit cost ratio.

References

Hussainy SAH, and Arivukodi S. 2020. Performance of rice under integrated nutrient management: A review. *Int. J. Curr. Microbiol. Applied Sci*, 9, 1390-1404.

Singh V. 2017.Effect of balanced use of nutrients on productivity and economics of wheat (*Triticum aestivum*). *Annals of Plant and Soil Research,* 19(1): 105-109.

ICSCI 2022/T3/91

Climate resilient agronomical practices for yield enhancement in system of rice intensification

R. Raman
Centre for Natural farming and Sustainable Agriculture
Faculty of Agriculture, Annamalai University
Annamalai Nagar 608002, Tamil Nadu.
Email: ramanagron@gmail.com

Introduction

Rice is the world's most important food crop and a primary source of food for more than half of the world population. More than 90 % of the world's rice is grown and consumed in Asia. It is also considered to be 'the stuff of life', since it provides major calorific requirement of the human beings. It is also learnt that more number of people have started consuming rice an hence, there is a growing demand for feeding the burgeoning population. According to Ministry of Agriculture & Farmers Welfare Annual Report, 2021-22, rice is cultivated over an area of 450.67 lakh hectares in India with a production of 122.27 million tonnes and productivity of 2713 kg ha^{-1}. Food security is the most challenging task for any country, including India. Due to rising population, migration of people from rural to urban regions, lowering trends in agricultural lands and depletion of natural resources for rice crop growth is major concern for increasing crop productivity. Most rice crops have historically been grown in irrigated and transplanted circumstances. However, because of climate change, the availability of water for rice crop is diminishing. As a result, most farmers have been unable to produce rice crops. Among various rice production methodologies followed all over the world, System of Rice Intensification (SRI) is one of the most promising climate-smart, agro-ecological methodology for increasing the productivity of rice by altering the crop geometry, irrigation, nutrient management, the need of future generation, global rice production must grow by at least 30% by 2050 (Shew *et al.*, 2019).

Methodology

Field experiments were conducted at Annamalai University Experimental Farm, Annamalai Nagar to study the agronomic practices of SRI method cv. ADT – 36 during *Kuruvai* 2020 and *Navarai* 2020. The experiments were laid out in split plot design with three replications. The main treatments (Age of seedlings) *viz.*, 12 days old seedlings (M_1), 15 days old seedlings (M_2), 18 days old seedlings (M_3) and Five Sub Plot treatments (INM) *viz.*, S_1 – Vermicompost @ 5 t ha^{-1} + 100% RDF + *Azospirillum* + Phosphobacteria, S_2 – FYM @ 12.5 t ha^{-1} + 100% RDF + *Azospirillum* + Phosphobacteria, S_3 – Press mud @ 10 t ha^{-1} + 100% RDF + *Azospirillum* + Phosphobacteria, S_4 –100% RDF + *Azospirillum* + Phosphobacteria, S_5 –100% RDF alone.

Results

Among the different seedlings tried out, M1 recorded the highest plant height at flowering stage with 75.85 cm and 77.42 cm, leaf area index at flowering with 6.31 and 6.41and dry matter production @ harvest with 15,174 kg ha^{-1} and 15428 kg ha^{-1} respectively in first and second crop. In the sub plot, S_1 – Vermicompost @ 5 t ha^{-1} + 100% RDF + *Azospirillum* + Phosphobacteria recorded the highest plant height at flowering with 72.61 cm and 74.15 cm, leaf area index @ flowering with 6.49 and 6.43 and dry matter production @ harvest with 15,247 kg ha^{-1} and 15,496 kg ha^{-1} respectively in first and second crop. In all the growth character, M_3S_5 recorded the least value. The total dry weight of above ground parts at harvest was greater in SRI than NTP. The divergence in grain yield between SRI and NTP was due to differences in harvest Index rather than dry matter production. The plants grown in SRI had more open architecture, with tiller spread out more widely, covering more ground area and more erect leaves that avoided mutual shading of leaves. These plants also had higher leaf area index due to significant increase in leaf size and erect leaves in rice (Mahender Kumar *et al.*, 2013). In the yield attributes, the highest number of panicles m^2 were observed in 12 days old seedlings (M_1) with 800 and 815 in first and second crop respectively. In Sub plot treatment, S_1 – Vermicompost @ 5 t ha^{-1} + 100% RDF + *Azospirillum* + Phosphobacteria recorded the highest number of panicles m^2 with 801 and 815 respectively in first and second crop. The similar trend were followed in number of filled grains panicle^{-1} with 113.79 and 114.41 in M_1 and 112.11 and 113.20 in S_1. Transplanting of 12 days old seedling produced the highest grain yield compared to other age of seedling. The transplanting of 12 days recorded the grain yield of 6,117 kg ha^{-1}and 6,194 kg ha^{-1} respectively in Crop I and II. Application of Vermicompost @ 5 t ha^{-1} + 100% RDF + *Azospirillum* + Phosphobacteria recorded the grain yield of 6,249 kg ha^{-1} and 6,334 kg ha^{-1} in Crop I and II respectively. The least grain yields were recorded in 18 days old seedlings with 100% RDF alone. Panicles m^2 gave significant relationship with grain yield and contributed for higher yield. Further, SRI method improved soil aeration achieved through the soil disturbance by cono weeder operation, in addition to effective weed suppression reported similar factors contributing for higher yield in SRI method (Choudhury *et al.,* 2005).

Table 1 Effect of age of seedling and Integrated Nutrient Management on growth and yield of rice under SRI method

Main Plot	Plant Height @ Flowering Stage (cm)		Leaf Area Index @ Flowering Stage		Dry Matter Production (Kg ha^{-1})		number of panicles m^2		number of filled grains panicle^{-1}		Grain Yield (Kg ha^{-1})	
	Kuruvai	*Navarai*	*Kuruvai*	*Navarai*	*Kuruvai*	*Navarai*	*Kuruvai*	*Navarai*	*Kuruvai*	*Navarai*	*Kuruvai*	*Navarai*
M_1	75.85	77.42	6.31	6.41	15174	15428	800	815	113.97	114.41	6117	6194
M_2	70.47	72.08	5.89	5.97	14180	14361	758	770	109.47	110.28	5740	5792
M_3	65.04	66.19	5.49	5.53	13283	13302	714	727	101.45	102.87	5369	5494
S.Ed.	0.28	0.40	0.04	0.04	131.30	145.28	18.90	20.01	0.37	0.75	55.75	65
CD (p=0.05)	0.58	0.82	0.08	0.08	262.60	290.59	38.91	41.10	0.75	1.51	111.50	130.16
Sub Plot												
S_1	72.61	74.15	6.41	6.49	15247	15496	801	815	112.11	113.20	6249	6334
S_2	70.45	71.76	6.02	6.13	14360	14424	758	768	109.56	110.27	5874	5887
S_3	71.53	73.30	6.36	6.43	14962	15027	779	790	112.01	112.78	6088	6106
S_4	69.55	70.89	5.98	6.08	14203	14201	743	764	107.98	109.79	5779	5848
S_5	68.30	69.70	4.84	4.73	12990	12670	703	714	99.16	99.56	4670	5188
S.Ed.	0.49	0.54	0.06	0.07	135.06	135.08	8.45	10.14	1.01	1.26	52.12	57.28
C.D (p=0.05)	0.99	1.14	0.13	0.15	270.16	270.59	16.98	20.28	2.04	2.55	104.24	114.57

M_1 - 12 days old seedlings, M_2 - 15 days old seedlings, M_3 -18 days old seedlings, S_1 – Vermicompost @ 5 t ha^{-1} + 100% RDF + *Azospirillum* + Phosphobacteria, S_2 – FYM @ 12.5 t ha^{-1} + 100% RDF + *Azospirillum* + Phosphobacteria, S_3 – Press mud @ 10 t ha^{-1} + 100% RDF + *Azospirillum* + Phosphobacteria, S_4 –100% RDF + *Azospirillum* + Phosphobacteria, S_5 – 100% RDF alone.

Conclusion

Based on the results, it can be concluded that 12 days old seedlings with Vermicompost @ 5 t ha^{-1} + 100% RDF + *Azospirillum* + Phosphobacteria (M1S1) hold promise as an appropriate technology for achieving higher yield under the SRI principles on both in *Kuruvai* and *Navarai* Season.

References

Mahender Kumar R, Raghuveer rao P, Somasekhar N, Surekha K, Padmavathi CH, et al. (2013) SRI- A Method for Sustainable Intensification of Rice Production with Enhanced Water Productivity. Agrotechnol S11: 009.

Choudhury BU, Singh AK, Bouman BAM (2005) Effect of establishment techniques on yield, crop water relationship in rice and wheat. Transitions in Agriculture for Enhancing Water Productivity: Proceedings of an International Symposium held in Killikulam, Tamil Nadu, India.

Shew, A. M., Durand-Morat, A., Putman, B., Nalley, L. L., & Ghosh, A. (2019). Rice intensification in Bangladesh improves economic and environmental welfare. *Environmental Science & Policy*, *95*, 46-57.

ICSCI 2022/T3/92

Effect of integrated nutrient management practices on growth and yield of upland paddy

A. K. Gore, D. P. Waskar, P.O. Bhutada, A.K. Kadam and S. A. Jawle
Upland Paddy Research Scheme, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani - 431 402m Dist. Parbhani (M.S), India
Email: ofrtcvnmkvparbhani@gmail.com

Introduction

The widespread deficiencies of micronutrients have been reported in soils of India in the recent past due to intensive cultivation practices and the use of chemical fertilizers which are free of micronutrients. The adoption of integrated nutrient management technique may ameliorate micronutrients deficiencies by adding micronutrients and through their mobilization from unavailable to available forms through organic sources and also increase their uptake by crops. Rice (*Oryza sativa* L.) is the staple food for more than half of the world's population (Seck et al., 2012) and soil nutrient depletion and shortage of adapted varieties are among the major constraints for the yield gap in rice. The gap was further increased due to lower use of external inputs that led to negative nutrient balances in the soil (Rhodes et al., 1996). Kumar and Yadav (2005) related the decline in productivity of rice with continuous cropping to deficiency of primary and micronutrients mainly N, P, K, Zn and imbalanced nutrition. To study the effect of integrated nutrient management on growth and yield of upland paddy a field experiment was conducted at the research farm of the Upland Paddy Research Scheme, VNMKV, Parbhani on medium black soil during 2018-10, 2019-20 and 2020-21 with objectives to study the effect of integrated nutrient management practices on growth and yield of paddy and to study the cost economics of various treatments.

Methodology

A field experiment was conducted on medium black soil with slightly alkaline in reaction. Variety Parag was sown on July 9th, 2018, July 19th, 2019 and July 8th, 2020 by keeping 30 cm distance in between two rows using 35 kg seed rate ha^{-1}. Recommended dose of fertilizers 80:50:50 kg NPK/ha was applied at the time of sowing. The experiment consists of eight treatments *i.e.* T_1: RDF100 %. (RDF100% + FYM 5t /ha), T_2: RDF 100 %+ Soil Appn. of ZnSO4 (25 kg / ha) + FeSO4 (25 kg /ha), T_3: RDF 100 %+ Soil Appn. of Micronutrient Grade - I (25 kg/ha), T_4: RDF 100 % + Foliar Appn. of ZnSO4 (0.5 %) + FeSO4 (0.5 %) (2 Sprays at 30 & 50DAS), T_5: RDF 100 % + Foliar Appn. of Micronutrient Grade-II (0.5 %) (2 Sprays at 30 & 50 DAS), T_6: RDF 100 %+ Soil Appn. of Vermi-compost (3t/ha), T_7: RDF 100 %+ Foliar Appn. ofVermi-wash (10 %) (2 sprays at 30 & 50 DAS) and T_8: Control (Zero Application) in randomized block design with three replications.The size of experimental plot i.e. net size was 4.2 m X 4.2 m and gross size was 4.8 m X 4.8 m. Soil was low in Nitrogen, ferrous and zinc, medium in phosphorous and rich in potash.

Results

The results of the present study have been discussed as below under various heads. Pooled mean showed that, the significantly highest rice grain yield (3095Kg/ha), was recorded with the application of 100 % RDF + Soil Application of Micronutrient Grade - I (25 kg/ha) (T_3), which was found to be at par with treatment T_5 i. e. RDF 100 %+ Foliar Application of Micronutrient Grade-II (0.5 %) (2 Sprays at 30 & 50 DAS) and found significantly superior over rest of the treatments. Lowest rice grain yield (1626 Kg/ha) was observed in treatment control (T_8). Pooled mean for GMR also showed that, the significantly higher GMR (Rs. 113416) was observed in T_3 i.e. (RDF 100% + Soil Application of Micronutrient Grade-I 25 kg/ha) which was found significantly higher than rest of the treatments. However, pooled mean for NMR showed that, the significantly higher NMR (Rs. 61793) was observed in T_3 i.e. (RDF 100% + Soil Application of Micronutrient Grade-I 25 kg/ha) which was found at par with treatment T_5 i.e. RDF 100% + Foliar Application of Micronutrients Grade –II (0.5%) (2 Sprays at 30 & 50 DAS) which gave NMR of (Rs.55043) and was significantly higher than rest of the treatments.

Table 01: Paddy grain yield (kg/ha), GMR (Rs/ha) and NMR (Rs./ha) as influenced by various treatments (during 2018-19, 2019-20 & 2020-21)

Treatments	Paddy grain yield (kg/ha)				GMR (Rs/ha)				NMR (Rs/ha)			
	2018	2019	2020	Pooled mean	2018	2019	2020	Pooled mean	2018	2019	2020	Pooled mean
T_1	2361	2691	2511	2521	83579	98759	94815	92384	37839	53019	46575	45811
T_2	2534	3080	2684	2766	89703	113036	101347	101362	38763	62096	47907	49589
T_3	2935	3266	3085	3095	103899	119862	116489	113416	52959	68922	63499	61793
T_4	2565	2864	2715	2715	90801	105108	102518	99476	39761	54068	48978	47602
T_5	2750	2895	2900	2848	97350	106246	109504	104366	48860	57756	58514	55043
T_6	3	2772	2610	2614	87084	101732	98553	95790	30944	45592	39913	38816
T_7	2437	2584	2587	2536	86269.8	94832	97685	92929.24	36679	45242	45595	42505
T_8	1373	1983	1523	1626	48604.2	72776.1	57508.48	59629.59	12829	37001	19233	23021
SE ±	89.24	125.5	132.14	84.64	2465.2	2629	2947.4	2994	1390.5	2575.8	2279.9	2383.4
CD at 5%	266.8	375.5	395.1	253.1	7370.3	7887	8815.7	8982	4157.4	7724.1	6816.7	7151.1
Mean	2427	2767	2577	2590	85911.38	101544.3	97302.8	94919.5	37329.5	52962.44	46277.18	45523.04
CV	10.5	11.2	9.25	10.3	11.2	9.40	8.42	9.67	8.10	7.90	11.0	9.0

T_1: RDF100 %. (RDF100% + FYM 5t /ha), T_2: RDF 100 %+ Soil Appn. of ZnSO4 (25 kg / ha) + FeSO4 (25 kg /ha), T_3: RDF 100 %+ Soil Appn. of Micronutrient Grade - I (25 kg/ha), T_4: RDF 100 % + Foliar Appn. of ZnSO4 (0.5 %) + FeSO4 (0.5 %) (2 Sprays at 30 & 50DAS), T_5: RDF 100 % + Foliar Appn. of Micronutrient Grade-II (0.5 %) (2 Sprays at 30 & 50 DAS), T_6: RDF 100 %+ Soil Appn. of Vermi-compost (3t/ha), T_7: RDF 100 %+ Foliar Appn. ofVermi-wash (10 %) (2 sprays at 30 & 50 DAS) and T_8: Control (Zero Application)

Conclusion

Balanced nutrient supply based on limiting nutrients for a rice crop improved yield and gave higher net monetary returns. Combined application of primary and micronutrients i.e. the application of 100 % RDF + Soil Application of Micronutrient Grade - I (25 kg/ha) and RDF 100 %+ Foliar Application. of Micronutrient Grade-II (0.5 %) (2 Sprays at 30 & 50 DAS) on upland rice showed a significant effect on growth and grain yield of rice crop and gave higher grain yield and higher gross monetary and net monetary returns and similar findings were reported by Aysha Siddika et.al (2016).

References

Kumar A, Yavdav SD (2005). Influence of continuous cropping and fertilization on nutrient availability and productivity of alluvial soil. Journal of Indian Society of Soil Science 55(2):194-198.

Aysha Siddika, Abu Hanif, Tahsina Hoque (2016) Effect of Different Micronutrients on Growth and Yield of Rice. International Journal of Plant and Soil Science 12(6)

Mehakpreet Kaur Randhawa, Salwinder Singh Dhaliwal, Vivek Sharma, Amardeep Singh Toor, Sandeep Sharma & Manpreet Kaur (2021) Impact of Integrated Nutrient Management on Transformations of Micronutrients and Uptake by Wheat Crop in North-western India *Journal of Soil Science and Plant Nutrition* volume 21(4), pages2932–2945 (2021).

Seck PA, Diagne A, Mohanty S, Wopereis MCS (2012). Crops that feed the world: rice. Food Science 4:7

ICSCI 2022/T3/94

Identification and development of mapping population for novel source of low soil phosphorus tolerance in rice

Shruti[1&2], Anantha M S*[1], R. M. Sundaram[1], C. Gireesh[1], Senguttuvel P[1], Kemparaju, K B[1], J. R. Diwan[2], B. V. Tembhurne[2], Mahadeva Swamy[2], Ch. Raveendra[1], T Harisha[1], Honnappa[1], D. Aleena[1], V. Swaty[1], L. V. Subbarao[1], C N Neeraja[1], R Mahender Kumar[1], Brajendra[1]

[1]ICAR – Indian Institute of Rice Research (IIRR), Hyderabad, Telangana – 500030
[2] University of Agricultural Sciences, Raichur, Karnataka – 584101
Email: anugenes@gmail.com

Introduction

Rice is one of the world's most important cereal crops and providing the calorific requirements for more than half of the global population. Rice production is constantly affected by threat of biotic and abiotic stresses, adverse effects of rapidly changing climate, nutrient-deficient soils, etc. Phosphorus (P) deficiency in soil is one of the major limitations of rice production as it significantly affects rice growth and development in terms of root development, number of productive tillers, spikelet sterility and root elongation. In India, only 9% of soils are found to have high in P, 40% soils are medium and 51% are low in P content. The natural reserves of P fertilizers are decreasing and there is need to identify the genes/QTLs that combat the deficiency of P in the soil. Till date, only one gene (*OsPSTOL1*) in the *Pup1* region on chromosome 12 has been identified in the background of 'Kasalath' an Indian landrace and used by many workers to improve the cultivars for low soil phosphorus tolerance in rice (Anila et al., 2018). Based on the background study, the present study was carried out to with the following objectives to identify the novel low soil phosphorus tolerance in the rice landraces and to develop and phenotype the mapping population for low soil phosphorus tolerance

Methodology

Rice landraces (500) were screened under low soil P (1-2 ppm) facility available at ICAR-IIRR and identified some promising landraces possessing excellent tolerance to low soil P which are devoid of *OsPSTOL1* gene. The identified landraces were crossed with Improved Samba Mahsuri (ISM), which is sensitive to low soil P and possessing three major bacterial blight resistance genes *viz*., *Xa21*, *xa13* and *xa5*. The F_2 mapping population was developed by selfing the 'true' F_1 hybrids which were confirmed by both morphological and molecular markers.

Results

The identified landraces which are showing tolerance to low phosphorus tolerance were screened for *OsPSTOL1* gene. Some landraces have shown the presence of gene and some have not amplified the allele, indicating the presence some novel region(s) responsible for the tolerance. The identified donors which are lacking the *OsPSTOL1* gene were crossed with ISM and the 'true' F_1 plants were confirmed by random molecular markers like RM336, RM493, etc. True F_1s were selfed to obtain F_3 generation. The developed mapping population will be phenotyped in the low P screening plot and genotyped using SSR/SNP markers

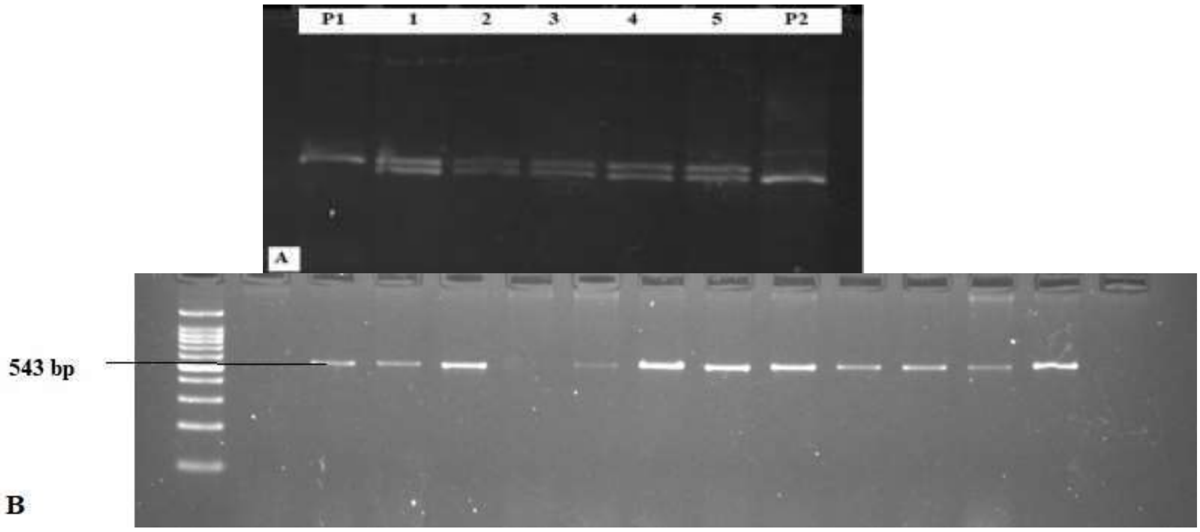


Fig. 1 (A) Confirmation of F_1 plants with the RM493 marker. P_1 – ISM; 1, 2, 3, 4, and 5 are true F_1 plants; P2 – Landrace. (B) Confirmation of identified landraces for *OsPSTOL1* gene with K46-1 marker

Conclusion

Landraces and wild species of crop plants possesses valuable genes, which are absent or eliminated from the modern cultivated varieties (Kale et al., 2021). The identified donors could be utilized in developing the low soil phosphorus tolerant genotypes, which will increase the yield under low phosphorus soils.

References

Anila M, Mahadeva HK, Kale RR, Bhadana VP, Anantha MS, Hajira SK, Balachiranjeevi C H, Ayyappa M, Bhaskar S, Dilip T and Pranathi K, et al. 2018. Breeding lines of the Indian mega-rice variety, MTU 1010, possessing protein kinase *OsPSTOL* (Pup1), show better root system architecture and higher yield in soils with low phosphorus. Mol Breeding, 38:147.

Kale RR, Durga CV, Anila M, Mahadeva HK, Badana VP, Senguttuvel P, Subramanyam D, Ayyappa M, Swapnali K, Anantha MS and Punniakotti E, et al. 2021. Novel major QTLs associated with low phosphorus tolerance identified from the Indian rice landrace, Wazuhopek. PLoS ONE, 16(7), e0254526.

ICSCI 2022/T3/95

Use of power of moisture regimes and p solubilizers for phosphorus management in rice growing soils

Ilakkia, K., L. Aruna*, R. Mohan and U. Bagavathi Ammal
PJN College of Agriculture and Research Institute, Karaikal, UT of Puducherry, India
Email: marunassac@gmail.com

Introduction

The world population is expected to reach 8.6 billion in 2030 with a significant increase in the developing countries like India, Pakistan, Indonesia, Philippines *etc*. (UN, 2017). India can easily feed its growing population plus produce rice for global exports if it can raise its farm productivity as that of other developing countries such as Brazil and China. One of the ways of attaining maximum yield is the balanced use of nutrients. Among major nutrients, the unique characteristic of P is its low availability due to slow diffusion and high fixation in soils. A significant fraction of fertilizer P is often fixed into insoluble forms through a range of soil – dependent reactions and results in low utilization by plants. As the fertilizer P has been added continuously more than the crop demand, it resulted in an accumulation in soil over time which is often referred as Non-labile P. It is, therefore, imperative and desired to reduce P fertilizer inputs and attempt to use non-labile P resources in agriculture. The amount of non-labile P in some soils are higher that it could be effectively mobilized and could reduce the inorganic fertilizer P requirement by 50 per cent (Owen *et al*., 2015).

Methodology

A pot culture experiment was carried out with farm soils of the Institute having four levels of P (*low labile and non-labile P, low labile and high non-labile P, high labile and low non-labile P, high labile and non-labile P*) to study the solubilization of soil P without external fertilizer application to ADT 45 rice crop under two levels of moisture regimes (*Continuous submergence and Alternate wetting and drying*) and two levels of P solubilizers (*With and without Phosphobacteria*). The post-harvest soil samples were analysed for P-fractions, among which, the NaCl-P and NaOH-P constitute labile pool of P and HCl- P constitutes the non-labile pool of P.

Results

The soil with low labile and high non-labile pool of P under alternate wetting and drying and in the presence of *Phosphobacteria* significantly recorded the highest grain (327.90 g pot^{-1}) and straw (292.96 g pot^{-1}) yield. The partial soil dryness during crop growth and solubilization of insoluble phosphorous by Phosphobacteria had resulted in increased grain yield by promoting faster remobilization of carbon, root enlargement, favorable redox *etc*. for maximum and balanced nutrient uptake. The P uptake by rice crop showed significant difference among the treatments only after panicle initiation stage of the rice crop and the magnitude of P uptake was more conspicuous in soils with high level of non-labile P irrespective of level of labile P bullying other ionic absorption leading to imbalanced nutrients. The alternate wetting and drying moisture regime and application of P solubilizers had proved their performance in increasing the P uptake in low labile soils conditions. In post-harvest soil, the Olsen-P was found to be low in all the soils except soil having both high labile and non-labile P and indicated that more phosphorus would have been released to the solution and utilized by rice crop in other levels of P in soils. The P-solubilizers registered low Olsen-P in post-harvest soil may be due to the solubilization by *phosphobacteria* based on the crop demand. Fractionation studies of P in soils provide information regarding depletion or accumulation of P in soils. The NaCl-P was significantly influenced by P levels in soils while HCl- P was influenced by *phosphobacteria* while other two fractions (NaOH – P and Residual P) did not respond to the treatments. The HCl-P, a non-labile pool fraction was higher due to the production of phosphatase enzyme by *phosphobacteria* (Hilda and Fraga, 2000) and release of organic anions by production of siderophores.

Conclusion

From the study, it could be concluded that the nutrient P availability, solubilization, absorption and translocation within the plants is a factor driven phenomenon and alters the availability and absorption of other cationic and anionic nutrients essential for the growth of the plants. The response of P solubilizers and moisture regimes like alternate wetting and drying to soils with low labile and high non-labile P and submergence to soils with high labile and non-labile P had concluded that the P solubility and availability as per demand of the crop is a factor driven phenomenon. Hence, it was suggested that due to continuous P fertilization over and above the demand of the crops, the labile and non- labile P status changes altering the other nutrient availability, plant growth and yield. It was high time to rethink the P fertilization rather mange its availability by agronomic practices like alternate wetting and drying along with P-solubilizer application to soils with low labile and high non-labile P and submergence without P solubilizers to soils with high labile and non-labile P

References

Hilda, R., and R. Fraga. 2000. Phosphate solubilizing bacteria and their role in plant growth promotion. Biotech. Adv. 17:319-359Owen, D., A. P. Williams, G. W. Griffith and P. J. A. Withers 2015. Use of commercial bio-inoculants to increase agricultural production through improved phosphorus acquisition. Appl. Soil Ecol., 86: pp.41-54

Owen, D., A. P. Williams, G. W. Griffith and P. J. A. Withers 2015. Use of commercial bio-inoculants to increase agricultural production through improved phosphorus acquisition. Appl. Soil Ecol., 86: pp.41-54.

ICSCI 2022/T3/98

Sustainable Sugarcane Initiative: Sweet Revolution – A review

Harshang Talaviya*[1], Hiteshvari Korat[2]

[1]*Ph.D. Scholar, Division of Agricultural Chemicals, ICAR-Indian Agricultural Research Institute, New Delhi-110012*

[2]*Ph.D. Scholar, Department of Agronomy, Junagadh Agricultural University, Junagadh, Gujarat- 362001*

*Email: talaviyaharshang@gmail.com

Sugarcane is important commercial crop of India and efficient convertor of incidental solar energy into cane sugar. It is a significant crop in contributing to national economy and development. There is a increasing demand for sugar in India. Exploiting the full production potential of sugarcane is much essential for maximizing its production and productivity. But, present scenario of cane cultivation is not sustainable enough to meet this demand as the input and labour costs are increasing. So, it is necessary to improve cane productivity. A new technology – System of Sugarcane Intensification or Sustainable Sugarcane Initiative (SSI) producing 'more with less' by adopting chip bud method of planting, younger seedling, wider spacing, sufficient moisture, INM and intercropping. Increase in growth, yield attribute and yield of sugarcane because of efficient utilization of sunlight, water and nutrient through wider spacing and drip fertigation. The improved practice recorded higher gross return, B:C ratio and profitability over conventional method which can effectively be replaced in the existing farming situation for higher productivity and profitability.

Key words: Sugarcane, sustainable, intensification, chip bud, drip fertigation

ICSCI 2022/T3/100

Empirical Models for Prediction of cation exchange capacity and bulk density using soil organic carbon

Pragya Kurmi*, Hitendra K. Rai, A.K. Upadhyay
[3]Department of Soil Science, Jawaharlal Nehru Krishi Vishwavidhyalay, Jabalpur, Madhya Pradesh, 482004, India.
Email:pragyakurmi14@gmail.com

Introduction

Soil is a collective system of soil constituents working in collaboration. The buffering capacity of soil to withstand anthropogenic stressors is a priority for sustainable agriculture. Regulation of soil organic carbon (SOC) through improved management practises is strategy to improve soil ecosystem services (Blanco-Canqui et al., 2013). Improvement in one soil property by SOC concomitantly affects other properties and processes as soil properties are all interrelated. Soil bulk density is a function of soil texture, mineral density of soil particles and organic matter as well as their packing arrangement (Nath, 2015; Tanveera et al., 2016), necessary to predict the change, flow and concentration of nutrients in the soils. There is a mutual relationship between SOC, cation exchange capacity and bulk density of soil. CEC is one of the most important concepts in soil fertility, govern the availability of nutrients to the plant and helps in maintaining the soil processes. The well-established techniques for soil analysis are laborious, time-consuming, and require specialised testing equipment. Development of prediction models using various mathematical equations can traverse the huge available dataset worldwide, through easy and routinely measured soil properties (Rai et al., 2003; Van Looy et al., 2017). There is enough data set available on organic carbon, bulk density and CEC for vertisols of central India, whereas the prediction models are less common. In this summary we tried to develop some empirical equations and also worked on easily understandable graphical representations for gaining better knowledge, particularly of this region.

Methodology

The field experiment was conducted on rice-wheat cropping system at research farm of JNKVV, Jabalpur, India. The experimental field was located at $23^0$10’ N latitude and $79^0$57’ E longitude and at an elevation of about 393.0 meter above mean sea level. The experimental area represents to *Kymore* Plateau and Satpura hills agro-climatic zone of Madhya Pradesh belongs to *Kheri* series. The soil is vertisol characterized as medium deep black soil. Clay mineralogy is dominated by fine montmorillonitic minerals. Taxonomically it belongs to of hyperthermic family of T*ypic Haplustert*. The field experiment on rice-wheat cropping system was designed under AICRP on STCR with three nutrient management practices along with a control in a split plot design with three replications. The treatments selected for this study consisted of (i) unfertilized control (control); (ii) General Recommended Dose (GRD) of NPK (120 N_2O: 60 P_2O_5: 40 K_2O ha^{-1}); (iii) Soil Test Based (STB) NPK + Targeted Yield (TY) of 6.0 t ha^{-1}; (iv) STB NPK + TY of 6.0 t ha^{-1} + FYM @10.0 t ha^{-1} yr^{-1} (NPK+ FYM). After completion of nine cropping cycles of rice- wheat, soil samples from 0-15, 15-30, 30-45 and 45-60 cm soil depth were collected. In each plot, soil was collected from three points randomly and mixed into one sample. The samples were air-dried in shade, ground to pass through a 2 mm sieve and used for the estimation of soil chemical properties. The pH was measured in 1:2.5 soil:

water suspension with a glass electrode. The organic carbon in soil was determined by rapid titration method (Walkley and Black, 1934). Samples collected with core sampler were used to determine bulk density soil samples. The empirical models of correlated properties were generated by exploiting correlation and multiple regressions techniques as suggested by Gomez and Gomez (1984).

Results

The empirical models were developed for the prediction of dependent soil properties using the data of studied soil parameters. For this purpose, regression equations for different soil properties were developed and the results thus obtained are described under the following sub-heads:

Cation exchange capacity (CEC)

The regression between CEC [C mol (P+) kg^{-1}] and SOC (g kg^{-1}) evidenced positive, linear correlation (figure 1). The predictability of model was found 84.9 per cent (R^2= 0.849). The regression model developed for the cation exchange capacity and soil organic carbon is given below:

CEC [C mol (P^+) kg^{-1}] = 3.397 x OC (g kg^{-1}) + 17.78

A linear and proportional relationship was obtained between organic carbon content and cation exchange capacity of soil (R^2 = 0.849) which may be attributed to higher cation exchange capacity of organic carbon. The finding was in good agreement with those reported Dangi (2015); Rashidi and Seilsepour (2008) and Ramos et al., (2018).

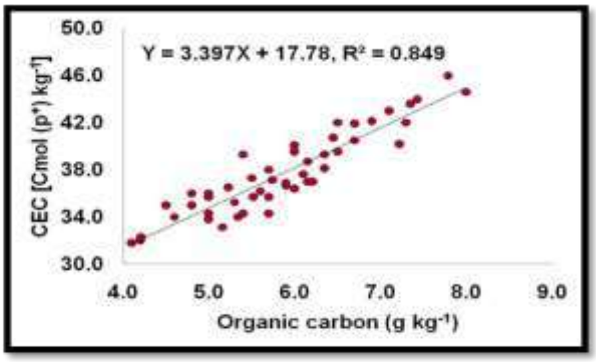


Figure 1: Relationship between organic carbon and CEC of soil

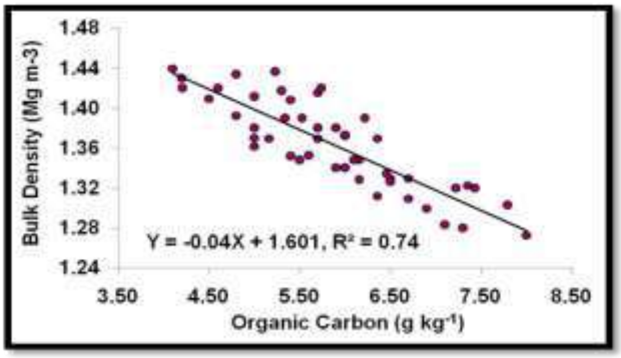


Figure 2: Relationship between organic carbon and bulk density of soil

Bulk density

The bulk density decreased linearly with every point increase in organic carbon. The soil properties were found inversely correlated to each other to a greater extent (figure 2). Regression equation accounts for 74.0 per cent of predictability (R^2 = 0.74).

The multiple regression equation for bulk density and organic carbon is as follows:

Bulk density (Mg m^{-3}) = - 0.04 x OC (g kg^{-1}) + 1.601

It might be because of lower mass per unit volume of organic carbon. The findings are well supported by those reported by Rai *et al.* (2003); Athira et al., (2019) which also indicated that bulk density increased with decreasing the organic carbon content in soil.

Conclusion

The SOC was directly and linearly correlated with CEC (R^2 = 0.849) but inversionaly and linearly correlated with bulk density (R^2 = 0.74) of soil. The empirical models developed for different soil properties showed good predictability ranging from 74 % to 84.9%.

References

Athira M, Ramasamy J, Ramalingam K, Duraisamy V. 2019. Influence of soil organic matter on bulk density in Coimbatore soils.International Journal of Chemical Studies, 7(3): 3520-3523

Blanco-Canqui H, Shapiro C, Wortmann C, Drijber R, Mamo M, Shaver T, Ferguson R. 2013. Soil organic carbon: The value to soil properties. Journal of Soil and Water Conservation, 68: 129A-134A.

Dangi D. 2015. Effect of STCR based integrated nutrients application on physical and chemical properties of a Vertisol in rice-wheat sequence. M.Sc. Thesis, JNKVV, Jabalpur.

Nath TN. 2015. Physico-Chemical Properties and its Relationship with Soil Bulk Density of Roadside Tea Cultivated Soils in Dibrugarh District of Assam, INDIA. Indian Journal of Advances in Chemical Science, 3(3): 288-292

Rai HK, Sharma A, Sindhu J, Das DK, Kalra N. 2003. Pedo-transfer functions for assessing the soil moisture and nitrogen availability in Indian soils. SAARC *Journal of Agriculture*, 1: 127-140

Ramos FT, Dores EFC, Weber OLS, Beber DC, Campelo JH, Maia JCS. 2018. Soil organic matter doubles the cation exchange capacity of tropical soil under no-till farming in Brazil. Journal of the Science of Food and Agriculture, 98(9): 3595–3602.

Rashidi M and Seilsepour M. 2008. Modeling of soil cation exchange capacity based on Soil organic carbon. ARPN Journal of Agricultural and Biological Science, 3(4): 41-45

Sakin E. 2012. Organic Carbon Organic Matter and Bulk Density Relationships in Arid-Semi Arid Soils in Southeast Anatolia Region, *African journal of Biotech*, 11(6): 1373-1377.

Tanveera A, Tasawoor AK, Parvaiz AT and Mehrajuddin N. 2016. Relation of Soil bulk Density with Texture, Total organic matter content and Porosity in the Soils of Kandi Area of Kashmir valley, India. *International Research Journal of Earth Sci*ences 4(1)

Van LK, Bouma J, Herbst M, Koestel J, Minasny B, Mishra U, Vereecken H. 2017. Pedotransfer functions in Earth system science: Challenges and perspectives. Reviews of Geophysics, 55, 1199–1256

ICSCI 2022/T3/101

Saturated soil irrigation: A water saving technology for different rice establishment methods with suitable weed control practices on water use and yield attributes under unpuddled condition

Shamina C[1] and Duraisingh R[2]
[1]TamilNadu Agricultural University, Madurai, TamilNadu-625104 and
[2] TamilNadu Agricultural University, Madurai, TamilNadu-625104
Email: shaminachan1996@gmail.com

Introduction

Rice (*Oryza sativa* L.) is the most important staple food in Asia where more than 90 percent of global rice is produced and consumed (FAO 2019). Due to increasing population, India should add 1.7 million tonnes of additional rice every year to ensure national food security. Saturated Soil Irrigation (SSI) has been reported as a great technique that increases water productivity in fully irrigated rice cultivation (Kima *et al*., 2020). However, this technique should be employed in a drought prone area where rainfall fails to meet the water requirements and fill up reservoirs for sufficient irrigation in rice. Direct sowing and un-puddled transplanting methods with minimum soil disturbance is an opportunity to expand Conservation Agriculture and better water saving techniques, where rice is grown like other cereal crop with supplemental irrigation. It can be fitted well in delta or canal irrigated regions. Weeds are the most important menace causing low productivity of rice. Thus, the application of herbicide mixtures or sequential application of herbicides may be useful for broad-spectrum control of weeds in rice. Due to herbicide resistance, recent herbicide combination is the need of the hour for effective weed management coupled with use low dose high efficiency herbicides so as to reduce the herbicide residue in the soil overall making it easier and economical to the farmer. The main objective of the present study was to save water and weed infestations to increase the yield and productivity of rice with saturated soil irrigation under unpuddled condition.

Methodology

Field experiment was conducted at Tamil Nadu Agricultural University, Madurai, India during *Kharif* 2021 to study the effect of different rice establishment methods and weed control practices under saturated soil irrigation in rice. The experimental field is geographically located in the southern part of TamilNadu (9º54′N, 78º54′E). The experiment was laid out in strip plot design with three replications. Treatment consists of three establishment methods (EM) in vertical strips and seven weed control practices (WCP) in horizontal strips. The establishment methods include 1. Drum seeded rice (DSR), 2. Machine transplanted rice (MTR) and 3. Conventional transplanting (CT). Weed management practices include 1. (P *fb* B) Pretilachlor (0.45 a.i g/ha) applied as pre emergence (PE) at 3 DAS/DAT *fb* Bispyripac sodium (25 g a.i/ha) as early post emergence (EPOE) application at 15 DAS/DAT, 2.(Pe + P *fb* Ce + Mm) Pyrazosulfuron + Pretilachlor (10 kg/ha) as pre emergence at 3 DAS/DAT *fb* Chlorimuron ethyl + Metsulfuron methyl (20g/ha) as early post emergence application at 15 DAS/DAT, 3.(Bm + P *fb* Ce + Mm) Benzsulfuron methyl + Pretilachlor (0.6 kg /ha) as pre emergence at 3 DAS/DAT *fb* Chlorimuron ethyl + Metsulfuron methyl (20g/ha) as early post emergence application at 15 DAS/DAT, 4.(Pe + P *fb* B) Pyrazosulfuron + Pretilachlor (10 kg/ha) as pre emergence at 3 DAS/DAT *fb* Bispyripac sodium (25 g a.i/ha) as early post emergence application at 15 DAS/DAT, 5.(Bm + P *fb* B) Benzsulfuron methyl + Pretilachlor (0.6 kg /ha) as pre emergence at 3

DAS/DAT *fb* Bispyripac sodium (25 g a.i/ha) as early post emergence application at 15 DAS/DAT, 6. (WFC) Weed free check and 7. (UC) unweeded control. Field was prepared by ploughing through reversible mould board which ploughs depth upto two feet. Seeds were treated with Azospirillum and soaked for 24 hrs except DSR. Nursery has been prepared by forming seed bed for conventional transplanting and tray nursery for machine transplanting a month before, release of water from PVC. After the receipt of water, land was irrigated through parshall flume (Throat width-7.5 cm, Head-5 cm and discharge rate- 1.7 lps) saturated to depth of 26 cm under un-puddled condition. Seedlings with the age of seventeen days were transplanted (manual and machine) and drum seeding (soaked seeds) was done by drum seeder with oval slot. Basal fertilizer application was done for all treatments at the rate of 150:50:50 kg NPK ha^{-1}. Yield components were measured such as the number of productive tillers $hill^{-1}$ were counted manually at the maturity stage, panicle length was measured from the base to the tip of the panicle and filled grains were counted randomly from five hills. Water use efficiency (WUE) and water productivity (WP) were measured using following formulae, WUE = Y/W (kg ha-mm^{-1})

Where,

Y = Grain yield (kg ha^{-1})

W = Total water consumed

Results

Water use efficiency

Water use efficiency determination in irrigation commands will indicate the unit quantity of grain yield obtained per unit quantity of water used. The different methods of establishment substantially influenced the WUE of the rice. Among various methods of transplanting, higher WUE was registered with machine transplanting (MT) (6.47 kg ha-mm^{-1}) over conventional transplanting (CT) (5.27 kg ha-mm^{-1}). Weed control practices also had significant influence on WUE. The WUE was significantly higher in Pyrazosulfuron + Pretilachlor (10 kg/ha) as pre emergence at 3 DAS/DAT *fb* Bispyripac sodium (25 g a.i/ha) as early post emergence application at 15 DAS/DAT was (Pe + P *fb* B) which registered 6.91 kg ha-mm^{-1} whereas lower WUE (3.51 kg ha-mm^{-1}) was recorded in unweeded control (UC) (Table 1).

Table 1. Effect of establishment methods and weed control practices on water use efficiency under saturated soil irrigation

Treatments	Water use efficiency (kg ha-mm^{-1})			
	DSR	MTR	CT	Mean
P *fb* B	5.77	6.12	5.26	5.72
Pe + P *fb* Ce + Mm	5.99	6.39	5.69	6.02
Bm + P *fb* Ce + Mm	5.69	6.08	4.74	5.50
Pe + P *fb* B	6.74	8.10	5.90	6.91
Bm + P *fb* B	6.11	6.55	5.82	6.16
WFC	6.70	8.11	6.35	7.05
UC	3.49	3.95	3.10	3.51
Mean	5.78	6.47	5.27	
	EM	WCP	EM at WCP	WCP at EM
SEd	0.18	0.17	0.16	0.19
CD (p=0.05)	0.41	0.36	NS	NS

Yield attributes

Number of Productive tillers hill^{-1}

Transplanting methods and weed control practices significantly influenced the productive tillers hill^{-1}. Among the establishment methods, Machine transplanting (MT) produced more number of productive tillers (23 hill^{-1}). Invariably, in this experiment, lesser number of productive tillers hill^{-1} (20 hill^{-1}) was noticed with conventional method of transplanting (CT). With regards to weed control practices, more number of productive tillers hill^{-1} were registered under Pyrazosulfuron + Pretilachlor (10 kg/ha) as pre emergence at 3 DAS/DAT *fb* Bispyripac sodium (25 g a.i/ha) as early post emergence application at 15 DAS/DAT was (Pe + P *fb* B) (25 hill^{-1}). Establishment methods and weed control practices had substantial interaction with each other on productive tillers hill^{-1}. Machine transplanting (MT) with Pe + P *fb* B registered more number of productive tillers hill^{-1} over other treatments (Table 2).

Table 2. Effect of establishment methods and weed control practices on productive tillers hill^{-1} under saturated soil irrigation.

Treatments	Number of productive tillers hill^{-1}			
	DSR	**MTR**	**CT**	**Mean**
P *fb* B	20	18	21	20
Pe + P *fb* Ce + Mm	22	21	13	18
Bm + P *fb* Ce + Mm	23	16	18	19
Pe + P *fb* B	25	29	22	25
Bm + P *fb* B	21	27	20	23
WFC	23	30	25	27
UC	15	17	18	17
Mean	22	23	20	
	EM	WCP	EM at WCP	WCP at EM
SEd	0.47	0.72	0.78	0.76
CD (p=0.05)	1.03	1.58	1.70	1.67

Conclusion

From the results of the present study, it could be concluded that, saturated soil irrigation under unpuddled condition was pronounced as better water saving technology which conserves water and minimized weed growth which would aid rice growing farmers for increasing yield and productivity.

References

FAO. 2019. Available online: http://www.fao.org/faostat/en/#data/QC/visualize (accessed on 26 December 2019)

Kima, A. S., E. Kima., B. Bacyé., PaW Ouédraogo., O. Traore., S. Traore., H. Nandkangré., W. G. Chung, and Y. M. Wang. 2020. "Evaluating Supplementary Water Methodology with Saturated Soil Irrigation for Yield and Water Productivity Improvement in Semi-Arid Rainfed Rice System, Burkina Faso." *Sustainability* 12 (12):4819

ICSCI 2022/T3/102

Effect of crop establishment methods on the microbial diversity and community structure in the rhizosphere of rice

Latha PC[1], Venkatanna B[1], Surekha K[1], Bandeppa S[1] and Kumar RM[1]
[1]ICAR-Indian Institute of Rice Research, Rajendranagar Hyderabad.
Email: lathapc@gmail.com

Introduction

System of rice intensification (SRI) method of cultivation increases rice productivity by provisioning favourable soil conditions for plant growth and development, compared to conventional transplanted rice production (NTP). The unique management of water, soil, nutrients and rice plants during SRI cultivation has been reported to improve rice plant phenotype and cause beneficial changes in the plant physiology. SRI plants are characterized by heavier and deeper root systems with a larger rhizosphere supporting a diverse group of microorganisms that play an essential role in influencing plant growth and yield. The changes induced by aerating the soil, reducing water, and using organic matter to supply nutrients in SRI method of cultivation have reported to have resulted in SRI rhizospheres supporting higher populations of bacteria, including nitrogen fixers and phosphate solubilizing bacteria. Actinomycetes and fluorescent pseudomonads have been observed to be enriched in the rhizosphere, while the endophytic niche of SRI root systems were found to harbour higher populations of endophytic bacteria than NTP. Most of these studies on the microbial community of SRI rhizosphere have generally focused on culture-based selective plating methods, wherein the readily culturable portion of the soil's microbiota is studied. Culturable microorganisms, despite representing an ecologically significant part of soil microbiota, are less than 1% of the microbial diversity in the soil. Currently, several culture-independent molecular and chemotaxonomic methods that can provide more comprehensive information on the soil microbial communities are gaining preference over traditional plating techniques for soil microbial community analysis. Consequently, employing these newer techniques to study the differences in the population of rhizosphere microbes under SRI and NTP cultivation can provide not only a sensitive and reproducible characterization of the microbial community but also a better resolution of their biodiversity. The chemotaxonomic approach of soil microbial community analysis uses microbial phospholipid fatty acid (PLFA), a major component of microbial membranes, as biomarkers of soil microorganisms. PLFA analysis, is a very a rapid, sensitive, and reproducible tool for studying the living biomass of soil microbial population while simultaneously providing quantitative information on the broad groups of microorganisms in the soil like bacteria, fungi, actinomycetes and eukaryotes. Microbial populations in the rhizosphere are known to play a role in the superior performance of SRI plants, and it has been opined that a more exhaustive and systematic evaluation (Thakur et al.,2022) of this aspect can help in better utilization of microbes for sustainable rice production.

Objectives

This study presents the results of the soil PLFA analysis performed to investigate the variation in the microbial biomass and composition of microbial groups in the rhizosphere of rice plants under SRI and NTP system of rice cultivation.

Methodology

Soil samples were collected from the rhizosphere of rice (Variety Akshaydhan) grown under NTP and SRI crop establishment methods at the flowering stage. Rice was grown under conventional flooded conditions under NTP treatment and was supplied with the recommended dose of NPK fertilizers, while in the SRI system, the rice crop was raised as per SRI principles and supplied with 50% organic and 50% inorganic fertilizers. PLFAs were extracted from the soil samples after adding nonadecanoic acid (C19:0 fatty acid), as an internal standard following the procedures of Buyer and Sasser (2012). Using standard methods, the extracted PLFA's were purified and analysed on a gas chromatograph with a flame ionization detector. The MIDI peak identification software was used to identify the individual PLFA by comparison with standards and to assign the PLFA's to different microbial groups. Total PLFAs computed as the sum of all PLFAs in a sample were used to calculate the microbial biomass.

Results

Microbial biomass was higher in SRI rhizosphere (1589.3 ηmoles/gm) than in NTP rhizosphere (1382.75ηmoles/gm). Biomarker PFLA for beneficial mycorrhizal fungi was higher in the rhizosphere soils of SRI, as was the total fungal abundance (4.98%) compared to NTP (3.27%), which could be attributed to increased aerobicity of SRI soils (Table 1). Small differences were observed for anaerobes, Gram-negative and Gram-positive bacterial signature fatty acid percentages. Eukaryotic abundances were higher in NTP (35.47%) compared to SRI (28.86%), which could be due to the increased presence of algae in NTP. PLFA biomarker concentrations of methanotrophs which are responsible for the oxidation of methane, were found to be present in SRI. Actinomycetes abundances were higher in SRI (6.22%) than NTP (4.72%).

Table 1: Relative concentration of marker PFLAs (% of total PLFA) under SRI and NTP

Biomarker PLFA	**SRI**	**NTP**
AM Fungi	1.02	0.47
Fungi	4.98	3.27
Anaerobe	15.10	14.79
Gram Negative	13.27	14.44
Gram Positive	28.13	26.84
Methanotroph	2.40	-
Actinomycetes	6.22	4.72
Eukaryote	28.86	35.47
Microbial Biomass	1589.3 ηmoles/gm	1382.75ηmoles/gm

Conclusion

To conclude, the findings of this study indicate that the rhizosphere of rice plants grown under SRI and NTP cultivation methods differ in the microbial composition, with SRI rhizosphere fostering higher fungal and actinomycete communities. Further, metagenomic sequencing studies can help to resolve the taxonomic and functional differences in the microbial groups in the rhizosphere under both crop establishment systems.

References

Buyer, J.S. and Sasser, M. 2012. High throughput phospholipid fatty acid analysis of soils. Applied Soil Ecology 61, 127-130.

ICSCI 2022/T3/103

Rice based integrated farming system for lowland situations for enhancing farm income and residue recycling

Paramesha, V[1], Parveen Kumar[2], Manohara, K.K.[3]
ICAR-Central Coastal Agricultural Research Institute, Old Goa, Goa-403402
Email: parameshagron@gmail.com

Introduction

Goa has a geographical area of 3,70,100 ha, with 34,112 land holdings, more than 80 % of which are being below one ha. The per capita farm holding of Goa is 0.5 ha. The land is characterized by undulating terrain with diverse soil conditions. The main crop of Goa are rice, coconut, cashew and pulse crops such as cowpea, moong and oilseed crops like ground nut. Further, the local milk production is insufficient to meet the present demand of 0.25 litres/head. At present Goa is importing essential agricultural commodities like milk, eggs, vegetables, rice, flower, etc. from neighbouring states. The demand for these commodities may increase due to the increase in population, tourism and scope for export. So, adoption of farming system would have been the possible solution to mitigate malnutrition and for livelihood of farm family (Parmaesh et al. 2022). ICAR- Central coastal agricultural research institute, Goa has standardised rice based lowland integrated farming system of Goa to meet the nutritional demand of a farm family having 0.5 ha of land area.

Methodology

The rice-based cropping systems were integrated with dairy, fishery, and poultry with border planting of banana, papaya and forage crops and a small kitchen garden with a total area of 0.5 ha. The rice crop was transplanted during Kharif season after rice harvest as sequential crops cowpea, moong, baby corn, and chilli were sown/planted in Rabi season. Two milching cross breed cow (Red Sindhi x Jersey) was maintained with a small fish pond (250 m2) and poultry unit (5 m2) was raised above the fish pond. A small kitchen garden (80 m2) was managed for production of fruits and vegetables. Fodder unit was maintained all along the border to provide feed to the dairy animals.

Results

The data in table 1 revealed that the cropping system recorded higher gross return followed by dairy. Similarly, the cropping system has recorded higher net returns followed by dairy. The IFS is having potential to generate employment throughout the year (Paramesh et al. 2019). In this study, also we have observed an employment of 340 man-days from 0.5 ha area, with highest contribution from cropping system followed by dairy. Further, the IFS is having scope to enhance residue recycling through composting, mulching, and as animal feed. In the current study, about Rs. 42921 worth of residues were recycled. In addition, the residue recycling reduced purchase of off farm inputs particularly chemical fertilizers and enhanced soil quality through improved soil microbial activity and nutrient availability (Paramesh et al. 2020).

Table 1. System productivity, net returns and energy efficiency of different cropping system

Components	Gross return	Cost of cultivation	Net return	Employment	B:C Ratio
Cropping system	96690	35459	61231	215	1.73
Dairy	66600	32000	34600	120	1.08
Kitchen garden	4625	850	3775	5	4.44
Residue recycling	42921	-	42921	-	-
Total	**210836**	**68309**	**142527**	**340**	**2.09**

Conclusion

IFS involving rice based cropping system like pulses, vegetables integrated with dairy, poultry and fishery were found more efficient in residue recycling, generated employment and enhances farm income. Furthermore, rice-based lowland IFS is found to be efficient in terms of soil fertility through reside recycling. With an increase in nutrient recycling under IFS, the use of chemical fertilizer can be reduced substantially. The improvement in soil nutrient dynamics in integrated farming indicates eco-friendly and sustainable farming system.

References

Paramesh, V., Parajuli, R., Chakurkar, E.B., Sreekanth, G.B., Kumar, H.B.C., Gokuldas, P.P., Mahajan, G.R., Manohara, K.K., Viswanatha, R.K., Ravisankar, N., 2019. Sustainability, energy budgeting, and life cycle assessment of crop-dairy-fish-poultry mixed farming system for coastal lowlands under humid tropic condition of India. Energy 188, 116101.

Paramesh, V., Ravisankar, N., Behera, U., Arunachalam, V., Kumar, P., Solomon Rajkumar, R., Dhar Misra, S., Mohan Kumar, R., Prusty, A.K., Jacob, D., Panwar, A.S., Mayenkar, T., Reddy, V.K., Rajkumar, S., 2022. Integrated farming system approaches to achieve food and nutritional security for enhancing profitability, employment, and climate resilience in India. Food Energy Secur. 11.

Paramesh, V., Sreekanth, G.B., Chakurkar, E.B., Chethan Kumar, H.B., Gokuldas, P., Manohara, K.K., Ramdas Mahajan, G., Rajkumar, R.S., Ravisankar, N., Panwar, A.S., 2020. Ecosystem Network Analysis in a Smallholder Integrated Crop–Livestock System for Coastal Lowland Situation in Tropical Humid Conditions of India. Sustainability 12, 5017.

ICSCI 2022/T3/104

Effect of fortified *in situ* paddy residue compost on growth and yield of rice (*Oryza sativa* L.)

V. Prabhu[1], H. Jakir Hussain[2], B. Ramakichenin Balagandhi[3] and K. Surekha[4]

[1]Programme Assistant (Soil Science), ICAR-PKKVK, Puducherry-605009, [2]Programme Coordinator, ICAR-PKKVK, Puducherry-605009

.[3]Director, Department of Agriculture and Farmers Welfare, Puducherry -605001

[4]Principal Scientist, ICAR-IIRR, Hyderabad-500030

Introduction

Rice (*Oryza sativa* L.) is the major staple crop and a mainstay for the rural population and their food security. India is the second-largest producer of rice. Rice production has been 112.91 mt during the year 2017-18 (DAC&FW, 2019). The extensive rice production resulted deterioration of soil health. The maintenance of soil health is an at most important of current rice cultivation. The amount of crop residue in India is estimated at 350×10^6 kg per year, of which paddy residue constitutes about 51 per cent. Huge quantities of paddy straw are left for disposal after harvest of the crop (Jusoh *et al.*, 2013). In northern India, surplus paddy straw residue is generally to a large extent burnt in open field. The burning of paddy straw in the field leads to GHG emissions causes severe air pollution. Straw contains various macro and micro nutrients, which make a payment to the nutrient budgeting of farms, if returned to soil (Lal, 2013). The applications of biofertilizers consortia along with straw compost have greater prospects to remediate soil health and increase the productivity in a sustainable way (Simarmata *et al*., 2015). Hence, a field experiment was conducted to study the effect of *in situ* paddy residue compost and FYM compost fortified with PGPM consortia and Bioactive compounds on the growth and yield of rice.

Methodology

A field experiment was conducted during the *kharif* season of 2019 at ICAR-Perunthalaivar Kamaraj Krishi Vigyan Kendra (PKKVK), Puducherry. Ten treatments were imposed; T_1 - 100% NPK, T_2 - 100% NPK+ *insitu* paddy residue compost, T_3 - 100% NPK+ PGPM consortia + Bio Active (BA) compounds fortified FYM @ 5 t/ha, T_4 - 100% NPK+ *insitu* paddy residue compost fortified with PGPM consortia + BA compounds, T_5 - 75% NPK+ *insitu* paddy residue compost, T_6 - 75% NPK+ PGPM consortia + BA compounds fortified FYM @ 5 t/ha, T_7 - 75% NPK+ *insitu* paddy residue compost fortification with PGPM consortia + BA compounds,T_8 - 50% NPK+ *insitu* paddy residue compost,T_9 - 50% NPK+ PGPM consortia + BA compounds fortified FYM @ 5 t/ha and T_{10} - 50% NPK+ *insitu* paddy residue compost fortified with PGPM consortia + BA compounds. The PGPM *viz.*, Azospirillum, Phosphobacteria, potash solubilizing bacteria, zinc solubilizing bacteria, *Pseudomonas fluorescence* and *Trichoderma sp.* were mixed in equal quantities to make consortia. Bioactive compounds (BA) *viz.*, humic acid and seaweed extract were also enriched in the compost. The field experiment was conducted in RBD with three replications using rice variety ADT R 53 of 110 days duration. The inorganic fertilizers were applied @ 120:40:40 NPK kg/ha. 50% N as urea, 100% P as superphosphate and 50% K as muriate of potash were applied as basal and the remaining 50% N and K were applied at tillering and panicle initiation stages. Biometric observations were recorded at harvest stages.

Results

The application of fortified organic manure with PGPM and BA compounds had significantly influenced the growth attributes of rice (Table 1). Among the treatments, T_3 -100 % RDF + fortified FYM @ 5 t/ha had recorded significantly the maximum plant height (123.3 cm), it was statistically on par with T_4, T_6 and T_7. The DMP and LAI of rice crop were significantly influenced by the application of PGPM and BA fortified organic manures. Among the treatments, T_7 - 75% RDF along with PGPM consortia and BA compound fortified *insitu* paddy residue compost application recorded the highest DMP (14.36t/ha) and LAI (6.03) which was statistically on par with fortified FYM 75 % RDF (T_6) or 100 % RDF (T_3) and 100 % RDF fortified *insitu* paddy residue compost (T_4).

Table 1. Effect of PGPM consortia and Bio Active compounds fortified *insitu* paddy residue and FYM compost on the growth of rice

Treatments	Plant height (cm)	DMP (t/ha)	No. of tillers m^{-2}	LAI
T_1	115.0	11.87	466	5.34
T_2	116.0	11.96	474	5.36
T_3	123.3	13.97	513	5.90
T_4	123.0	13.57	509	5.92
T_5	114.3	10.69	414	4.65
T_6	120.7	13.98	526	5.99
T_7	121.3	14.36	540	6.03
T_8	105.0	9.15	359	4.19
T_9	110.7	10.43	403	4.59
T_{10}	112.3	10.18	393	4.52
SEm±	1.51	0.34	7.88	0.16
C.D(p=0.05)	4.50	1.00	23.4	0.47

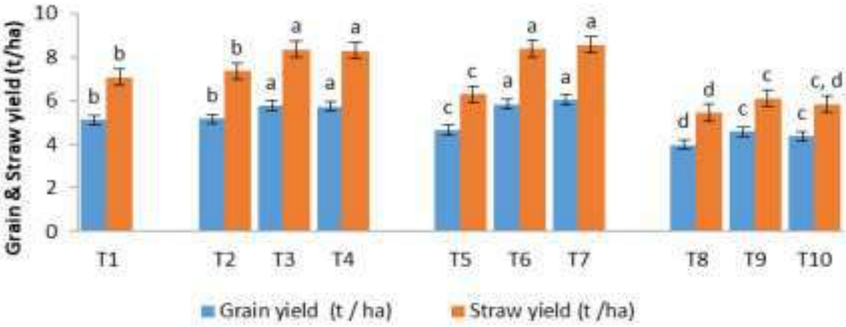
Table 2. Effect of PGPM consortia and Bio Active compounds fortified *insitu* paddy residue compost on the yield attributes of rice

Treatments	Panicle wt(g)	No. of filled grains /panicle	No. of unfilled grains / panicle	No. of productive tillers m^{-2}
T_1	2.99	153	56	332
T_2	3.00	166	49	341
T_3	3.27	168	45	386
T_4	3.31	167	44	388
T_5	2.70	151	57	326
T_6	3.42	172	40	416
T_7	3.63	174	36	422
T_8	2.37	140	65	266
T_9	2.64	146	57	294
T_{10}	2.61	148	58	268
SEm±	0.09	4.17	2.13	10.80
C.D(p=0.05)	0.25	12.39	6.33	32.10

A significant increase in the number of tillers also clearly showed the superiority due to the addition of fortified rice residue. Application of fortified FYM compost (T_6) or *insitu* paddy residue compost (T_7) along with NPK @ 75 per cent which recorded the highest number of tillers of 526 and 540, respectively. Tillering has a significant correlation with the supply and availability of nutrients.

PGPM consortia and Bioactive compound fortification of paddy residue and *insitu* composting in paddy field proved to be significant in increasing yield and yield attributes of rice (Table 2). Among the treatments, T_7 -75% RDF along with PGPM consortia and BA compound fortified *insitu* paddy residue compost application resulted in significant higher number of productive tillers (396), panicle weight (3.63 g) and number of filled grains per panicle (174). With respect to unfilled grains, treatment T_7 recorded the least number of unfilled grains per panicle (36).

The grain and straw yields were significantly influenced by different treatments (Fig. 1). Among the treatments, T_7 -75% RDF along with PGPM consortia and BA compound fortified *insitu* paddy residue compost application recorded the highest grain yield (6.03 t/ha) and straw yield (8.57 t/ha), which was closely followed by T_6, T_3 and T_4. The lowest grain yield (3.97 t/ha) and straw yield (5.45 t/ha) was obtained in T_8, where the plot was applied with 50 per cent NPK and paddy residue without fortification.



Data with the same letter is not significantly different (p=0.05)

Fig. 1. Grain and straw yield of rice under *in situ* paddy residue, fortified PGPM & BA compost and different dose of fertilizers treatments.

Conclusion

The results of the experiments unequivocally proved that *in situ* incorporation of fortified paddy residues compost significantly increased the growth, yield attributes of rice and save inorganic fertilizers considerably. Thus, it can be suggested as a low-cost eco-friendly technology for managing the paddy residue and sustaining rice productivity.

References

DAC&FW. 2019. Annual Report, 2018-19. Department of Agriculture, Cooperation and Farmers Welfare, New Delhi, 3p.

Jusoh, MLC, LA Manaf and PA Latiff 2013. Composting of rice straw with Effective Microorganisms (EM) and its influence on compost quality. *Iran. J. Environ. Heal*. 10 :17.

Lal R. 2013. Food security in a changing climate, *Ecohydrology and Hydrobiology* 13, 8–21,

Simarmata T, B Joy, ET Sofyan, A Citraresmini, T Turmuktini, and B Sudjana, 2015. Innovation of biofertilizers-organic based nutrients management and water saving technology to secure rice productivity. In: Proceeding of Tropentag, September 16-28, 2015, Berlin, Germany.

ICSCI 2022/T3/105

Productivity and profitability of diversified cropping systems for designing crop plan in integrated farming systems

Ch. Pragathi Kumari[1], M.V. Ramana[2], G.Kiran Reddy[3], Santhosh Kumar, R. Karthik, G. Vinay and M. Goverdhan
[1]AICRP on IFS, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana State, India-500030
Email: pragathi.agronomy@gmail.com

Introduction

There is a need to identify new diversified systems considering economic, ecological and social dimensions for overall development of the state, particularly farming community. To meet diverse needs of farm family in IFS perspective the cropping systems involving pulses, oilseeds, cereals and fodder crops are evaluated for their long term sustainability and inclusion in the crop module of IFS for efficient utilization as well as recycling of resources within the system. Several workers in the recent past reported that the productivity and income is far higher when integrated farming systems are practiced than crops alone (Ravisankar *et al*., 2007). In view of this farming system perspective, inclusion of ecological cropping systems, cropping system to meet the household nutritional security, cropping system for round the year green / dry fodder production and cropping systems involving high value crops are to be studied for their productivity and sustainability.

Methodology

The study was conducted at college farm, All India Coordinated Research Project on Integrated Farming Systems unit, Professor Jayashankar Telangana Sate Agricultural University, Rajendranagr, Hyderabad during 2021-22 under irrigated conditions. The treatments consisted of ten crop sequences. The experiment was laid out in RBD and replicated thrice. The ten combinations of cropping systems, evaluated during *kharif*, *rabi* and summer seasons, were grouped into five subsets. The first subset included pre-dominant cropping systems of the region [T1: rice-maize, and T2: Bt cotton]. The second subset included ecological cropping systems involving pulses for improving soil health [T3: Bt cotton + green gram (1:3) - groundnut, and T4: pigeon pea + green gram (1:6) - sesame]. The third subset comprised of cropping system involving cereals/pulses/oilseeds to meet the household nutritional security [T5: pigeon pea + maize (1:3) - groundnut, and T6: pigeon pea + groundnut (1:7) - ragi]. The fourth subset involved cropping systems for round the year green/dry fodder production [T7: fodder sorghum + fodder cowpea (1:2) - horse gram - sunhemp, and T8: fodder maize - lucerne]. The fifth subset involved cropping systems comprising of vegetables and other high value crops for income enhancement [T9: sweet corn - vegetables i.e. tomato, and T10: okra - marigold - beet root].

Results

In the context of identifying best crops and cropping systems that are suitable for different farming systems of STZ of Telangana, various combinations of crop sequences were studied (Table.1). In the context of farming systems, out of all the systems, Okra–Marigold–Beetroot system recorded significantly higher rice grain equivalent yield (26736 kg ha^{-1}) over other crops evaluated in different cropping systems. Among the cropping systems involving vegetables and other high value crops for income enhancement, Okra–Marigold–Beetroot system was found to be more remunerative (26736 kgha^{-1} with 3,49,244 Rsha^{-1} net returns) than Sweet corn-tomato.

Table 1. Performance of crops in various cropping systems during 2021-22

Treatments		*Kharif* (2021)				*Rabi* (2021-22)		Summer (2021-22)		Rice Grain Equivalent Yield (kg ha^{-1})						Productivity			
		Grain yield (kg ha^{-1})		Straw/ Stover yield (kg ha^{-1})		Grain Yield	Straw/ Stalk/ Stover yield	Grain Yield	Stover yield	*Kharif*		*Rabi*		Summer		(RGEY kg ha^{-1})			
	Kharif-Rabi	Main crop	Inter crop	Main crop	Inter crop	(kg ha^{-1})	(kg ha^{-1})	(kg ha^{-1})	(kg ha^{-1})	Grain	Straw	Grain	Straw	Grain	Straw	*Kharif*	*Rabi*	*Summer*	*System*
T1	Rice-Maize	5890	0	7013	0	5673	6842	0	0	5890	361	5468	353	0	0	6252	5821	0	12072
T2	Bt Cotton	1888	0	4083	0	0	0	0	0	5573	53	0	0	0	0	5625	0		5625
T3	Bt cotton+Greengram (1:3)-Groundnut	1847	495	4002	1010	2010	3078	0	0	7307	156	5464	793	0	0	7463	6258	0	13721
T4	Pigeon pea + Greengram (1:6) - Sesame	790	656	2901	1523	715	1882	0	0	5026	194	2692	24	0	0	5220	2716	0	7936
T5	Pigeon pea+Maize (1:3)-Groundnut	497	5213	1806	6397	2041	3108	0	0	6639	353	5551	801	0	0	6992	6352	0	13343
T6	Pigeonpea + Groundnut (1:7) - Ragi	1113	1643	3965	2768	2632	4540	0	0	8317	764	4572	59	0	0	9081	4630	0	13711
T7	Fodder sorghum + Fodder cowpea (1:2) – Horsegram - Sunhemp	0	0	15364	20169		9865	0	16244	0	4703	0	1017	0	1256	4703	1017	1256	6976
T8	Fodder maize - Lucerne	0	0	37519	0		32326	0	0	0	3868	0	3333	0	0	3868	3333	0	7200
T9	Sweetcorn-Vegetables (Tomato)	13014	0	16391	0	30040	6140	0	0	6037	1267	15484	79	0	0	7305	15563	0	22868
T10	Okra – Marigold - Beetroot	7757	0	1981	0	10217	5571	15600	3866	7997	26	10533	72	8041	50	8023	10605	8091	26736
	S Em$\pm$															501.0	1401		702
	CD (0.05)															1500.0	468		2102
	CV (%)															13.0	14.3		9.3

Sale price for Grain (kg^{-1}) : Rice = Rs 19.4, Maize = Rs 18.7, Groundnut = Rs 52.75, Bhendi = Rs 20.00, Bt Cotton = Rs 57.26, Greengram = Rs 72.75, Pigeonpea = Rs 63.0, Sweet corn = Rs 9.00, Sesame = Rs 73.07, Fingermillet = Rs 33.7, Marigold = Rs 20.00, Beetroot = Rs 10.00; Sale price for stover (kg^{-1}) : Rice = Rs 1.00 Maize = Rs 1.00, Bhendi = Rs 0.25, Groundnut = 5.00, Greengram = Rs 2.00, Sweet corn = Rs 1.5, Bt cotton = 0.25, Pigeonpea = Rs 0.25, Fodder sorghum = Rs 2.00, Fodder cowpea = 3.00, Fodder maize = 2.00, Tomato = Rs 0.25, Sesame =Rs 0.25, Fingermillet = Rs 0.25, Horsegram = Rs 2.0, Sunhemp = Rs1.5, Lucerne = Rs 2.0, Marigold = Rs 0.25, and Beetroot = Rs 0.25

Among the ecological cropping systems, *Bt* cotton + Greengram (1:3)- Groundnut cropping system recorded significantly higher rice grain equivalent yield (13721 $kgha^{-1}$) and net returns (162161 Rs ha^{-1}) than Pigeon pea + Greengram (1:6) - Sesame (7936 kg ha^{-1}) cropping system. However, due to lower cost of cultivation, Pigeonpea + Greengram (1:6) – Sesame system recorded higher BC ratio compared to *Bt* cotton + Greengram (1:3)- Groundnut cropping system. Out of the two systems tested to meet the household nutritional security involving cereals / pulses / oilseeds, Pigeonpea + Maize (1:3) – groundnut system reported to be more remunerative (13343 $kgha^{-1}$ RGEY with 158217 Rs ha^{-1} net returns and 1.57 B:C ratio) than Pigeon pea + Groundnut (1:7) - ragi system. Out of the two fodder crops/cropping systems, Fodder maize – Lucerne (1.51 BC ratio) system resulted in higher rice grain equivalent yield (7200 $kgha^{-1}$) and net returns (84113 Rs ha^{-1}) than fodder sorghum + fodder Cow pea (1:2) - Horsegram –Sunhemp system (6976 kg ha^{-1} with 1.26 BC ratio). Rice-maize and Bt cotton were tested as pre-dominant cropping systems of the region and rice – maize system recorded higher rice grain equivalent yield (12072 $kgha^{-1}$) and net returns (144808 Rs ha^{-1}) than Bt cotton alone (5625 $kgha^{-1}$).

Conclusion

Under high value crops, okra – marigold - beetroot system, among the ecological cropping systems, *Bt* cotton + greengram (1:3) – groundnut, under the cropping systems for household nutritional security, pigeonpea + maize (1:3) - groundnut system, under two fodder crops/cropping systems, fodder maize – lucerne system and under predominant cropping systems, rice – maize systems were most profitable and can be suggested for different farming systems of Southern Telangana Zone of Telangana.

References

Ravishankar N, Pramanik Rai, Rai SC, Shakila Nawab, Tapan R, Biwas B. 2007. Study on integrated farming system in hilly areas of Bay Islands. *Indian Journal of Agronomy*. 52:7-10.

ICSCI 2022/T3/106

Attraction of the egg parasitoid, *Oligosita* sp. to induced volatiles by Brown plant hopper, *Nilaparvatha lugens* (Stål) and Synthetic HIPV, Methyl Salicylate in Rice

Himabindu Parsi[1], Chitra Shanker[2] and S.S. Shaw[1]
[2]*Indian Institute of Rice Research (ICAR-IIRR), Rajendranagar, Hyderabad, India, 500030.*
[1]*Indhira Gandhi Krishi Vishwavidhyalaya, Raipur, Chattisgarh, India, 492012.*
Email: chitrashanker@gmail.com

Introduction

The brown planthopper (BPH), I (Stål) (Homoptera: Delphacidae) is one of the most serious pests of rice. (Hu et al. 2011) causing damage, both, by feeding and acting as a disease vector. Continuous and contiguous planting of rice and indiscriminate use of chemicals for management has led to severe outbreaks and loss of beneficial biodiversity in field. We need to look into ecofriendly ways of harnessing the natural enemy services in rice ecosystem. Rice crop is Plants under attack by herbivores release herbivore-induced plant volatiles (HIPVs). These (HIPVs) have the ability to repel insect herbivores and attract the natural enemies of pests (Mandour *et al*., 2013).

Salicylic acid, jasmonic acid and ethylene are the three plant hormones that govern the expression of volatiles through these signaling pathways (Gill *et al*., 2010). Salicylic acid was known to have a defensive role against piercing and sucking insects (Vallad and Goodman, 2004)**.** Exogenous applications of these hormones can be used in pest management as they induce responses similar to biotic stresses (Erb *et al*., 2012). A study was taken to compare the attractiveness of the volatiles induced from *N. lugens* infested and Methyl Salicylic Acid (MeSA) treated rice plants to the hopper egg parasitoid, *Oligosita* sp.

Methodology

The potted rice plants of variety TN 1 at thirty-five days after transplanting were used for the study. Twenty BPH nymphs at third instar stage were released onto each plant for 24 hours, prior to the experiment. The potted rice plants were treated with Methyl Salicylic Acid (MeSA) @ 100 mg/ litre of water with a hand atomizer (Indhumathi *et al.*, 2019). The plants were used for the experiment after 24 hours of MeSA treatment. In another treatment, the plants were mechanically wounded by poking the plant culms with a needle for 20 times before 24 hours of the experiment.

The attraction of the egg parasitoid, *Oligosita* sp. to the various combinations of treatments was tested in a Y-tube olfactometer. The parasitoid was released at the stem of the olfactometer where the arms were connected to the treated plants. The response of the parasitoid was recorded when the individual moved towards one of the arms within 2 minutes. This experiment was conducted with 4 treatments and 5 replications. For each replication 20 egg parasitoids were released and their response was recorded.

The treatments were:

T 1 - MeSA treated plants x Plants infested with BPH
T 2 - MeSA untreated plants (mechanically wounded) x Plants infested with BPH
T 3 - MeSA treated plants x Plants un infested with BPH
T 4 - MeSA untreated plants (mechanically wounded) x Plants un infested with BPH

Results

A total of 400 egg parasitoids were tested for their attraction towards different choices given in an olfactometer. When four different treatments with two different choices in each treatment were given to the BPH egg parasitoid, *Oligosita* sp., in an olfactometer, the parasitoids made a significant choice between them. A mean number of 12.4 parasitoids showed significant attraction towards the plants infested with BPH whereas a mean number of 7.6 parasitoids chose to move towards MeSA treated plants. Between the two choices of MeSA untreated plants (mechanically wounded) and plants infested with BPH a mean no of 16.8 parasitoids significantly preferred the plants infested with BPH. In the third comparison tested, a mean number of 14.0 parasitoids were significantly attracted towards MeSA treated plants and a mean number of 6.0 parasitoids chose plants uninfested with BPH (healthy). The fourth treatment with the two choices MeSA untreated (mechanically wounded) plants and plants uninfested with BPH when given to the parasitoids for their attraction, a mean number of 13.6 parasitoids significantly attracted towards the plants uninfested with BPH. And a mean number of 6.4 parasitoids preferred MeSA untreated (mechanically wounded) plants.

Conclusion

These results clearly indicate that the natural volatiles emitted from the BPH infested plants were strongly attractive to parasitoids. The volatiles from plants treated with synthetic MeSA were also effective in attracting parasitoids compared to the volatiles emitted from healthy unifested plants.

References

Mandour NS, Y Kainoh, R Ozawa, M Uefune and J Takabayashi. 2013. Effects of prohydrojasmon-treated corn plants on attractiveness to parasitoids and the performance of their hosts. Journal of Applied Entomology, 137(2): 104-112.

Erb M, S Meldau and GA Howe. Role of phytohormones in insect-specific plant reactions. 2012. Trends in Plant Science, 17: 5-9.

Gill RS, AK Gupta, GK Taggar and MS Taggar. 2010. Review article: Role of oxidative enzymes in plant defenses against insect herbivory. Acta Phytopathologica Entomologica Hung., 45: 77–90.

Vallad GE and RM Goodman. 2004. Systemic acquired resistance and induced systemic resistance in conventional agriculture. Crop Science, 44: 20–34.

Indhumathi J, N Muthukrishnan, C Durairaj, N Thavaprakaash and RP Soundararajan. 2019. Effect of methyl salicylate on rice leaffolder *Cnaphalocrocis medinalis* (Guenee), Parasitoid *Xanthopimpla flavolineata* (Cameron) and Predator *Micraspis* sp. Madras Agriculture Journal, 106(1-3): 74-79.

ICSCI 2022/T3/107

Soil nematode community, organic matter, nutrient status, and crop productivity in rice under a long-term System of Rice Intensification (SRI)

Nethi Somasekhar, R. Mahender Kumar and K. Surekha
ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad, 500030, India
Email: nssekhar@hotmail.com

Introduction

The system of Rice Intensification (SRI) method of rice cultivation is gaining popularity among farmers in recent years due to its high yield and water-saving potential (Uphoff and Thakur, 2019). The transition from Conventional Transplanted System (CTS) to SRI has the potential to alter the composition of the soil food web (Anas *et al*, 2011) and the status of organic matter and nutrients in the soil. However, information on the ability of SRI to sustain the yield gains and its long-term effects on soil organic matter, mineral nutrient pools, and below-ground food web is very limited. In this study, we assessed the status of crop yield, organic matter, major nutrients, and soil food-web, in rice plots maintained continuously under SRI for seven years in comparison to the CTS.

Methodology

A long-term field experiment was laid out at the Indian Institute of Rice Research (IIRR) research farm, Hyderabad, India, with two treatments i.e. System of Rice Intensification (SRI) and Conventional Transplanted System (CTS) with a plot size of 75 m^2 for each treatment. Each treatment plot was subdivided into 15 subplots of 5 m^2 size for sampling. Rice crop was cultivated in these plots continuously for seven years with two crops per year (14-crop cycle). After seven years, observations on crop yield, soil nutrient status, and organic matter (expressed in terms of per cent organic carbon) were recorded at the time of harvest of the 14^{th} season rice crop. Plants from each subplot were harvested separately and observations on grain and straw yields were recorded. Soil samples were collected (0-15 cm depth) randomly from each subplot for recording observations on soil organic matter, available N, P, and K following standard laboratory protocols. Soil nematode community composition was used as an indicator for assessing the long-term effects of SRI practices on the soil food web. Nematodes extraction from soil samples, enumeration, and identification of trophic groups was done using standard nematology protocols. Nematodes were grouped into two major groups i.e. plant parasitic nematodes (nematodes that feed on rice crop as obligate parasites and are detrimental to the crop growth) and free-living nematodes (which includes bacterial feeders, fungal feeders, predatory nematodes, etc., which promote decomposition of organic matter, nutrient mineralization, and are beneficial to the crop growth). Data were analyzed using two sample independent *t*-test for comparing the treatment effects.

Results

The SRI system recorded significantly higher grain yield, straw yield, and total biomass over the CTS even after seven years of continuous monocropping (Table 1 A). However, no significant differences were observed in available N, P, K, and organic matter content in soil between the SRI and CTS systems suggesting that the soil nutrients pools were not depleted due to higher yields observed in the SRI system over the years (Table 1 B). Nematode analyses revealed that after seven years, the total nematode abundance was higher under the SRI compared to the CTS system (Table 1C). Although the total nematode abundance was more in the SRI system, the absolute and relative abundance of plant-parasitic nematodes (PPN) were significantly low in the SRI compared to the CTS system. In contrast to this, the abundance of free-living microbial feeding nematodes was significantly higher in SRI compared to the CTS system (Table 1C). The plant-parasitic nematode community in experimental plots was dominated by rice root nematode (*Hirschmanniella* spp.) accounting for more than 60% of total plant parasitic nematodes. More damaging nematode species like rice root-knot (*Meloidogyne graminicola*.) and root-lesion nematodes (*Prtaylenchus* spp.) were absent in the samples.

Table 1. Crop yield (A), soil organic carbon, available N, P, K (B), and abundance of nematode trophic groups (C) in rice plots under System of Rice Intensification (SRI) or Conventional Transplanted System (CTS) systems for seven years.

	SRI	CTS	*t-value*	*df*	*P*
A. Crop yield					
Grain yield (t/ha)	6.44	5.65	6.03	28	<0.01
Straw yield (t/ha)	7.22	6.46	5.58	28	<0.01
Total biomass (t/ha)	13.66	12.11	6.14	28	<0.01
B. Nutrients & Organic carbon					
Available N (kg/ha)	371.91	378.77	-0.72	28	0.24
Available P (kg/ha)	148.92	141.33	1.22	28	0.12
Available K (kg/ha)	550.84	557.48	-1.11	28	0.14
Organic Carbon (%)	1.16	1.17	-0.56	28	0.29
C. Nematode abundance					
Total nematodes	234.17	215.14	5.36	28	<0.01
Plant parasitic nematodes (PPN)	114.45	121.89	-1.67	28	0.05
Free-living nematodes (FLN)	119.72	93.25	5.72	28	<0.01
Relative abundance of PPN	0.49	0.57	-4.72	28	<0.01
Relative abundance of FLN	0.51	0.43	4.20	28	<0.01

SRI = System of Rice Intensification; CTS = Conventional Transplanted System

Conclusion

Our results demonstrate that the SRI system can sustain the yield gains recorded over the CTS system over a period of seven years under the monocropping of rice with a significant reduction in water usage. Despite sustaining higher yields, the SRI system did not result in the depletion of major nutrients N, P, K, and the organic matter content in soil compared to the CTS system. Our results also demonstrate that in the long run, SRI practices alter soil food web structure by reducing the abundance of plant parasitic nematodes and promoting the build-up of beneficial free-living microbivorous nematodes in the rice ecosystem. These changes will have a positive impact on crop productivity. Further, our results also suggest that the yield advantage of the SRI system may not be compromised despite the increase in total nematode population when the nematode community is dominated by relatively less pathogenic nematode species like rice-root nematodes (*Hirschmanniella* spp.) as seen in the present case. However, this may not be the case in fields having inherent populations of more damaging nematode species like rice root-knot and root-lesion nematodes.

References

Anas I, OP Rupela, TM Thiyagarajan and N Uphoff. 2011. A review of studies on SRI effects on beneficial organisms in rice soil rhizospheres. Paddy Water Environment, 9: 53-64.

Uphoff N. and AK Thakur. 2019. An Agroecological Strategy for Adapting to Climate Change: The System of Rice Intensification (SRI). In: Sarkar, A., Sensarma, S., vanLoon, G. (eds) Sustainable Solutions for Food Security. Springer, Cham.

IICSCI 2022/T3/108

Climate induced phenological shift and potential risk distribution of rice insect pests

Repalle Naganna[1], Thalari Vasanthrao[2], Ch. Padmavathi[3] and Chitra Shankar[4]
[1,2] ICAR-Indian Institute of Maize Research, Winter Nursery Center, Rajendra Nagar, Hyderabad.
[3,4] ICAR-Indian Institute of Rice Research, Rajendra Nagar, Hyderabad
Email: vasanthmosestalari333@gmail.com

Introduction

Climate change affects insect species abundance, distribution pattern, habitat suitability, niche area, reproduction capacity, invasion risk and outbreak frequencies. Advances in phenology (the annual timing of species' life-cycles) in response to climate change are generally viewed as bioindicators of climate change. The objectives our study is to identified the risk distribution of important pest of rice and review the phenological shit of rice pests under the climate change scenarios.

Methodology

Data on phenological and population dynamics of rice pest acquired from the existing literature and data was analyzed in MS Excel and R statistical programme. The potential distribution mapping of current and future climate scenarios was done using the freely available software likely, MaxEnt (Pandi *et al*, 2021) or DIVA GIS (Sridhar *et al*, 2014)

Results

BPH potential risk distribution mainly expanded and persistently highly suitable to the north-eastern Asia-Pacific region. The expansion of the pest in the Asia-Pacific region is illustrated in Figure-01. The geographical distribution rice pests in Indian given in the Table-1.

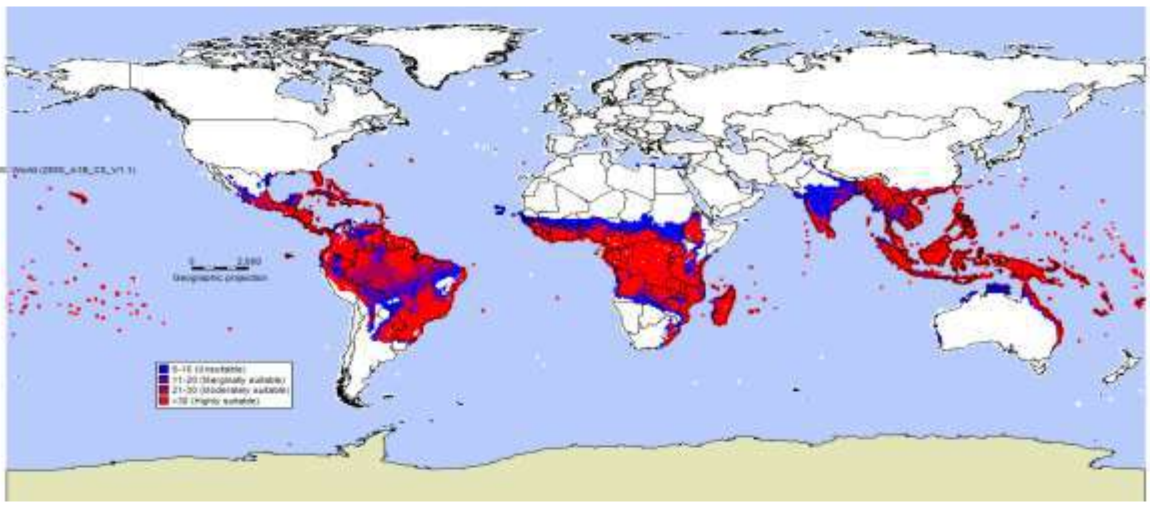


Figure-01: Potential global distribution of *N. lugens* under future climatic conditions (2050)

Table-01: Year wise expansion of rice pests in India (David and Ramamurthy, 2012; Jena *et al*, 2018)	
	YSB, Gall midge and Green leaf hopper
1975	Brown plant hopper and White backed plant hopper
1980	Case worm, Gundhi bug and Hispa
1985	Leaf folder and Termite
1990	Thrips, Mite
2000	Root Weevil and Black bug
2005	Pink stem borer, Panicle mite
2010	Swarming caterpillar and Blue beetle
2015	Ear cutting caterpillar
2017	Mealy bug and Grass hopper

Conclusion

As per our model BPH mostly persisted in the northeast and coastal regions of Asia-pacific regions, this information can be used for the implementation IPM programme.

References

David BV and Ramamurthy VV 2012. Elements of economic entomology: 7th Edition. Namratha Publications, Chennai, Pp: 168-169.

Jena M, Adak T, Rath PC, Gowda GB, Patil NB, Prasanthi G and Mohapatra SD, 2018. Paradigm shift of insect pests in rice ecosystem and their management strategy. ORYZA-An International Journal on Rice, 55(spl), pp.82-89.

Pandi GP, Choudhary JS, Chemura A, Basana-Gowda G, Annamalai M, Patil N, Adak T and Rath PC, 2021. Predicting the brown planthopper, Nilaparvata lugens (Stål)(Hemiptera: Delphacidae) potential distribution under climatic change scenarios in India. Current Science (00113891), 121(12).

Sridhar V, Verghese A, Vinesh LS, Jayashankar M and Jayanthi PK, 2014. CLIMEX simulated predictions of Oriental fruit fly, Bactrocera dorsalis (Hendel) (Diptera: Tephritidae) geographical distribution under climate change situations in India. Current Science, pp.1702-1710.

Theme IV

Agro-industries/Mechanization for scaling up SCI

Lightning talk **ICSCI 2022/T4/02**

Upscaling of mechanization through planter and harvester in rainfed maize cultivation

D. Sreelatha[1], G. Manjulatha[2], E. Rajanikanth[1], M. Rajaih[3] and B. Laxman[3]

[1] Regional Agricultural Research Station, Jagtial, [2]Agricultural Research Station, Karimnagar
[3] All India Coordinated Research Project on Farm Implements and Machinery,
Professor Jayashankar Telangana State Agricultural University, Rajendranagar,
Hyderabad, Telangana State, India
Email: lathadogga@gmail.com

Introduction

Maize is cultivated mainly as rainfed crop (about 6.0 lakh ha) in the state of Telangana and timely sowing is very crucial in the rainfed regions. Further, intensive maize-based cropping systems need timely harvesting for seeding of successive crop and moreover, rain/thunder storms at the time of harvesting is very much common which causes huge losses to the farmers. Mechanized harvesting is the solution for overcoming such problem. Conventionally maize is sown by manual dibbling or behind the plough and harvest by manual labour. These two activities have become more expensive due to high labour demands in peak period of agricultural operations which adversely affect the timeliness of operations, thereby reducing the crop yields in maize cultivation.

Methodology

Two mechanization interventions are evaluated one at the time of sowing using multi-crop vacuum planter and second at the time of harvesting using maize combine in Malkapur village, Chilpur mandal, Jangoan district by conducting large size demonstrations in 70.0 acres during *Kharif*, 2019 in red chalka soils with an objectives to study the feasibility of sowing and harvesting machines in maize; work out economics; Identification of operational problems in using machinery and finally popularization of mechanization in maize among the farming community. The sowings were taken up from 15th June to 24th July soon after receipt of monsoon rains with multi-crop vacuum planter (John Deere) and harvesting with combine harvester (W70, John deer) during 2019. A public bred single cross maize hybrid DHM 121 was taken for demonstration. Recommended seed (20 kg) and fertilizers (200-60-50 kg N-P_2O_5-K_2O ha^{-1}) were filled in bins and then sowing was taken up. The energy equivalents in terms of input and output in maize production system and economics were computed. Labour and time saving under mechanized vs conventional methods were analysed.

Results

Based on the findings, it was observed that seed requirement per ha was the lowest in multi-crop vacuum planter (17.5 kg/ha) compared to conventional method behind the plough (25.0 kg/ha) and there was a saving of Rs.1500/- per hectare in seed cost with multi-crop vacuum planter without compromising plant stand. The initial plant stand was found optimum with multi-crop vacuum planter (8.2/m^2) and was on par with recommended plant stand (8.3/m^2). But in conventional method where farmers were taken up sowing behind the plough, the plant stand was marginally lower than that of State recommendation (8.0/ m^2) due to lack of precision unlike in multi-crop vacuum planter (Fig 1). The planter effectively metered out single seed per discharge at average planting depth of 4.0 cm with minimum percentage of seed damage. This is in conformity with Singh *et al.* (2007), who stated that conventional practice where higher seed rate and non-uniform plant population was observed which affect grain yield and profitability.

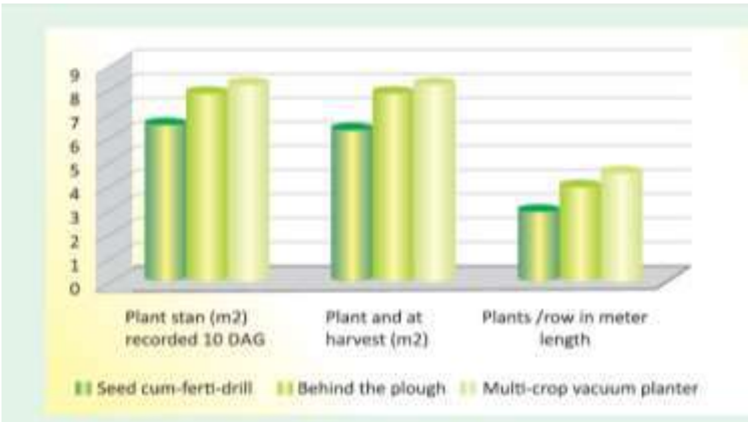


Fig 1. Plant stand/m^2 under mechanized *vs* conventional methods

Grain yields recorded were high in mechanized method (6916 kg/ha) over conventional method (6138 kg/ha) (Fig 2).

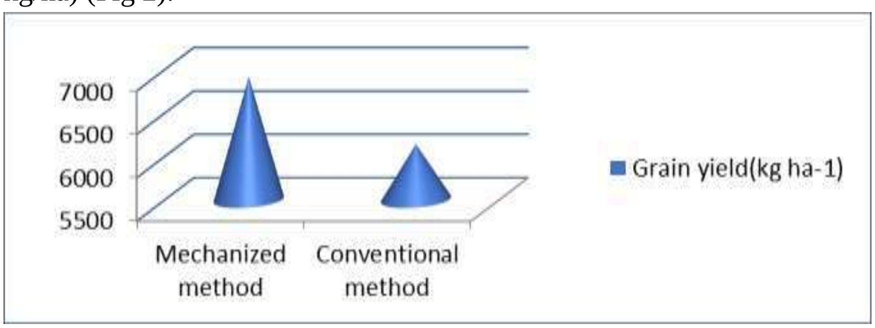


Fig 2. Grain yield (kg ha^{-1}) under mechanized *vs* conventional methods

Economic analysis and Energy Requirement

The cost of cultivation for sowing in mechanized method was Rs.2800 ha^{-1} and the time required for sowing one hectare was 2½ hours where as in conventional method of sowing it was completed in 8 hours incurred a cost of cultivation including thinning operation Rs.7900 ha^{-1}. There was a saving of Rs.5500 ha^{-1} and 10.5 man days' ha^{-1}, with mechanized method (Table 1). It was observed that the cost of cultivation for harvesting, shelling and drying along with removal of stover in mechanized method was Rs.9000ha^{-1} and time taken was 20 hours 15 minutes where as in conventional method, it was Rs.13400ha^{-1} and time taken was 82 hours. There was a saving Rs.4400/ha in mechanized method and time taken was also saved with a tune of more than 60 hours and 33 man days (Table 1). These results are in conformity with Jagvir Dixit *et al*. (2010). Over all, there was a saving of Rs. 9500 ha^{-1} with mechanized practice.

In terms of energy requirement, the total energy in maize production in conventional method was 13116.54 MJ ha^{-1}whereas in mechanized method was 22079.18MJ ha^{-1}. Further, the dependency on human labour was drastically reduced in mechanized method (1.70%) over conventional method (10.04%) with a tune of 8.34%. Finally, the energy output and input ratio was less in mechanized method (4.60) compared to conventional method (6.87) (Annexure 1).

Table 1. Mandays, time and cost economics of maize in mechanized *vs* convention practice

S.No.	Parameters	Conventional practice			Mechanized practice			Saving by mechanization practice (Rs./ha)
		Time taken (hrs)	Labour required	Cost (Rs/ha) (Labour + Machinery)	Time taken (hrs)	Labour required	Cost (Rs/ha) (Labour + Machinery	
2	Sowing, Fertilizer application and thinning	24	13	7900	2.5	2.5	2800	5100
3	Harvesting, dehusking, shelling and drying	82	36	13400	20 hrs 15 min	5	9000	4400
4	Total Time taken(hrs)	106			23			
5	Total labour required		49			7.5		
6	Total cost of operation, Rs./ha			21300			11800	9500
7	Yield (t/ha)	6916			6138			778

Note: Labour charges @Rs. 300/person/day

Cost of Intervention

Particulars	Conventional practice (Rs/ha)	Mechanized practice (Rs/ha)	Saving of Time (hrs)	Saving Cost (Labour +machinery) Rs/ha
Seed rate	5000	3500	--	1500
Sowing operation	7900	2800	21	5100
Harvesting Dehusking, shelleing and drying	13400	9000	62	4400
Over all saving			83	11000

Conclusion

The inference from the above results is that, sowing with multi-crop vacuum planter followed by W70 Combine harvester saved time with reduced drudgery of farm labour and cost of cultivation with higher maize grain yield per hectare is a viable option for rainfed farmers in scaling upscale up mechanization in maize cultivation. Though there is advantage in mechanization in maize cultivation, farmers expressed certain constraints in availability of machines on custom hiring in implementation of technology. These constraints can easily be addressed either by the State or Central Governments or both the Governments by offering subsidy on purchase of these machines. With this support, it is possible to increase agricultural productivity, employment of rural youth and thereby increase in per capita income of the farmers

References

Jagvir Dixit, Khan, J.N., Shukla M.M, 2010. Mechanization possibilities of maize cultivation in Hilly Regions of Jammu and Kashmir state of India. Agricultural mechanization in Asia, Africa and Latin America Vol.41(3): 59-63.

Singh, H., Kushwaha, H.L. and Mishra. 2007. Development of seed drill for sowing on furrow slants to increase the productivity and sustainability of arid crops. Bio-systems Engineering 98: 176-184.

Lightning talk **ICSCI 2022/T4/03**

Comparative study on Mechanical and manual transplanting in Paddy

M. Parimal Kumar[1], K. Mamatha[2], S. Ramesh[3], Dr M. Goverdhan[4]
[1,2] Scientist (Agronomy), Regional Agricultural Research Station, Palem
[3]Scientist (Entomology), Regional Agricultural Research Station, Palem
[4]Associate Director of Research, Regional Agricultural Research Station, Palem
E mail: mparimal.kumar@gmail.com

Introduction

Rice (*Oryza sativa L.)* is one of the most important cereals in Asia and India and it is staple food for 90 % of Asia and 60 % of India. The continuous growing population requires nearly 137.29 MT of rice by 2030-31 to meet food demand with an annual incremental rate of 2.15% (Pathak, 2020). In India majority of farmers grow rice either by manual transplanting (Traditional practice) or by dry/wet direct seeding method (Kumar *et al.,* 2017). Among these, manual transplanting is more common practice as it is advantageous over direct seeding method in terms of yield but labour-exhaustive and involves more energy (Verma, 2010). The migration of agriculture labour to other labours has shown negative impact on availability and cost incurred towards engaging labour for agricultural operations. Engaging labour for rice cultivation manually accounts for the maximum input cost and timely availability of labour has become cumbersome due to which productivity is declining constantly. Delayed sowing or planting expose the crop to unfavorable climatic condition and results in the endemic pest attack which leads to lower production and productivity. Mechanical transplanting of rice is a cost-effective establishment method for rice when compared to the existing and common method of manual transplanting. The primary drivers of the adoption of the mechanical transplanting are raising labor scarcity and the high costs associated with manual transplanting. Mechanical transplanting had been found encouraging choices to ensure planting at right time, to achieve optimal plant population and to attaining maximum yield (Manjunatha *et al.,* 2009). Higher grain yield of rice with yanmar eight row transplanter over conventional transplanting owing to more tillering ability, filled grains panicle^{-1} and more number of panicle hill^{-1}. Age of seedling is the most significant aspect among all agro-techniques inducing grain yield of mechanically transplanted rice (Shen *et al.,* 2006). Seedling age less than 25 days is considered ideal for achieving higher yield in mechanical method. Accurate running of the transplanters and lessening root damage, three weeks old seedling were found appropriate (Aswini *et al.,* 2009). Significant yield reduction had been noticed whenever transplanted aged seedling through mechanical method (Liu *et al.,* 2017). In this connection to achieve good yield and higher returns proper land preparation and timely transplanting are the keys of success under mechanical method. In spite of having superiority over the conventional transplanting method, small land holding and feeble financial status of the Indian farmers are the major shortcomings for the adoption of this technology.

Methodology

On farm trials were conducted under jurisdiction of Regional Agricultural Research Station, Palem during 2020-21 of Southern Telangana Zone. The experimental fields were traditional paddy fields in the Wanapatla, Nawabpeta, Papagal and palem villages. The rice varieties *viz.,* BPT 5204, RNR 15048, MTU

1010, KNM 118 and JGL 18047 were selected to assess the performance under machine transplanting and manual transplanting. Self-propelled 8 row Yanmar transplanter (Diesel) was used for mechanical transplanting. The nursery raised for mechanical transplanter is quite unique. A mat-type nursery was prepared, in this nursery rice seedlings were raised on a thin layer of soil and farm yard manure (FYM) or compost mixture placed on a polythene sheet. The polythene sheet prevents the seedling roots from penetrating the underlying soil, creating a dense mat. This type of nursery is a pre-requisite for machine transplanting. The mat can be cut into desired shapes and sizes to fit into the trays of the transplanter. Seedlings are ready for planting within 14-18 days after seeding (DAS). A uniform dose of N-P-K: 120-60-40 kg ha^{-1} applied where entire $P_2O_5$and half of K_2O applied as basal, Nitrogen fertilizer divided in to 3 equal splits and applied at basal, active tillering stage and panicle initiation stage. Remaining half of K_2O applied at panicle initiation stage. In addition to this 5 tonnes ha^{-1} FYM is applied 15-20 days before the sowing. The weed management taken care by the pre-emergent herbicides like pretilachlor, oxadiargil and post emergent herbicides like penoxulam and byspyribac sodium.

Results

The results obtained from the on farm demonstrations conducted at Wanapatla, Nawabpeta, Papagal and palem villages was found that four labour were enough to transplant 5-6 acres in a day using machine. Nursery raising cost was reduced as only 15 kg seed was sufficient for one acre transplanting and seedlings were ready to transplant within 15 days. This has saved input cost, labour and also time. Moreover, it can help in timely transplanting of rice in large area within less time.

Table no. 1. Performance of Machine transplanted Rice vis-a-vis Manual Transplanting in on farm demonstrations in Erstwhile Mahabubnagar Dist, Telangana during *Vanakalam* 2020

Sl. No	Name of the Farmer	Village	Variety	Mode of Planting	No of hills /Sq m	Plant ht.	Yield attributing character				Yield (t ha^{-1})
							No of Productive tills/hills	Panical length	No of graines /panicle	Test wt	
1	G. Rangarao	Wanapatla	BPT 5204	Machine	22	106.3	17.4	22.3	135	18.4	3.41
				Manual	30	102.1	13.2	20.5	124	18.1	2.84
2	VijayaRaghava	Wanaparthy	RNR - 15048	Machine	22	111.2	18.0	24.5	214	12.1	3.45
				Manual	35	103.5	14.7	23.2	162	11.5	3.06
3	Ananthaiah	Nawabpeta	MTU-1010	Machine	22	106.8	23.4	23.4	167	20.6	3.78
				Manual	34	103.6	18.9	20.2	132	19.4	3.22
4	Satyanarayan Reddy	Papagal	KNM 118	Machine	22	108.3	28.3	25.3	217	21.3	3.85
				Manual	31	101.1	23.6	23.1	177	19.8	3.34
5	Agriculture Polytechnic	Palem	JGL 18047	Machine	22	115.7	21.8	23.6	201	22.2	3.12
				Manual	34	102.8	18.0	21.0	194	20.3	2.61

Among all the varieties tested varieties were shown superior performance in the machine transplanting. The number of hills per square meter was recorded 30 to 35 in the manual transplanting method and it was higher compared to mechanical transplanting, where 22 hills were recorded. The plant height was noted higher in the mechanical transplanting over manual transplanting due to availability of sunlight, space and nutrients. The yield parameters like productive tillers, grains per panicle were found higher in the mechanical transplanting. The yield advantage of 10-15 % was recorded with mechanical transplanting in tested varieties.

Conclusion

Mechanical paddy transplanter is one of the possible options to get rid of labour shortage and drudgery of labour in farm operations and can be used magnificently as an economic, practicable and alternative opportunity for attaining higher productivity and curtail the cost of cultivation as the traditional rice transplanting needs more workforce.

References

Aswini, G.K., Swain, S., Debaraj, B., 2009. Effect of seedling age on performance of rice transplanter. Agricultural mechanization in Asia, Africa and Latin America 40(3), 41–46.

Kumar, A., Nayak, A.K., Pani, D.R., Das, B.S., 2017. Physiological and morphological responses of four different rice cultivars to soil water potential based deficit irrigation management strategies. Field Crops Research 205, 78–94.

Liu, Q., Zhou, X., Li, J., Xin, C., 2017. Effects of seedling age and cultivation density on agronomic characteristics and grain yield of mechanically transplanted rice. Scientific Reports 7, 14072.

Manjunatha, M.V., Reddy, B.G.M., Shashidhar, S.D., Joshi, V.R., 2009. Studies on the performance of self-propelled rice transplanter and its effect on crop yield. Karnataka Journal of Agricultural Sciences 22(2), 385–387.

Pathak, H., 2020. Agricultural research and development: policy and program priorities in India. Agricultural Policy and program framework: Priority Areas for Research & Development in South Asia 5, 93–115.

Shen, J.H., 2006. Effects of sowing density, fertilizer amount in seedbed and seedling age on seedling quality and grain yield in paddy field for mechanical transplanting rice. Acta Agronomica Sinica 32(3), 402–409.

Lightning talk **ICSCI 2022/T4/07**

Machine transplanting is the economical rice establishment method

P. Spandana Bhatt[1], P. Raghu Rami Reddy[1] and MV Ramana[2]
[1] *Institute of Rice Research*
[2]*IFS, Rajendranagar, Professor Jayashankar Telangana state Agricultural Institute, Hyderabad, Telangana, 500030*
E mail: spandana9119@gmail.com

Introduction

Rice is the "global grain" as it is the most important and extensively grown food crop in the world. The major cost involved in the rice production is attributed to transplanting, which is time bound to be completed with 21-25 days old seedlings and require huge labour. Conventional rice demand 25–30-man days for transplanting one hectare. The labour shortage due to migration or industrialisation, rising wage rates and drudgery involved during transplanting created a condition for a move towards mechanisation (Rajendran et al., 2018), as it facilitate timely completion of operation, increase the production, productivity, profitability at one hand and decrease the cost per unit production at a time on other.

Methodology

A field experiment conducted during *kharif*, 2020 and 2021 at Institute of Rice Research, Rajendranagar, Hyderabad, Telangana state comprised of twelve treatments in randomized strip plot design, replicated thrice. Main plot treatments comprised M1: Normal Planting time Mechanical Transplanting (15 days seedlings),M2: Delayed Planting time (15 days late) Mechanical Transplanting (15 days seedlings), M3: Manual transplanting – Normal time (25 days old seedlings)and M4:Manual transplanting – Delayed sowing (25 days oldseedlings).Three varieties i.e., S1: RNR 15048, S2: KNM 118 and S3 JGL 24423were tested in sub plot.

Results

Establishing rice through machine transplanting with 15 days old seedlings recorded higher grain yield of 8.4 % *i.e.* (6595 kg/ha) and was at par with manual transplanting (6081 kg/ha) with 25 days old seedlings. Among tested varieties grain yield recorded under machine transplanting was JGL 24423 (6545 kg/ha), KNM 118 (6347 kg/ha) and RNR 15048 (6002 kg/ha) and were on par among themselves. The economic indicators are also high with these practices over conventional transplanting. Highest net returns(Rs.92990/ha) and B:C ratio (2.56) was realised when the rice was established through machine transplanting with JGL 24423 variety. For establishing rice through conventional transplanting, the cost involved is Rs.10000/ha, the cost of cultivation decreased under machine transplanting by Rs.4850/ha with increased net returns of Rs.7500 /ha. These results are in agreement with finding s of Rupsikha (2020).

Table 1: Pooled analysis of grain yield (kg/ha)as influenced by different sowing dates and transplanting methods during *kharif*, 2020 and 2021

	M1	M2	M3	M4	Mean
RNR15048	5741	6292	5964	6012	6002
KNM 118	6376	6493	6454	6063	6347
JGL24423	6576	7000	6434	6169	6545
Mean	6231	6595	6284	6081	
Varieties at same level of main plots		Main plots at same level of Varieties			
CD (P=0.05)	617	CD (P=0.05)	441		

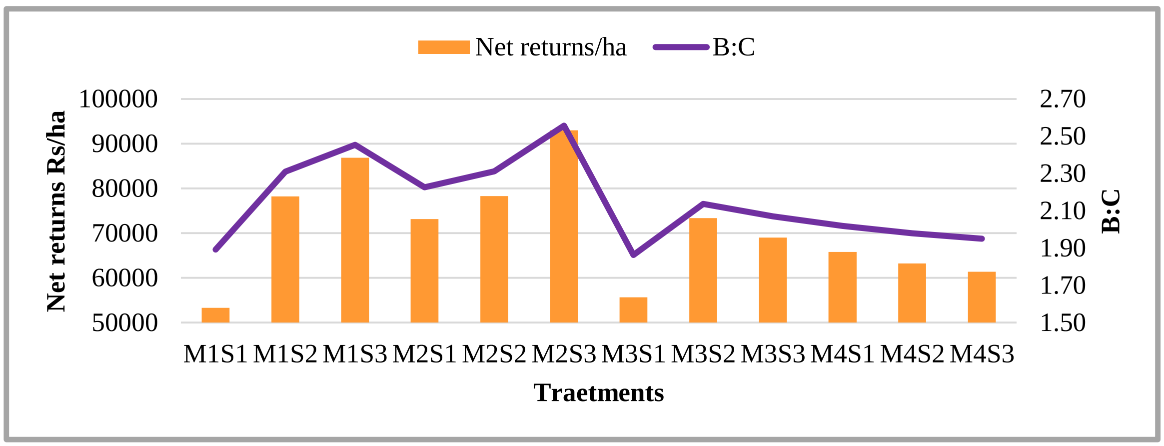


Fig 1: Economics as influenced by different sowing dates and transplanting methods during *kharif* 2020 and 2021

Conclusion

Machine transplanting is the alternative methods of rice establishment over conventional manual transplanting, particularly under the conditions of acute labour shortage. Large areas can be sown within a short span of time with these techniques besides higher yields and more net returns.

References

Rajendran T, Kavitha R, Balaji PP and Mathivanan A 2018. Economic analysis of Machine transplanted Rice in Thuthukudi district. International Journal of trends in scientific research and development 2(4):1576-1578.

Rupsikha Goswami, Mouchumi Dutta and Sanju Borgohain. 2020. Economic Analysis of Mechanical and Manual Transplanting of Rice: A comparative study. International journal of current micro biology and applied sciences. 9(07): 392-396.

Lightning talk **ICSCI 2022/T4/08**

Impact of age of seedling and time of planting time on yield of machine transplanted rice

Elamathi, S and K. Subrahmaniyan
Tamil Nadu Rice Research Institute, Aduthurai – 612 101.
Email: elamathi_aaidu@yahoo.co.in

Introduction

Rice is the most important cereal crop in India. It is considered to be on the front line to fight against the world's hunger and poverty. Increasing rice production can solve the country's is food problem. It is important to find out the optimum age of seedling suitable for mechanized transplanting is essential. Suitable date of transplanting is the most important factor for maximizing the yield. Yield of rice also differs due to growing environment such as different locations. Seasonal fluctuations different dates of transplanting etc. (Sarkar, 2002). Optimum age of seedling required for machine transplanting is not standardized. Neither young seedling nor Old seedling is not suitable for machine to pick up for transplanting and ultimately results in lower yield. In this context, the present experiment was carried out to find out the suitable age of seedling required for machine transplanting under normal and delayed time of transplanting to enhance the rice yield.

Methodology

A field experiment was conducted during *kharif* 2020-21 at TRRI, Aduthurai. The soil of the experimental field was clay in texture with a pH of 8.21, organic carbon (0.42%), low in available nitrogen (221 kg/ha), medium in available phosphorus (25 kg/ha) and high in available potassium (486 kg/ha). The experiment was laid out in randomized block design with four replications. The treatment included were T_1 - Normal planting time Mechanical Transplanting (15 days old seedling and recommended spacing), $_{T2}$ - Normal planting time Mechanical Transplanting (21 days old seedling and recommended spacing), T_3 – Delayed planting time (15 days late) Mechanical transplanting (15 days old seedling s and recommended spacing), T_4 – Delayed planting time (15 days late) Mechanical transplanting (21 days old seedling s and recommended spacing), T_5 – Manual Transplanting – Normal time (25 days old seedlings), T_6 - Manual Transplanting – Delayed sowing time (25 days old seedlings). ADT 53 was used as a test variety. Normal and delayed time of sowing was done on 15.06.2020 and 02.07.2020 respectively. Whereas Transplanting was done 30.06.20 (T_1), 06.07.20 (T_2), 15.07.20 (T_3), 23.07.20 (T_4), 11.07.20 (T_5), 28.07.20 (T_6) respectively as per treatment schedule. The crop was harvested when plants turned yellow and attained maturity. The yield was expressed in kg/ha and the grain weight was expressed in 14 % moisture basis. In economic analysis, the benefit cost ratio was worked out by using the formula of ratio between the gross return (Rs./ha) and total cost of cultivation (RS./ha). the data were statistically analyzed.

Results

Rice age of seedling significantly influenced on the yield and yield attributes. Taller plants were recorded when the transplanting were done at 15 and 21 days old seedling under normal time of planting. Whereas under delayed transplanting recorded shorter plants. The 15 days old seedlings produced highest number of tillers/m^2 (355) and the lowest tiller (326) was recorded at 25 days old seedling. Wang et.al., (2002) reported that transplanting of younger seedling had a positive effect on increasing number of tillers and promoting the early occourence of maximum tiller. Roy et.al., (1994) opined that number of grains/panicle decreased with the increase of age of seedlings. Higher grain yield was recorded in 15 days old seedling transplanted as compared to 25 days old seedling. The increased grain yield in 15 days old seedling was due to increase in the number of tillers and number of grains/panicle. Higher

Table 1: Influence of different treatments yield attributes and grain yield (Kharif 2020)

Treatments	Plant Height (cm)	Total Tiller/m2	Panicle Weight (g)	Grains/ Panicle (No)	Grain Yield (Kg/ha)	Test weight (g)
T_1 – Normal planting time Machine planting (15 days)	146.1	355.3	2.5	162.6	5511.0	17.2
T_2 - Normal planting Machine planting (21 days)	146.5	347.3	2.4	153.5	5150.7	17.1
T_3 – Delayed planting time (15 days late) Machine planting (15 days)	133.7	326.3	2.5	147.1	4832.7	17.1
T_4 - Delayed planting time (15 days late) Machine planting (21 days)	142.4	321.3	2.3	142.2	4615.7	17.1
T_5 – Manual transplanting – Normal time (25 days)	124.0	341.3	2.2	147.6	4984.7	17.0
T_6 – Manual transplanting – Delayed sowing time (25 days)	123.3	326.7	2.2	134.9	4510.0	17.0
SEd	1.13	4.12	***0.02***	2.58	247.4	0.05
CD= (0.05)	2.52	9.19	***0.05***	5.74	551.4	0.12

Table 2: Influence of different treatments economics

Treatments	Cost of cultivation (Rs/ha)	Gross Income (Rs/ha)	Net Income (Rs/ha)	B.C. Ratio
T_1 – Normal planting time Machine planting (15 days)	44692	99198	54506	2.2
T_2 - Normal planting Machine planting (21 days)	44692	92712	48020	2.1
T_3 – Delayed planting time (15 days late) Machine planting (15 days)	44692	86988	42296	1.9
T_4 - Delayed planting time (15 days late) Machine planting (21 days)	44692	83082	38390	1.9
T_5 – Manual transplanting – Normal time (25 days)	47922	89724	41802	1.9
T_6 – Manual transplanting – Delayed sowing time (25 days)	47922	81180	33258	1.7

Time of transplanting

Plant growth parameters were significantly affected by time of transplanting. Transplanted on 30th June recorded significantly higher yield parameter and yield than July transplanting. Beyond June 30th transplanting of seedling recorded decreased in tiller/m^2 and grains/panicle and yield. The lowest grain yield (450 kg/ha) was recorded in 28th July transplanting. The lower grain yield may be due to lesser number of tillers grains/panicle higher gross income (54506) and B.C Ratio (2.2) was recorded in 30th June transplanting of 15-day seedling.

Conclusion

It may be concluded that for realizing higher yield and Higher Income Mechanized transplanting with 15 days old seedlings recorded higher grain yield of 5511kg/ha which was statistically on par with 21 days old seedlings. The same treatment recorded higher net income of 54506 Rs / ha with B.C ratio of 2.2. Whereas delayed planting time (15 days late) in mechanical transplanting with 15 days old seedlings recorded grain yield of 4833 kg/ha.

References

Roy B C, Sattar S H, Gaffer M A & lslam M A. 1992. Seedlings age effect on yield of irrigated rice. Bangladesh Rice J.3 (1&2):83-88.

Sarker U. 2002. Stability of Grain yield under difference planting times in rice. Bangladesh J. Agril. Res. 425-430.

Wang S, Cao W, Jiang D, Dai T & Zbu Y. 2002. Physiological characteristics and high-yield techniques with SRl rice. ln: Assessment of the system of rice intensification. In: Proc. lntl. Conf., Sanya, China. April 1-4, 2002. pp. 117-121.

Lightning talk **ICSCI 2022/T4/11**

Agro-industries/Mechanization for scaling up SCI
Smart Precision models for Sustainable Rice Production

B. Sailaja[1], S. Gayathri[1], D. Subrahmanyam[1], K. Surekha[1], Santosha Rathod[1], Ch. Padmavathi[1], G.S. Laha[1], M.S. Prasad[1], R. Nagarjuna Kumar[2] and R.M. Sundaram[1]
[1]*ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad- 30*
[2]*ICAR-Central Research Institute for Dryland Agriculture, Hyderabad-59*
Email: bandasailaja@gmail.com

Introduction

Data is moving very fast in world by the advancement in the internet and mobile technologies. Current advances in ICT are making smart farms as DATA has become key element in modern agriculture to help growers in critical decision making. Rice is among the three leading food crops of the world, with maize (corn) and wheat being the other two. India has the largest area (45 M.Ha) under rice in the world. The average productivity of rice is still low (~2.7 t/ha) because of the diversity in its growing environments. Therefore, future improvement in crop productivity requires management technologies that are tailored to specific characteristics of individual farms / fields and environments through adoption of precision technologies. Hence, Integration of smart precision technologies like Internet of Things (IoTs), Remote sensing, GIS with crop growth and AI based models is needed to improve the quality of decisions of farmers.

Methodology

Our study aimed at integration of remote sensing, GIS, weather sensors, crop models and AI based climate models to generate site specific management advisories to get the optimum yield. ICAR-IIRR developed a Spatial Rice Decision Support System by integrating Oryza2000 crop model (Sailaja, B. *et al.*, 2019) with RS/GIS technologies to estimate the Rice yield. This DSS is further refined by integration of weather sensors and AI based climate models to generate intelligent site specific advisories for sustainable rice production. The following are the six smart precision models to integrate with Rice DSS.

i. Wireless Sensor Networks integrating with Rice DSS model for real time advisories

DHT 11 weather sensor for recording temperature, humidity and weather bit sensor for wind speed, direction and rainfall along with Raspberry PI were fabricated. This mini weather station is connected to solar panel and recharging battery for the power backup.

ii. AI and GIS based Temperature forecasting using Random forest (RF) machine learning algorithm

Temperature variation always influence crop growing, different biotic and abiotic stresses of rice crop. Forecasting day wise temperatures during crop growing season is needed to identify vulnerable temperature zones to transfer the heat tolerant technologies/forecasting pests and diseases. Day wise grid based temperature data of 307 gird points from IMD for the period 2009-2019 (Srivastava *et al*., 2009) was used for the development of forecasting model. Data was extracted and cleaned using QGIS. A Random Forest Machine Algorithm was used for developing forecasting model.

iii. Estimating potential yield, optimum crop sowing dates and management practices to minimize yield gap

Radiation and Nitrogen Use Efficiency experimental data of 2018 was utilised for this estimation. MTU1010 (130 days) variety was chosen and IIRR weather data of 2018 was used. Rice DSS was executed for several combinations of sowing dates (before one week and after one week from sowing date 180th day i.e. 29.6.2018), seedbed duration (SBD-20 and 25 days), application of nitrogen (0,50 and 100 kg/ha.).

***iv.* Estimating Nutrient Requirement using AICRIP long term data**

Quantitative evaluation of the fertility of tropical soils (QUEFTS) model was chosen for estimating nutrient requirement of rice crop. Long term soil fertility experimental data of AICRIP, Maruteru for 7 years was used for calculating accumulated (*a*) and diluted (*d*) coefficients of the model. The treatments of single-nutrient omission plots such as +PK (N omitted), +NK (P omitted) and +NP (K omitted) were selected for computation of *a* and *d* values. N, P and K uptake values were estimated.

v. GIS based soil data file for estimating soil polygon wise rice yield

Six soil layers on each parameter i.e. texture, sand, bulk density and organic carbon from FAO soil grids (https://soilgrids.org). These layers were processed in QGIS and soil management, physical and hydrological parameters were derived and soil data file was prepared for Rice DSS

vi. Rice disease mapping using historical weather and Production Oriented Survey data by applying Machine Learning Algorithm

Digital rice disease mapping was done using the minimal dataset of Production Oriented Survey data(POS) during 1980-2000 and historical weather data (1970-2000) (Fick and Hijmans, 2017). R program and Random forest machine learning algorithm were used for training and predicting Leaf Blast(LB) disease severity at missing pixels. Combined Andhra Pradesh state was selected for this study.

Results

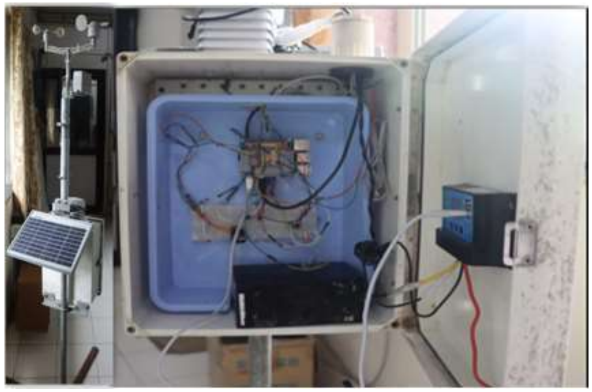
i. Wireless Sensor Networks integrating with Rice DSS model for real time advisories

Python programs were developed to record the data from each sensor into one Google sheet and further a dot net program was developed in Rice DSS to convert this data into Rice DSS weather file (Fig 1).

ii.AI and GIS based Temperature forecasting using Random forest(RF) machine learning algorithm

Day wise maximum temperature was estimated using RF algorithm. There was very good correlation between observed and predicted values with R^2>0.8 using RF model (Fig 2). IMD grid data of 2020 was used as a validation dataset. There was very good correlation of (r=0.88) between validation data and RF predicted data.

Fig 1: Mini weather station fabricated at IIRR



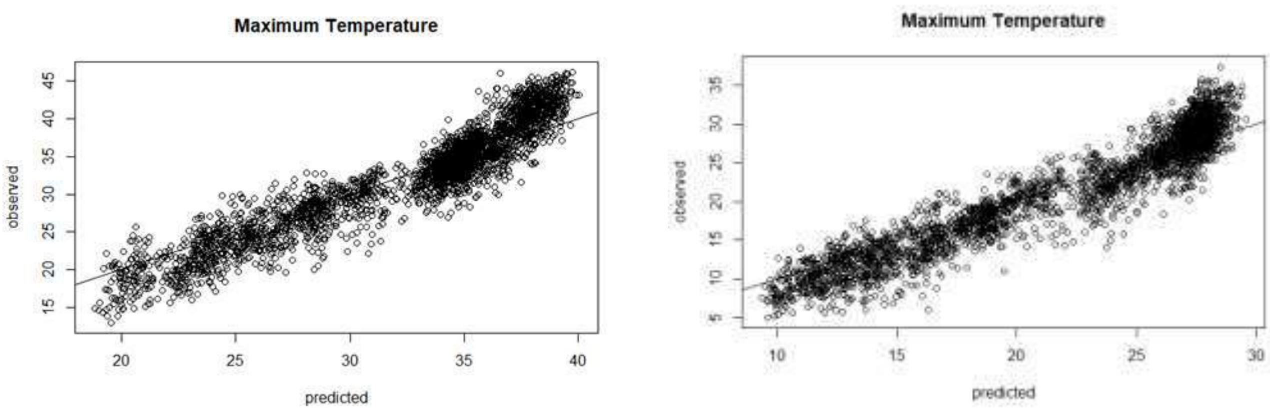


Fig 2: RF model scatter plot for predicted and observed maximum temperature values i.e. Left side figure: longitude-75.5, latitude-34.5; Right side figure: longitude-76.5, latitude-27.5

iii. Estimating potential yield, optimum crop sowing dates and management practices to minimize yield gap

The combination of sowing date one week before the actual sowing date (cumulative day number 173) with seedbed duration 20 days and application of nitrogen (N) 100 kg/ha gives optimum yield i.e. 10 t/ha with MTU1010 variety for the location IIRR, Hyderabad (Fig 3).

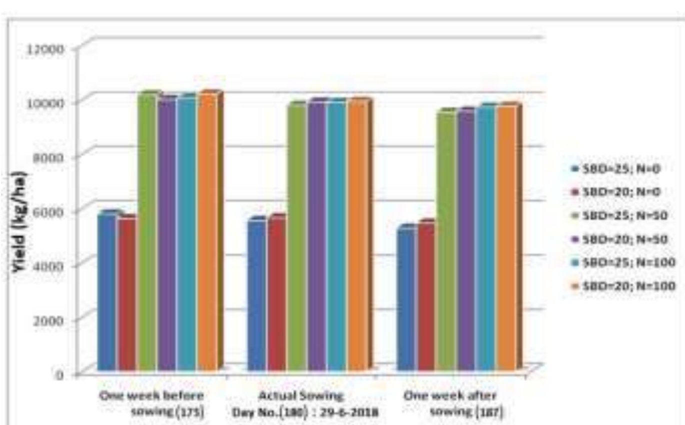
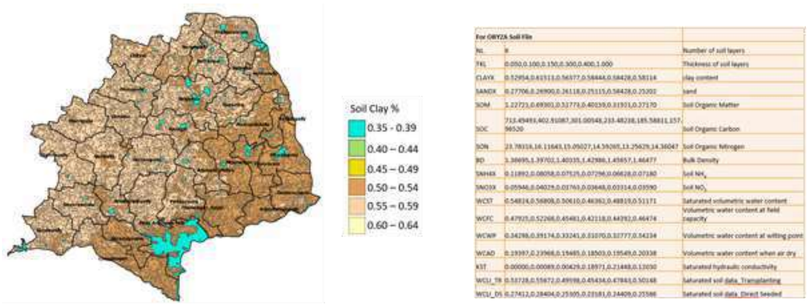


Fig 3: Histogram showing the yields estimated by Rice DSS for combination of seedbed duration (SBD) and N application (kg/ha) values to get the optimum sowing date with rice variety-MTU 1010 at location-IIRR

iv. GIS based soil data file for estimating soil polygon wise rice yield

Soil texture wise data layers were grouped and other layers like sand, bulk density and organic carbon were merged into texture layer to prepare one shape file with 24 attributes (4 parameters × 6 layers). Soil management, physical and hydrological parameters required for Rice DSS were derived (Fig 4).



For ORYZA Soil File		
NL	6	Number of soil layers
TKL	0.050,0.100,0.150,0.300,0.400,1.000	Thickness of soil layers
CLAYX	0.52954,0.61513,0.56377,0.58444,0.58428,0.58114	clay content
SANDX	0.27706,0.26900,0.26118,0.25115,0.58428,0.25202	sand
SOM	1.22721,0.69301,0.52773,0.40159,0.31901,0.27170	Soil Organic Matter
SOC	713.49493,402.91087,301.00548,233.48238,185.58811,157.96520	Soil Organic Carbon
SON	23.78316,16.11643,15.09027,14.59265,13.25629,14.36047	Soil Organic Nitrogen
BD	1.38695,1.39702,1.40335,1.42986,1.45657,1.46477	Bulk Density
SNH4X	0.11892,0.08058,0.07525,0.07296,0.06628,0.07180	Soil NH_4
SNO3X	0.05946,0.04029,0.03763,0.03648,0.03314,0.03590	Soil NO_3
WCST	0.54824,0.56808,0.50610,0.46362,0.48819,0.51171	Saturated volumetric water content
WCFC	0.47925,0.52268,0.45481,0.42118,0.44292,0.46474	Volumetric water content at field capacity
WCWP	0.34298,0.39174,0.33241,0.31070,0.32777,0.34234	Volumetric water content at wilting point
WCAD	0.19397,0.23968,0.19485,0.18503,0.19549,0.20338	Volumetric water content when air dry
KST	0.00000,0.00089,0.00429,0.18971,0.21488,0.13030	Saturated hydraulic conductivity
WCLI_TR	0.53728,0.55672,0.49598,0.45434,0.47843,0.50148	Saturated soil data_Transplanting
WCLI_DS	0.27412,0.28404,0.25305,0.23181,0.24409,0.25586	Saturated soil data_Direct Seeded

Fig 4: Soil texture map processed from FAO soil grids map along with the derived soil parameters

v. Developing Nutrient Requirement Model using AICRIP long term data

Internal efficiencies(IE) of N, P and K were derived and by eliminating upper and lower 2.5 percentiles of nutrient IE values *a* and *d* values were computed as *a*N=46, *a*P=124 , *a*K= 35 and *d*N=98, *d*P=251, *d*K=58. Nutrient requirement at yield target of 6 t/ha was estimated. Estimated of N, P, K uptake values were 98, 32, 118 kg/ha respectively.

vi. Rice disease mapping using historical weather and Production Oriented Survey data of IIRR by applying Machine Learning Algorithm

Leaf Blast (LB) disease severity was predicted and influencing weather parameters on the LB disease were estimated for combined Andhra Pradesh state using RF model (Fig 5). The R^2 value is 0.65. RF Model predicted that among the five weather parameters (precipitation, solar radiation, wind speed, maximum and minimum temperatures), maximum temperature followed by wind speed and minimum temperature were the major influencing factors on LB severity.

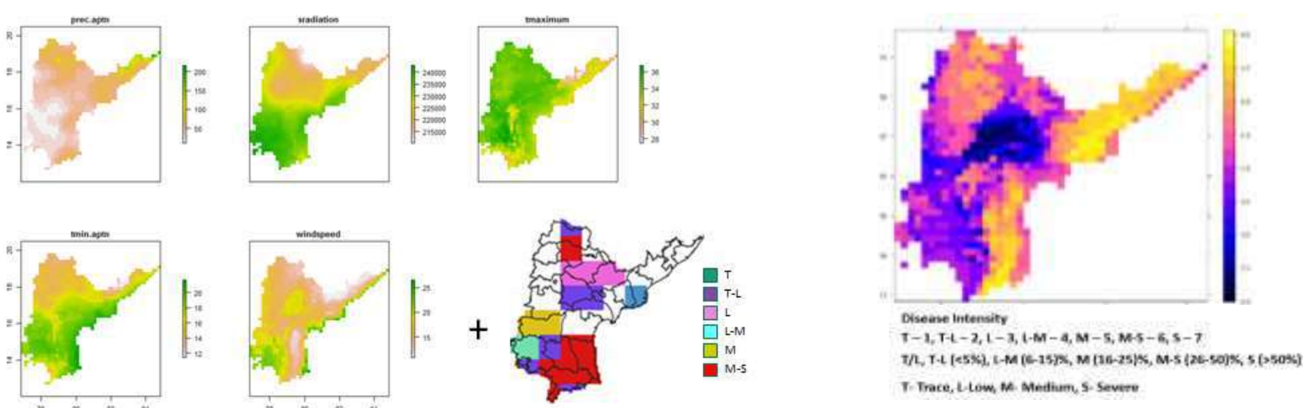


Fig 5 : Left side: RF training data maps leaf blast severity and historical weather maps of precipitation, solar radiation, wind speed, maximum and minimum temperatures; Right side: RF model predicted leaf blast severity

Conclusion

Above six models are performing well with the experimental/test datasets. These models will be further refined and integrated with Spatial Rice DSS to generate intelligent site specific advisories for sustainable rice production.

References

Fick SE and RJ Hijmans, 2017. WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. International Journal of Climatology 37(12): 4302-4315. https://www.worldclim.org/data/worldclim21.html.

Sailaja B, SR Voleti, D Subrahmanyam, P Raghuveer Rao, S Gayatri, R Nagarjuna Kumar and Shaik N Meera. 2019. Spatial Rice Decision Support System for Effective Rice Crop Management. Current Science, Vol. 116(3), 412-422.

Srivastava AK, M Rajeevan, SR Kshirsagar. 2009. Development of High Resolution Daily Gridded Temperature Data Set (1969-2005) for the Indian Region. ATMOSPHERIC SCIENCE LETTERS Atmos. Sci. Let. DOI: 10.1002/asl.232. https://www.imdpune.gov.in/lrfindex.php.

Lightning talk **ICSCI 2022/T4/13**

Single-Plant Transplanting of Rice in Natural Farming Saves the Cost of Production

Anupam Paul[1] and Soumik Banerji[2]
[1] *Kangsabati Command Area Development Authority,*
Water Resource Investigation Development Directorate, Bankura, West Bengal,
[2] *Independent Researcher, Madhya Pradesh*
Email: anupampaul99@gmail.com, soumix2009@gmail.com

Introduction

Mainstream agriculture focuses on increased rice yield through the application of chemical fertilizers to modern rice varieties that have high fertilizer responsiveness. Farmers go on increasing their fertilizer doses and buy new rice seed before each season. But in the case of natural farming and organic farming, yield does not decline over the years unless the crop is exposed to severe climatic stress. In organic farming, farmers need to use traditional crop varieties along with natural soil nutrients like cattle manure, oil cake, green manures, and azolla, etc. As traditional rice is used in all our rituals, it can be termed as 'folk rice'. The seeds of folk rice can be used for years without any appreciable decrease in grain and straw yield. There are several ways to transplant rice. Farmers usually transplant 25-35-day-old seedlings at the rate of 2-3 seedlings per hill. Double transplanting is another popular method in Cooch Bihar, 24 Parganas, and Hooghly districts of West Bengal, where farmers re-transplant rice 20-25 days after first transplanting by separating newly emerged tillers.

Single-Seedling Planting (SSP) is not new in India and has been practiced in Sundarbans, West Bengal since time immemorial. Transplantation of single young seedlings, 8-15 days old, was recommended along with 2 or 3 intercultural operations using a manual rotary weeders and the alternate wetting and drying of rice fields.In the Sundarbans delta of West Bengal where flash flooding is quite common during kharif season (July to Nov), seedlings often get washed away just after transplanting. A few days after the water level recedes, farmers transplant the tillers of the flood-tolerant folk rice that have come up with the older seedlings (40 days or more) left unused in seed bed. They transplant single seedlings more than one foot apart into approximately 8 inches of water with a spacing of 30 x 30 cm to cover entire area. The plant grows profusely and gives dozens of tillers in stagnant water.

Methodology

Agricultural Training Centre (ATC) at Fulia, Nadia, under the Directorate of Agriculture, West Bengal, started practicing SSP with folk rice under organic inputs since 2002. The crop cycle followed is Dhaincha or Groundnut (pre-Kharif) - folk rice (Kharif) – pulses (Rabi). Since 2010, the farm stopped using external organic inputs like cattle manure, oil cake, biofertilizers, etc. Soil samples were taken twice in a year (2015-19), once prior to cultivation and once after harvest. Only floating Azolla is allowed to grow along with rice ecosystem in one inch of water, thus becoming a naturally sustaining farming system.

Results

Table 1: Cultivation methods used for evaluating folk varieties under SST management

[redacted]			
3 times, pulverizing a foot depth. *Dhaincha* worked into soil with a gap of 5 days.	Seedlings raised in seed bed, 15–20-day-old seedlings with a spacing of 25 x 30 cm. 3 kg of seed is used for transplanting an acre of land (7.5 kg per ha).	22 DAT with gap-filling of seedlings if any; 2 kg of Azolla is sprinkled over 33 decimals of rice fields in one inch of water; this covers the entire land in 10 days. Then 2nd interculture @ 42 DAT. Rouging of off-types	Monsoon rain and sometimes irrigation

Table 2 Soil microbes of rice fields under different management

[redacted]						
Rice field under Natural Farming (ATC-Fulia)	Sandy loam	$89x10^5$	$109x 10^5$	$64 x10^5$	269	$49 x10^5$
Rice field under chemical inputs (BCKV-Mohonpur)	Sandy loam	$53.6 x 10^5$	$35.3 x10^5$	$30.6x10^5$	--	$43.6x 10^5$

Most of the folk rice varieties gave profuse tillering, ranging from 10 to 45, with a mean of 15. The crop had luxurious growth with spotless leaves and no major insect attacks. All the varieties were transplanted following SSP method. Table 4 gives average number of tillers and yield recorded across 4 years.

Table 3: Average yield of folk rice (paddy) varieties under Natural Farming mode

[redacted]				
Kerala Sundari	132	18	6	4.5 feet tall, a selection from Purulia District; tolerates drought to some extent; good straw; is used to make rice bubbles.
Bahurupi	138	12	5.5	Good yielder; straw is slightly pungent.
Kesabsal	136	17	5.5	Like Kerala Sundari.
Balaramsal	151	17	4.4	Medium grain.
Rabansal	144	17	4.8	Bold rice tolerates 1.5 feet of water; fish-cum-paddy culture is possible.
Kabirajsal	145	14	4.1	Medium; medicinal rice; used to make rice bubbles.
Madhumala	120	14	4.5	Erratic flowering.
Nagra Patnai	143	16	3.9	Medium grain; used to make rice bubbles.
Nandiswar	138	15	4.7	Selected by Nandiswar Naskar of West Bengal, bold rice
Patnai 23	150	17	4.4	Medium rice tolerates 1.5 feet of water; fish-cum-paddy culture; was selected by Sir Daniel Hamilton during 1920s in Sundarbans area.
Khejurchori	141	15	4.2	Cluster rice; tolerates water; used to make rice bubble.
Talomuli	146	15	4.4	From Sambhav, Odisha; reddish husk , puffed rice.
Megha	145	14	5.2	From Odisha; long panicle of 12 inches; some panicles

Dambaru				weigh up to 14.5 gm
Khara	139	16	4.0	From Odisha; anthocyanin-containing purple-colored tender leaves can be eaten as *Pakoda*; red rice, medicinal uses; tolerates 1-2 feet of water.

A higher count of CFU is a measure of living soil, and it is always higher than on chemical farms. Generally sandy-loam soils in the region have low Soil Organic Carbon of 0.4% while at the centre it is 0.65%. It requires several years of adding organic matter to build Soil Organic Carbon however once achieved, the soil manifests its living nature provided that no chemical fertilizer, pesticides, or weedicides are used, and normal cropping sequences are maintained. Biodiversity in the soil is benefited by diversity and rotation of crops.

Soils of this sort are like a forest soil which takes care of the crop because it is a living soil, and it produces healthy crops with adequate mineral and antioxidant content. Thereby, it does no harm to the health of human beings and cattle that depend on the particular land (Howard 1943). Further, Azolla provides N, organic matter, micronutrients, and to some extent potassium besides conserving soil moisture and constraining the growth of associated plants (weeds) in rice ecosystems. Farmers who have adopted the system get substantial yield and also improved soil. Single-seedling planting with wider spacing under Azolla helps by supporting more adequate aeration and better growth with almost no competition among the seedlings. It fosters more microbial populations in the rhizosphere, adequately nourishing the rice plants with good tillering; 90% of tillers are observed to form panicles. The mean grain yield (paddy) recorded from this methodology -- 4.69 MT/ha -- is 72% and 62% above the respective national and West Bengal state averages of 2.72 MT/ha and 2.89 MT/ha (data from 2019-20).

Conclusion

Desi HYVs can compete with modern varieties in terms of yield and profitability given the reduced cost of production under organic management with SSP. *Desi* HYVs commonly command a higher price in the markets because of consumer preferences for flavorful folk rice. In this era of climatic change and rising costs of cultivation, farmers need to adopt eco-friendly agricultural practices that can save them money and also save the environment. With the passage of time, more than 30 Farmers' Groups in West Bengal have adopted folk rice along with SSP so as to minimize their costs of cultivation and to get sustained yield. A unique scheme under RKVY[1] on "Folk Rice Conservation, Cultivation and Value Addition" was initiated 16 blocks of 16 districts in 2015 and continued through 2019. Currently, West Bengal is one of the highest producers in folk rice in India, with more than 400 ton of just one variety -- *Kalabhat* -- produced in 2021.

References

Bengal District Gazateers: 24 Parganas, L.S. S. O' Malley, 1914

Agricultural Journal of India, Vol. 2, Part IV, 1907Gujja et al, 2012, *Transforming Rice Production with SRI Knowledge & Practice*, National Consortium of SRI (NCS).

Howard, Albert, 1943, *An Agricultural Testament*, Oxford University

ICSCI 2022/T4/01

Impact of different ovipositional substrates and mating duration on fecundity and egg hatchability of eri silkworm *Samia ricini* Donovan

R. K. Gokulakrishnaa and Selvamuthukumaran Thirunavukkarasu
Department of Entomology, Faculty of Agriculture, Annamalai University, Annamalai nagar - 608 002
E mail: entogokul230696@gmail.com

Introduction

Eri silkworm is a polyphagous and multivoltine species and it is the only domesticated silkworm among the non – mulberry silkworms. In case of silk production eri accounts for about 19.80 per cent (7,157 MT) only (CSB, 2020). The main reason behind this low production is lack of popularity when compared to mulberry silkworm and production of poor-quality eggs by farmers in private grainages without proper knowledge. Production of good quality eggs (Disease Free Layings) and high fecundity rate are influenced by ovipositional substrates and mating duration. Hence, present study was aimed to find the impact of mating durations and ovipositional substrates on fecundity and egg hatchability.

Methodology

Rearing of eri silkworm

Eggs of eri silkworm were procured from Eri Silkworm Seed Production Centre, Central Sericulture Germplasm Resource Centre, Hosur, Tamil Nadu. The worms were reared using leaves of castor. First and second instar larvae were fed two times a day and third, fourth and fifth instar larvae were fed thrice. Cocoon harvest was done five days after spinning. After harvesting the cocoons were cut opened and healthy pupae were collected for experiments

Effect of Different Mating Durations on Fecundity and Egg Hatchability

Collected healthy pupae were placed in cardboard box for adult emergence. After emergence, moths were allowed to mate for various mating durations *viz.*, one hour, two hours, three hours, four hours, five hours, and six hours on *kada* cloth. Naturally decoupling pairs were treated as control. Each treatment was replicated thrice, and each replication consisted of three pairs of eri moth (Subramanian *et al.* 2012). After the respective mating duration was over, the male moths were separated gently without damaging their genital organ. Each mated female eri moth from respective replications were kept separately in cardboard boxes for egg laying. Fecundity was measured and the DFLs were maintained till fifteen days in the same cardboard boxes for calculating per cent hatchability.

$$\text{Per cent Hatchability} = \frac{\text{No of Normal Eggs} - \text{No of Unhatched Eggs}}{\text{No of Normal Eggs}} \times 100$$

Effect of different Ovipositional substrates on Fecundity and Egg Hatchability

Seven treatments *viz.*, *Kharikas* (sticks) of Castor, Mulberry, Jack fruit tied vertically along a rope, Plastic tray, Cardboard box, Polythene bags and *Kada* cloth lined container were evaluated for their suitability as ovipositional substrates. All the treatments were replicated thrice and each replication consisted of three mated females. Naturally decoupled female moths were collected after mating and allowed to lay eggs in respective ovipositional substrate. Fecundity and per cent hatchability was calculated as described above.

Results

The results revealed that maximum DFLs were recorded in the control (Natural decopulation: 353 eggs with 98 % hatchability) followed by the treatment, mating duration of six hours (332 eggs with 96 % hatchability). Poor egg laying and egg hatchability was noticed in the treatment mating duration of one hour (151 eggs with 41 % hatchability) (Table. 1). Correlation coefficients between mating duration, fecundity and per cent egg hatchability are 0.992 and 0.971 respectively, both showing strong positive correlation. The studies on the ovipositional substrate's impact on fecundity and egg hatchability revealed that *kada* cloth recorded the best results (344 eggs with 96 % hatchability) whereas polythene cover recorded poor fecundity (203 eggs) and Jack fruit kharika recorded poor hatchability (90 %) (Table. 2).

Table. 1 Effect of different mating durations on fecundity and egg hatchability

Mating durations	Fecundity*	Egg hatchability# (%)
1 hr	151 (12.30)^{g}	41 (38.93)^{g}
2 hrs	194 (13.93)^{f}	48 (42.60)^{f}
3 hrs	241 (15.52)^{e}	66 (53.13)^{e}
4 hrs	253 (15.91)^{d}	71 (58.50)^{d}
5 hrs	292 (17.09)^{c}	92 (71.57)^{c}
6 hrs	332 (18.23)^{b}	96 (76.31)^{b}
Control	353 (18.80)^{a}	98 (80.12)^{a}
C.D = 0.05	1.920	5.556
SE(d)	0.887	2.545

Table. 2 Effect of different ovipositional substrates on fecundity and egg hatchability

Ovipositional substrates	Fecundity*	Egg hatchability# (%)
Castor kharika	325 (18.04)^{a}	96 (76.00)^{ab}
Mulberry kharika	298 (17.27)^{d}	92 (73.78)^{b}

Jack fruit kharika	308(17.56)[c]	90 (70.79)[c]
Cardboard box	319(17.86)[b]	96 (78.25)[a]
Kada cloth	344(18.55)[a]	96 (78.74)[a]
Polythene cover	203(14.27)[e]	93 (74.34)[b]
Plastic tray	317(17.80)[bc]	95 (78.30)[a]
C.D = 0.05	0.456	2.938
SE(d)	0.223	1.17

Conclusion

The Present findings revealed that a minimum of 6 hours of mating duration is needed for the eri moth to attain its full fecundity potential and best egg hatchability. Further, the kada cloth is found to be the best ovipositional substrate.

References

CSB, 2020. Central silk board. Functioning of central silk board and performance of Indian Silk Industry. Pp: 21.

Subramanian K., Sakthivel N. and Qadri SMH. 2012. Effect of Cocoon Characters, Copulation and Oviposition Devices on the Grainage Performance of *Samia ricini* Donovan. International Journal of Life Science Biotechnology and pharmacology.

ICSCI 2022/T4/04

Social engineering activity on rodent pest management as farmers' participatory adaptive research

B. Anusha[1], N. Srinivasa Rao[2] and ADVSLP Anand Kumar[2]
[1]*Scientist (Entomology), All India Network Project on Vertebrate Pest Management, ANGRAU*
[2]*Regional Agricultural Research Station, Maruteru – 534 122, West Godavari dt, Andhra Pradesh, India.*
Email: b.anusha@angrau.ac.in

Introduction

Rice is the staple crop for most Asian countries and rodents are a major pest in both lowlands irrigated and upland rainfed rice cropping systems. The pest rodents cause 5–10% losses to various production systems such as agriculture, horticulture, forestry and stored food grains (Jain and Tripathi, 2000). The lesser bandicoot rat, *Bandicota bengalensis* is the most predominant rodent pest species in India and is well distributed in crop fields and residential areas all over the country, apart from the extremely hot arid regions and islands (Chakraborty, 1992). Although effective options for their management are available in India, rodents continue to be a serious threat to food and health security. Among all the available rodent control practices, use of rodenticides is the most common and expedient method (Makundi *et al.*, 2005). One of the most important constraints is the lack of community participation in rodent management actions. Most farmers show a general neglect towards the problem due to poor awareness, small land holdings, poor education and low economic status. Often, failures of rodent control activities are due to adoption of the wrong methods of bait preparation, and application also discourages the farmers. Rodent management can be done effectively on community basis by working all the farmers together (Morin *et al*., 2003). Social engineering activity on rodent control initiated by the All India Network Project on Rodent Control yielded over 60 % success in the adopted villages (Mathur, 1992).

Methodology

Three villages were selected under the guidance of Department of Agriculture/KVK's/DATTA Centers. In 1st village, knowledge was provided and rodent control campaign was organized on community basis. In 2nd village, only knowledge was provided and in 3rd village where no knowledge was provided and no campaign was conducted selected as control village. Damage assessment was made before and after organizing rodent control campaign

1. By tiller damage i.e., from each field 10 samples (10 x 1 sq. mt) on No. of healthy/undamaged tillers and No. of damaged hills.
   Per cent rodent damage incidence (P.D.I.) was calculated by using the formula
   P.D.I. = A/ (A+B) x 100
   Where, A=Total number of damaged tillers, B= Total number of healthy/undamaged tillers
2. By burrow count i.e., No. of live burrows before and after treatment.

Per cent rodent control success was calculated by using the formula.

(A-B)

% Rodent control success = **------**X 100

A= Per cent tiller damage / No. of burrows before and after campaign

B= Per cent tiller damage / No. of burrows before and after campaign

Results

During 2020-21, Mass Rodent control campaign on community basis was organized in the adopted village Goteru in paddy fields during Tillering stage of the crop where knowledge was provided and campaign was also organized on community basis with complete technical support from the project. The pre-treatment live burrow counts were 16.5 and 14.5 per hectare of paddy in Goteru and Iragavaram villages, respectively. These burrows were reduced to 4.3 and 6.42 in respective villages after conducting the campaign. The tiller damage was also showed similar trend in both villages. The per cent rodent control success of 74.24% in terms of live burrows and 77.76% in terms of tiller damage was achieved in social engineering village (Goteru). In another village (Iragavaram) where only knowledge was provided per cent rodent control success of 55.60%was achieved in respect of LBC/ha and 25.89 per cent in terms of tiller damage.

Table 2b. Social Engineering on Rodent Control through PAR in Rice (*2020-21)*

Particulars			
Name of the village	**Goteru**	**Iragavaram**	**Vadali**
Area in hectares	120	110	110
Treated area in hectares	25.0	-	-
Mean no. of live burrows / ha			
a) Pre treatment	16.5	14.5	17.3
b) Post treatment	4.3	6.42	8.14
Per cent Rodent control success	**74.24**	**55.60**	-
Percent tiller damage/ha			
a) Pre treatment	6.5	8.4	9.8
b) Post treatment	1.5	6.2	12.4
Per cent Rodent control success	**77.76**	**25.89**	**-**

Conclusion

For successful planning of the community programme in rodent control, a thorough education of the farmers along with the distribution of rodenticide baits at regular intervals is a prerequisite. Training programmes and demonstrations may be organized at regular intervals to provide accurate and timely knowledge about the use of rodenticides.

References

Chakraborty S. 1992. The Indian 'mole-rat'or lesser bandicoot rat, *Bandicota bengalensis* (Gray). Rodents in Indian agriculture, 1:173-192.

Jain AP and Tripathi RS. 2000. An integrated approach to rodent pest management. IPM System in Agriculture, 7:.275-307.

Makundi RH, Bekele A, Leirs H, Massawe AW, Rwamugira W and Mulungu LS. 2005. Farmer's perceptions or rodents as crop pests: knowledge, attitudes and practices in rodent pest management in Tanzania and Ethiopia. Belgian Journal of Zoology 135 (Suppl.): 153–157.

Morin SR, Palis FG, Chien HV, Chi TN, Magsumbol M and Papas A 2003. A sociological perspective to the community based trap barrier system. In: Singleton GR, Hinds LA, Krebs CJ, Spratt DM, editors.Rats, mice and people: rodent biology and management. Canberra: Australian Centre for International Agricultural Research. 380-388.

Mathur, R.P., 1992. Social engineering activity on rodent control. Rodents in Indian Agriculture, 1:605-64.

ICSCI 2022/T4/05

Marker trait association for grain quality, yield and yield attributes in rice

Harendra Verma[1], Lamalakshmi Devi[2], Kaberi Mahanta[3], Dipjyoti Rajkhowa[1]
[1]*ICAR Research Complex for NEH Region, Nagaland Centre, Medziphema-797106, Nagaland, India*
Email: harendraicar@gmail.com

Introduction

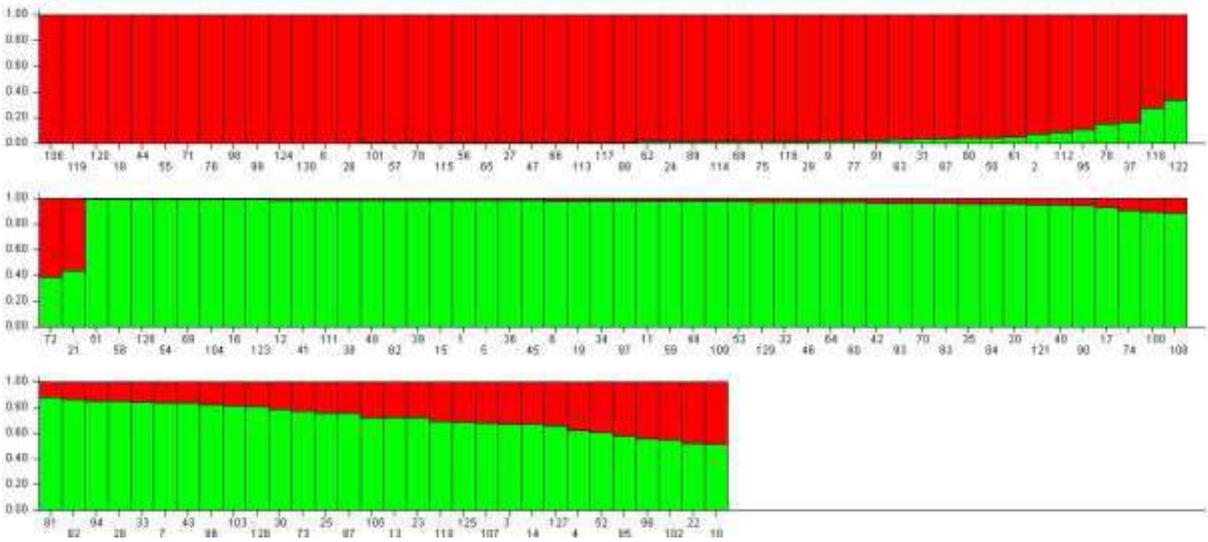
Rice plays a pivotal role in the Indian economy and is the mainstay in the total income of the major rural communities in India. The global population is anticipated to reach 10 billion by 2050 (FAO, 2022) and the incidence of various stresses compel an increase in rice grain yield by 70 percent to meet the prevailing food needs of the growing population. Rise in living standards and awareness about the importance of nutritional value increased the demand for better quality rice. That necessitates the plant breeders to develop rice varieties with high yields as well as improved grain quality rice to overcome this bottleneck (Hori and Sun, 2022). The grain quality preference varied across countries and within the country from one region to another region. The historical, geographical and socio-cultural factors play a significant role in deciding the preferences of rice grain quality (Custodio *et al*., 2019). Thus, there is a need to study grain quality parameters to meet the various location-specific preferred quality rice demands in the market. North East India region is gifted with a rich diversity of rice landraces that needs to be explored. However, studies on grain quality and yield attributes are highly limited in rice of the North East Hill region. Therefore, these landraces need to be conserved and exploited for selecting appropriate landraces among the local cultivars based on genetic structure and diversity for the development of improved rice varieties (Tarang *et al*., 2020). The grain quality, yield and yield contributing traits are highly influenced by environmental factors (Berdugo-Cely *et al*., 2017). Association mapping helps in dissecting important agronomic traits for identifying alleles or QTLs controlling key traits. It searches for functional variation in a much broader germplasm context.

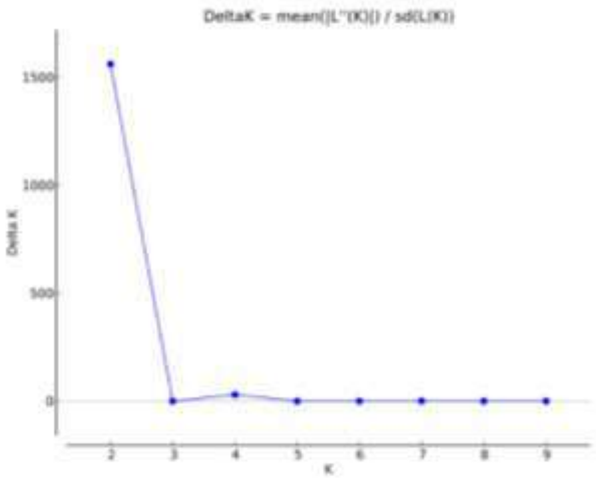
Methodology

To identify the genetic structure of the given population and assign individuals to populations, the software STRUCTURE version 2.3.4 was used (Pritchard *et al.*, 2000). To derive the optimal number of groups (K), STRUCTURE was run with K varying from 1 to 10, with five runs for each K value. To determine the true value of K, ad hoc statistic ΔK was followed. Parameters were set to 3,00,000 burn-in periods and 5,00,000 Markov Chain Monte Carlo (MCMC) replications after burn-in with an admixture and allele frequencies correlated model. The method described by Evano *et al.* (2005) was used to estimate the most probable K value for the analyzed data, using the web tool Structure Harvester ver. 0.6 application (Earl and Vonholdt, 2012). Association analysis between marker loci and phenotypic traits was performed in all trials using TASSEL (Trait Analysis by association, Evolution and Linkage) software version 4.0 (Bradbury *et al*., 2007) after accounting for the gross level population structure (Q) in GLM analysis. The Q+K (kinship) model was used in the MLM analysis with the P3D algorithm (Zhang *et al.*, 2010). It has been reported that the Q + K model reduces the false positive associations (Rincent *et al.*, 2014). Hence, the results of MLM which uses the Q+K model are reported in the study. The marker P value (0.001) was used to determine the significance of each marker-trait association.

Results

The population structure of the 130 germplasm lines was analysed by Bayesian clustering model based approach. The model based simulation estimated the maximum ΔK value at K=2 which is an indication that the whole population can be grouped into two subpopulations (Fig 1). These subpopulations were assigned P1 and P2 (Fig 1). The genotypes having probability of ≥ 80 % were considered as pure and assigned to corresponding subgroups while the others as admixtures. P1 subpopulation have Deihou, Mapok Chi, Chachak Hou and Epyo Tsuk Longsa landraces with long panicles, whereas P2 consisting of Yunghah Hakla and Aongsho are short duration varieties. Population structure may lead to a spurious association between marker and traits. Therefore, structure analysis was carried out to avoid spurious associations.





Marker trait association analysis using MLM model (mixed linear model) based on Q matrix generated in STRUCTURE and kinship matrix of TASSEL revealed a total of six associations at P < 0.0001 for grain quality and yield attributing traits with R^2 ranging from 3.55 to 11.91% under upland situation without type 1 error (Table 1). The marker RM240 located on chromosome 2 was associated with gel consistency explaining 11.91 % of variation, whereas marker RM112 located on same chromosome is associated with 3.17% of variation.

Table 1. Marker-trait association

Trait	Trait	Marker Name	Chromo some	F value	P value	R2	markerR2 (%)
Days to flowering	DF	RM101	12	17.4665	5.48E-05	0.0472	4.720106
Decorticated grain width	DGW	RM515	8	5.2489	6.22E-04	0.0355	3.552735
Days to maturity	DM	RM105	9	13.0216	4.45E-04	0.0398	3.980196
Gel consistency	GC	RM240	2	7.6777	1.51E-05	0.1192	11.91805
Gelatinization temperature	GT	RM112	2	13.0405	4.41E-04	0.0372	3.715737
Plant height	PH	RM1256	3	4.7851	2.09E-04	0.0958	9.576851

Conclusion

The world population is increasing at alarming rate and demand for better quality rice is coming up, this issue can be overcome by identification of genes associated with grain quality and yield contributing traits through association mapping analysis. In the present study, six significant marker-trait associations were detected for grain quality and yield attributing traits. These markers can be used in marker assisted selection for improvement of grain quality and yield attributing traits in rice.

References

Berdugo-Cely, J., Valbuena, R. I., Sanchez-Bentancourt, E., Barrero, L. S. & Yockteng, R. (2017). Genetic diversity and association mapping in the Colombian Central Collection of Solanum tuberosum L. Andigenum group using SNPs markers. *PLoS ONE*, 12(3), e0173039.

Bradbury, P. J., Zhang, Z., Kroon, D. E., Casstevens, T. M., Ramdoss, Y. & Buckler, E. S. (2007). TASSEL: Software for association mapping of complex traits in diverse samples. Bioinformatics,23, 2633–2635.

Custodio, M. C., Cueves, R. P., Ynion, J., Laborte, A. G., Velasco, M. L. & Demont, D. (2019). Rice quality: How is it defined by consumers, industry, food scientists, and geneticists? Trends in Food Science & Technology, 92, 122-137.

Earl, D. A. & VonHoldt, B. M. (2012). Structure Harvester: A website and program for visualizing STRUCTURE output and implementing the Evanno method. Conserv Genet Resour. 4, 359–361.

Evanno, G., Regnaut, S. & Goudet, J. (2005). Detecting the number of clusters of individuals using the software STRUCTURE: a simulation study. Mol. Ecol. 14(8), 2611–2620.

FAO. 2022. Food Outlook – Biannual Report on Global Food Markets. Rome. https://doi.org/10.4060/cb9427e

Hori& Sun. (2022). Rice Grain Size and Quality. Rice, 15, 33.

Pritchard, J., Stephens, M. & Donnelly, P. (2000). Inference of population structure using multilocus genotype data. Genetics 155, 945–959.

Rincent, R., Moreau, L., Monod, H., Kuhn, E., Melchinger, A., Malvar, R. A., MorenoGonzalez, J., Nicolas, S., Madur, D., Combes, V., Dumas, F., Altmann, T., Brunel, D., Ouzunova, M., Flament, P., Dubreuil, P., Charcosset, A., & MaryHuard, T. (2014). Recovering power in association mapping panels with variable levels of linkage disequilibrium. Genetics, 197, 375–387.

Tarang, Alireza, Kordrostami, M., Kumleh, S., Chaleshtori, M. H., Saravani, M, G. & Sattari, M. (2020). Study of genetic diversity in rice (*Oryza sativa* L.) cultivars of Central and Western Asia using microsatellite markers tightly linked to important quality and yield-related traits. *Genetic Resources and Crop Evolution*, 67, 1537-1550.

Zhang, Z., Ersoz, E., Lai, C. Q., Todhunter, R. J., Tiwari, H. K., Gore, M. A., Bradbury, J., Yu, J., Arnett, D. K., Ordovas, J. M.,& Buckler, E. (2010). Mixed linear model approach adapted for genome-wide association studies. Nature Genetics, 42, 355–360.

ICSCI 2022/T4/06

Effect of industrial wastes, organics and fertilizers on soil health, productivity and carbon sequestration in rice based cropping system in vertisol

Sriramachandrasekharan, M.V., Abdalla Ahmed Mohamed Adda, P. Senthilvalvan and R. Manivannan
Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Annamalainagar- 608002, Tamil Nadu, India
E-mail: ram_uthrat @yahoo.com

Introduction

Proper protection of the soil health is essential to make certain proper physical, chemical and biological processes for supporting higher crop productivity. Rice-based cropping systems form an integral part of agriculture in India. Integrated nutrient management (INM) still play an essential role in the sustainable crop production of rice-based cropping system. Soil fertility restorer inputs like compost, city wastes, agro industrial wastes, fly ash, crop residues and industrial wastes have to be recycled in soil through INM approach (Kumar *et al*., 2018).

Methodology

The field experiments were conducted in farmer's holding at Pinnalure village, Cuddalore district during 2018-19 with the following treatment structure. Factor A- two levels of LFA (0 and10 tha^{-1}) and Factor B- Ten treatments involving; T_1 - Absolute Control, T_2 - 100% NPK, T_3 - 50% N + 100% PK + FYM @12.5 t ha^{-1}, T_4 - 50% N + 100% PK + Vermicompost @ 5 t ha^{-1}, T_{5} - 50% N + 100% PK + green manure 6.25 t ha^{-1}, T_6 - 50% N + 100% PK + sugarcane press mud @10 t ha^{-1}, T_7-100% N PK + FYM @12.5 t ha^{-1}, T_8- 100% NPK + Vermicompost @ 5 t ha^{-1}, T_9- 100% NPK + green manure 6.25 t ha^{-1}, T_{10}-100% NPK + sugarcane press mud @10 t ha^{-1}.The design is factorial experiment in RBD with two replications. The total number of treatment combinations were 10 x 2 = 20. The experiment was conducted in cropping sequence rice- rice- pulse. The *kharif* rice crop variety was ASD 16, *rabi* rice crop variety BPT5204 and rice fallow pulses (black gram – ADT 3). The calculated quantity of organics and fly ash for a plot size of 5 x 4 m^2 was applied two weeks before transplanting. The soil samples were analysed for major nutrients and organic carbon. The rice yield and pulse yield were recorded at harvest. The carbon sequestration was worked for the cropping system.

Results

Direct and residual effect of lignite fly ash and organics applied with chemical fertilizers brought in significant changes in grain and straw yield of ASD 16(kharif) and BPT5204 (rabi) over control.(table1) .The maximum grain (6922 kg ha^{-1}) and straw yield of ASD16 (8440 kg ha^{-1}) was realized in plots which was applied with 100 % NPK + SPM @10 t ha^{-1} in the presence of LFA. The per cent increase in grain yield ranged from (4.7 to 13.9) and straw yield ranged from (6.1 to 18.9) due to combination of organics and fertilizer over fertilizer alone. The highest grain yield (4871 kg ha^{-1}) and straw yield of BPT 5204 (7520 kg ha^{-1}) was recorded with the application of 100% NPK + SPM + LFA. The extent of improvement due to organics plus fertilizer over fertilizer alone for grain yield ranged from (2.6 to 27.5%) and for straw yield ranged from (4.6 to 28. 4%).Grain and haulm yield of black gram were remarkably influenced by the residual action of lignite fly ash, organics and fertilizers over control. The highest grain yield (607 kg ha^{-1}) and haulm yield (3102 kg ha^{-1}) in black gram was recorded with 100% NPK + SPM + LFA. Supply of nutrients but also the better utilization of nutrients made available on account of the complementary effect of organic manures and FA, favourable physical conditions, and electro-chemical properties under submerged conditions would have paved the way for realizing the full potentials of rice (Kalaivanan and Hattab , 2016) . Direct and residual effect of LFA, organics and industrial wastes caused a lasting influence on improving soil organic carbon, available nitrogen, phosphorus and potassium in soil compared to control. The higher nutrient status was noticed with 100% NPK + SPM+ LFA. This could be attributed to the long-lasting effect of organics and its complementary effects on fertilizer and fly ash and also its role to modifying the soil environment, which improved the availability of nutrients and resulted in improvement of the soil fertility (Lakum *et al.*, 2020). Carbon sequestration rate in rice-based cropping system was strongly elevated by the action of lignite fly ash, organics and chemical fertilizers compared to control. The soil carbon sequestration rate ranged 0.84 to 1.92 t ha^{-1} at the end of cropping system due to different treatments. Higher carbon sequestration due to the addition of organics and fertilizer might be attributed to better crop growth with concomitant higher root biomass generated and higher return of left-over surface plant residues, besides high clay content in soil (Lim *et al.*, 2017).

Table 1. Effect of industrial wastes, organics and fertilizer on yield of rice-rice-black gram and carbon sequestration

Treatments	**Rice (kharif) (kg ha^{-1})**		**Rice (rabi) (kg ha^{-1})**		**Black gram(kg ha^{-1})**		**Carbon sequestration (t ha^{-1})**
	Grain	**Straw**	**Grain**	**Straw**	**Seed**	**Haulm**	
LFA (t ha^{-1})							
0	5865	6911	3315	5277	355	1757	1.25
10	6198	7295	3835	5785	411	2066	1.53
CD(p=0.05)	171	205	152	252	8	60	.06
Treatments							
T_1	3557	4429	2437	3682	192	953	-
T_2	5842	6757	3275	5026	286	1433	0.77
T_3	6329	7548	3830	5910	448	2228	1.74
T_4	6138	6921	3526	5437	343	1711	1.09
T_5	6090	6883	3350	5184	318	1581	0.94
T_6	6418	7903	3871	6004	466	2325	1.92
T_7	6628	7994	4001	6175	475	2371	2.22
T_8	6275	7211	3712	5766	424	2115	1.47
T_9	6158	7124	3595	5473	349	1754	1.21
T_{10}	6882	8256	4159	6650	530	2646	2.55
CD(p=0.05)	383	458	340	562	18	135	0.14

Table 2 Effect of industrial wastes, organics and fertilizer on soil health rice-rice-black gram

Treatments	Rice (kharif)				Rice (Rabi)				Black gram			
	N	P	K	OC	N	P	K	O C	N	P	K	O C
LFA (t ha^{-1})												
0	258.8	13.0	278.8	7.4	234.3	11.1	312.1	5.99	270.4	7.28	286.6	3.87
10	287.5	16.2	313.3	7.9	253.8	12.7	323.3	6.87	280.7	10.1	303.8	4.16
CD(p=0.05)	6.2	0.5	8.0	0.14	9.1	0.2	6.0	0.27	4.8	0.9	9.7	0.13
Treatments												
T_1	212.0	7.5	230.4	6.5	172.6	4.5	260.5	3.40	211.4	5.17	223.7	2.65
T_2	246.5	12.3	258.6	7.3	233.7	10.1	305.1	6.03	261.5	7.68	280.0	3.68
T_3	279.7	16.1	305.8	8.0	254.9	13.0	324.7	6.48	285.9	9.28	308.6	4.25
sT_4	259.0	13.1	293.5	7.4	242.6	10.9	318.7	6.45	276.9	8.24	296.7	4.00
T_5	257.3	12.8	283.7	7.4	240.1	10.5	309.7	6.18	271.0	8.03	289.5	3.88
T_6	304.0	17.5	316.9	8.2	259.4	13.5	331.2	7.30	288.8	9.73	310.2	4.30
T_7	308.2	18.2	320.7	8.2	265.8	15.2	338.2	7.70	293.1	9.95	315.6	4.40
T_8	275.5	15.0	303.4	7.7	251.7	12.4	323.9	6.33	287.8	8.88	307.0	4.20
T_9	265.1	15.0	300.5	7.7	245.9	11.6	320.6	6.50	281.8	8.69	299.1	4.13
T_{10}	321.2	18.6	346.8	8.5	273.6	17.7	344.7	7.93	297.7	11.0	321.4	4.65
CD(p=0.05)	13.8	1.2	17.8	0.30	20.3	0.5	13.4	0.61	10.7	2.1	21.8	0.30

Conclusion

In rice-rice-pulse cropping system grown in vertisol, adoption of 100% NPK + SPM + LFA favoured highest yield, soil health and carbon built up

References

Kalaivanan, D. and O. Hattab. 2016. Recycling of sugarcane industries byproducts for preparation of enriched pressmud compost and its influence on growth and yield of rice (*Oryza sativa* L.). Int. J. Rec. Org. Waste Agri., 5(3): 263-272

Kumar, K., C.J. Sridhara and K.M. Nandini. 2018. Effect of integrated use of organic and inorganic fertilizers on soil fertility and uptake of nutrients in aerobic rice (*Oryza sativa* L.). Int. J. Chem. Stud., 6(4): 417-421.

Lakum, Y.C., H.K. Patel, G.G. Patel, P.D. Patel and Patel, D.K. 2020. Residual effect of manure and fertilizer on growth, yield of chickpea and soil nutrient status under maize - chickpea cropping system. Int. J. Curr. Microbiol. App. Sci., 9(4): 2940-2945.

ICSCI 2022/T4/09

Rice Crop area estimation using SARex model in Nizamabad district

T.L. Neelima, S. Pazhanivelan, K. Avil Kumar, Anand Vetriwar and R. Jagdeeshwar
Water Technology Centre, PJTSAU, Rajendranagar, Hyderabad-500030
Water Technology Centre, TNAU, Coimbatore
Email: t_l_neelima@yahoo.co.in

Introduction

Rice is grown in both *kharif* and *rabi* seasons and predominantly in irrigated agro-ecosystem of India. Accurate and up-to-date assessment of the spatial distribution of cultivated area under this crop is a key information requirement for all stakeholders. A methodology for timely assessment with high precision of rice crop using microwave satellite data is yet not operational in India. In this scenario, Synthetic Aperture Radar (SAR) is found to be a reliable form of gathering crop information, especially during monsoon season where obtaining optical data is a challenging task during the crop growth period (Jain *et al*, 2019).

Methodology

The study area is Nizamabad district which is located in the North-Western region in Telangana state, India. it is tenth largest district with a total geographical area of 4,288 km^2. It is located at 18^{0}40'N Latitude and 78^0 06'E Longitude. The climate in the district is tropical and is characterized by hot summer and dry conditions except during the south-west monsoon season. The Godavari river enters Telangana from Nizamabad district at Kandhakurthi. The district has 29 mandals and 452 villages. with predominantly red and black soils. It comes under Northern Telangana Zone. The sentinel-1A and 1B satellite data was collected during the crop growth period at 12 days' interval from June to November month (1 FN June, July, August, September, October, 1 FN November). These time series datasets with both VV and VH polarizations were downloaded for the required time period and region of interest. The downloaded images were subjected to several pre-processing techniques in order to make it an analysis-ready data and the standard pre-processing workflow is depicted in the below figure 1.

Results

During crop growth period, several field visits were made matching with the dates of satellite data acquisition during *kharif*, 2021 in Nizamabad district of Telangana. Further, the ground truth samples on rice and other competing crops (approximately 200 reference points) were collected. The important stages (puddling, transplanting, vegetative and flowering and harvest) of the crop were monitored.

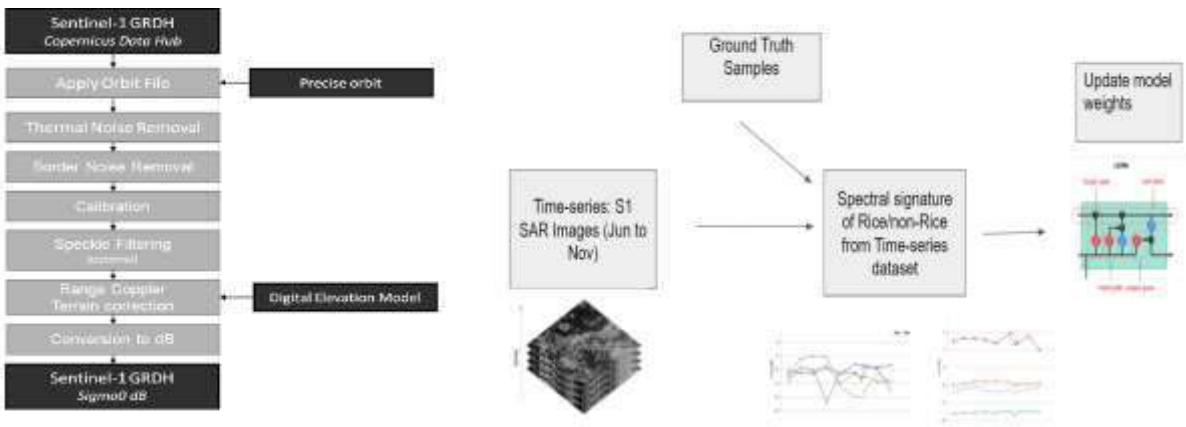


Fig 1: Pre-processing workflow of SAR images and overall workflow of the model training

The deep learning algorithm LSTM (Long-Short Term Memory) was performed to train the model with the provided sample points (Rice - 749 and Non rice – 1008) during *kharif*, 2021 in the **SARex cloud computing software**. This model was used to generate the required crop map. LSTM is a more powerful and suitable deep learning paradigm for processing sequence data for predictions. It is a special type of Recurrent Neural Networks (RNNs) that can learn long-term dependencies. Hence, LSTM captured the crop growth dynamics by analysing the sequence of images**.** Rice area was classified with 92.8% accuracy during *kharif*, 2021 and deviation from the DOA statistics was found to be - 6.62%. The same model when used for rice mapping during *kharif*, 2022, it was classified with 95% accuracy and deviated 3% from the DOA statistics.

Conclusion

SARex software using the LSTM algorithm can classify rice pixels within the time series dataset given for a particular area of interest. Rice area was estimated with 98% accuracy during *kharif*, 2022 with the model trained during *kharif*, 2021 and it showed a deviation of only 3% from the DOA statistics. The model can further be refined to attain utmost precision and upscaled to map the rice area for entire Telangana. It is highly useful for stakeholders to make tactical and strategic decisions.

References

Jain, Varunika Saxena, Suvigye Dubey, Sunil Choudhary, Karan Ray, Shibendu Neetu. (2019). Rice (kharif) production estimation using sar data of different satellites and yield models: a comparative analysis of the estimates generated under fasal project. ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. XLII-3/W6. 99-107. 10.5194/isprs-archives-XLII-3-W6-99-2019.

ICSCI 2022/T4/10

Performance of tractor drawn seed drill for direct seeding in paddy

S. Sreenivasulu[1], V. Divya, T. Ramu Kumar and B. Nirmala
Krishi Vigyan Kendra, Tirupati, A.P., India,
Senior Scientist, ICAR-Indian Institute of Rice Research, Hyderabad, India
Email: rasskvk@gmail.com

Introduction

Rice (*Oryza sativa* L.) is the most important and widely consumed staple food among cereals over half of the world's human population. India is the second largest producer after China accounting for 24% of the production. Rice is cultivated in India in an area of 44m.ha with a production of 121.46 million tonnes and with an average yield of 2760kg/ha. In Andhra Pradesh it is cultivated in 15.26 lakh ha in kharif. Paddy is the 2nd major crop followed by groundnut in Chittoor district, growing in 19155 ha during *kharif* with an average productivity of 3500 kg/ha. Even though the productivity in the district is more than national average there is still scope to improve the yields in rice by adopting of suitable agronomic practices. Manual transplanting is the most common method of crop establishment in rice growing areas in Chittoor district. Though it is effective method it involves nursery bed preparation, raising of nursery, care of seedlings in the nursery, pulling and transport to the main field and transplanting. All these operations require more number of labour and time and hence increase the cost of cultivation. Also often results in delay in transplanting because of shortage of labour. Transplanting takes about 250-300 man hours per ha which is roughly 25percent of total labour requirement of the crop. Hence less expensive, farmer friendly and labour saving method of crop establishment is needed. Direct seeding using tractor drawn seed drill is an alternative method as it saves labour and other resources. It offers faster and easier sowing, reduces labour requirement, require less water, early crop maturity by 7 to 10 days and also higher yields. Hence demonstrations were conducted to know the performance tractor drawn seed drill for paddy under direct seeding method in collaboration with ICAR - Indian Institute of Rice Research (IIRR), Hyderabad.

Methodology

The study was conducted in Sirunambuduru village, Satyavedu mandal, Chittoor district, Andhra Pradesh to know the performance of tractor drawn seed drill for direct seeding method in paddy. Demonstrations were organized in 50 farmers' fields during late Kharif 2021. The soil was sandy loam in texture, normal in soil reaction (6.8), normal in electrical conductivity (0.32), low in Organic Carbon (0.38), low in available Nitrogen (195kg/ha), high in available Phosphorus (135kg/ha) and medium in available Potassium (338kg/ha). The variety MTU-1224 was used both in the demonstration and farmers practice. Sowing was taken up using 11 tyned tractor drawn seed drill and seed (75kg/ha) was placed at a distance of 22.5cm apart during 1st fortnight of September. Pre emergence application of Pendimethalin @ 1kg a.i. per ha was applied within 24-48hrs after sowing. Nitrogen at 100kg/ha was applied in three equal splits, 1/3 at the time of sowing, 1/3 at the time of tillering stage and remaining 1/3 at panicle initiation stage.

Total quantity of Phosphorus (45kg/ha) and Potassium (40kg/ha) and Zinc sulphate was applied @ 50kg/ha at the time of sowing. After germination the direct seeded rice fields were kept moist throughout and 5cm irrigation was applied at 10-15 days' interval and irrigation was withheld 10days before harvesting of the crop. In the case of farmers practice nursery was raised and the transplanting was taken up at 30 days after sowing and other existing practices being used by the farmers were followed.

Results

The results from the Table 1 clearly indicated that direct seeding with tractor drawn seed drill recorded significantly higher grain yield (7475kg/ha) when compared to manual transplanting (5875kg/ha). About 27.2% increase in yield was observed in direct seeded rice than farmers practice. It might be due to uniform germination of paddy seed without any gap using the seed drill and resulted in more number of productive tillers and lead to more yield. Tejeswara Rao et al (2020) also reported similar findings.

The observations from Table 1 that cost of cultivation was low in direct seeded rice than manual transplanting. An amount of Rs.7450/- per ha was saved by adopting direct seeding method in paddy using tractor drawn seed drill. It is mainly due to ease in operation without raising of nursery, puddling, pulling and transport of seedlings to main field for transplanting. Data also revealed that gross returns, net returns and BC ratio were more in direct seeded rice than manual transplanting. Additional net returns of Rs.26412/- per ha was recorded in direct seeded rice than manual transplanting method. It was due to more grain yield and low cost of cultivation in direct seeding method. Similar findings were reported by Bairwa et al (2019).

Table 1: Grain yield and economics of direct seeded rice using tractor drawn seed drill

Particulars	**Plant Height (cm)**	**No of productive tillers/hill**	**No of grains / panicle**	**Grain yield/ha**	**Cost of Cultivation (Rs/ha)**	**Gross Returns (Rs/ha)**	**Net Returns (Rs/ha)**	**B.C Ratio**	**'Z' Value**
Direct seeding using seed drill	112.9	21	272	7475	50663	123504	72841	2.43	7995** (grain yield)
Manual transplanting	112.6	16	202	5875	58113	97092	38979	1.67	

**Significance at 0.01 level of probability

Conclusion

Based on the findings of the study, it is concluded that direct seeding of paddy using tractor drawn seed drill is better as compared to conventional manual transplanting. The study showed that farmers realized 27.2% more yield, 14.7% less cost of cultivation and 86.8% more net returns per ha in direct seeding method using tractor drawn seed drill than manual transplanting method. Therefore, this technology is economically viable and could be adopted by the farmers in the district wherever it is feasible.

References

Bairwa, R.K., B.L. Dhaka, B.L. Nagar and Mahajani, K. 2019. On Farm Assessment of Direct Seeded Rice (DSR) Technology in Humid South-Eastern Plain of Rajasthan, India. Int.J.Curr.Microbiol.App.Sci. 8(07): 2492-2498.

Tejeswara Rao, K., D. Umamaheswara Rao, P. B. Pradeep Kumar and Chandrayudu, E. 2020. Resource Optimization in Rice through Direct Seeding with Ferti Cum Seed Drill. Int.J.Curr.Microbiol.App.Sci. 9(12): 1053-1058.

ICSCI 2022/T4/12

Robotics for Sustainable Agriculture

K.V. Lakshmi[1] and Natarajan Seenivasa[2]
[1]*Department of Vegetable Science, College of Horticulture, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University, Hyd-500030, Telangana, India*
[2] *Controller of Examinations, Sri Konda Laxman Telangana State Horticultural University, Telangana*
Email: chittitalli95@gmail.com

Introduction

Living in the 21st century, humans face some big problems like population growth, labour shortages and centuries of over-farming and environmental abuse which threaten food and agriculture sustainability. It might be the robots that save humanity. New technological developments related to robotics can offer opportunities to agriculture in developing countries. Agricultural robots or agrobots are defined as perceptive programmable autonomous machines that perform a variety of agricultural tasks without direct human intervention. The main objectives of creating an agrobot is; 1. To meet the current demands of farmers with a focus on commercial farming and intensive production, 2. Perform wide tasks on the farm from land preparation to harvesting without human interventions and 3. To create a new class of machines for sustainable agriculture that will increase broad-acre crop production and reduce environmental impact.

Methodology

Agricultural robots comprise a wide range of sizes and are designed for a variety of uses with different technologies. For an autonomous robot, new technologies like Wireless Sensor Networks and Internet of Things, efficient 3D path planning algorithms for mobile devices, energy resources, imaging data that are processed later are required. The selection of suitable sensors and data depends on the nature of their applications. The effectual design of an agribot consist of multiple components including manipulator used to assist the end-effector as well as gripper in the process of navigation in the field, gripper used for grasping or holding device in the harvesting process associated with the crops and the end-effector that is placed at the end or tail-point of the robotic arm in the agricultural robot, used and integrated for multiple agricultural tasks, purposes and operations including cutting, pushing, spraying, grasping and similar functions.

Results

An agrobot can perform a vast array of tasks. However, the first commercially available agrobots cover three main tasks: eliminating weeds, monitoring pests and diseases, and harvesting specialized crops (berries or vegetables). The uptake of these technologies at field level requires farmers to adapt their farming practices and capacity accordingly. Few agribots in assorted domains are vinobot, vinoculer, strawberry picking agrobot, casmobot slope mower, Fieldrobot-mobile agricultural robot, hortibot-a plant nursing robot, Lettucebot for thinning of lettuce and organic weed elimination, Japanese rice planting agribot, IBEX weed spraying robot, extreme terrain functioning agribot, farmbot, open source CNC farmingbot…etc.

Conclusion

These technologies are mainly targeted to support farmers those who struggle with the cost of inputs for general cropping operations. The savings in terms of both cost and time due to the precision in the use of inputs represent an entry point for commercial farmers. Studies on many aspects of robotics used to advance agriculture are at its fundamental stages. Hence there is necessity for research on efficient and precise.

References

Patil NU and S Tiwari. 2017. Effective design of an agribot for smart farming. International Journal of Computing and Business Research, 7(4).

Santos VS and J Kienzle. 2020. Agriculture 4.0 – Agricultural robotics and automated equipment for sustainable crop production. Integrated Crop Management,Vol. 24.

Theme V

SCI adoption and their Socio-economic Impacts including gender, labour and Institutional dynamics

ICSCI 2022/T5/01

Space-based observations for monitoring a multi-locational trial under the All India Coordinated Research Project on Rice

D.V.K. Nageswara Rao*, K. Surekha, L. Aruna and R.M. Sundaram
ICAR - Indian Institute of Rice Research, Hyderabad, Telangana – 500030, India
Email: DVKN.Rao@icar.gov.in

Introduction

Agricultural applications of remotely sensed data mainly include the assessment of crop health condition and mapping the distribution of agricultural crops in given area, for all practical purposes. During the course of time the launch of Sentinel series of satellites and making the data freely available along with software, SNAP (Sentinel Application Platform) with several processors gave unprecedented opportunities (Clerici *et al*., 2017) for use in agriculture. There are several indices derived from remotely sensed data for monitoring the crop growth and yield modelling and NDVI (normalised vegetation difference index) (Tucker, 1979) is one among such indices. All India Coordinated Research Programme (AICRP) on Rice is mandated for coordination of multi-locational testing to develop location specific varieties and technologies for various ecosystems. It is obvious that several factors including variability in soils cumulatively influence the crop performance in different test sites under multi-locational trials. It is not/less known about the application of remotely sensed data to monitor the trials under AICRP on Rice, which is technically possible, considering the resolution of satellite data and field dimensions. Hence, a temporal study was taken up to record the changes in NDVI during the period of cultivation to experience applied remote sensing in field monitoring under a multi-locational yield maximisation trial conducted by Soil Science Section as a post-event analysis.

Methodology

Triplicated yield maximisation trial with varieties, BPT 5204, ADT 46 and CO 50 with treatments; Farmer Fertiliser Practice (T1), recommended dose of fertiliser (T2) and software, Nutrient Expert based recommendations (T3) was conducted in Karaikal during *Kharif* 2019-20. The plot size under different treatments varied from 809 to 2023 m^2. The other details were given in Table 1. Field upkeep was done according to the package of practices. Grain yield was measured from a 15 m^2 grid plot and extrapolated to a hectare. GPS readings from these grids were recorded and created point vectors. Six cloud free temporal Sentinel -2 L2A (bottom of atmosphere) data product were downloaded (https://scihub.copernicus.eu) covering the period between sowing/transplanting to harvesting and created NDVI images using SNAP (https://step.esa.int). The values of NDVI were extracted to the point vectors created earlier for analysis.

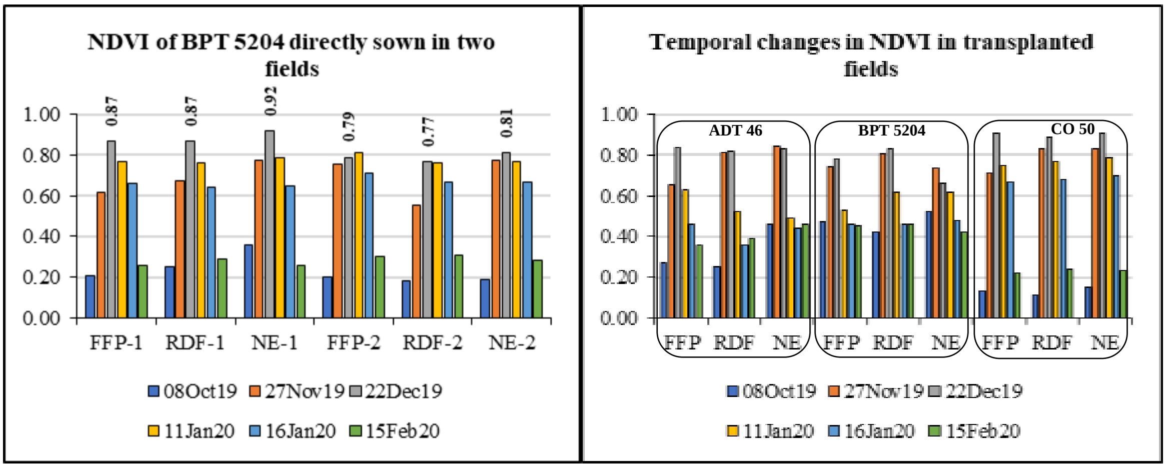
Table 1. Experimental details

Site No.	Treatment	Type	Variety	Duration-d	DOS	DOP	DOH	Initial soil properties						Applied fertilisers		
								pH	EC dS m^{-1}	OC (%)	N	P_2O_5	K_2O	N	P_2O_5	K_2O
											kg ha^{-1}			kg ha^{-1}		
1	FFP	Direct sowing	BPT5204	150	02-10-19		10-02-20	6.4	0.23	0.98	229	62	563	94	58	37
1	RFD													150	50	50
1	NE													141	39	77
2	FFP				02-10-19			7.7	0.39	0.70	169	37	491	71	58	37
2	RFD													150	50	50
2	NE													159	49	77
3	FFP	Transplanted	ADT 46	135	08-08-19	02-09-19	08-01-20	7.7	1.07	0.93	154	45	327	110	58	60
3	RFD													150	50	50
3	NE													159	39	72
4	FFP		BPT5204	150	01-09-19	01-10-19	18-01-20	7.2	0.42	0.90	167	37	270	107	58	60
4	RFD													150	50	50
4	NE													159	49	72
5	FFP		CO 50	135	20-09-19	20-10-19	13-02-20	6.9	0.18	0.95	166	20	270	107	58	60
5	RFD													150	50	50
5	NE													159	49	72

DOS = Date of sowing; DOP = Date of Planting; DOH = Date of harvesting

Results

Crop production factors (Table 1) including soil properties, varieties, farmer fertiliser practices, NE software based and RDF dosage and cultural practices, varied in first instance. Values of NDVI, a net reflectance of plant characteristics, production factors and management, were also different even in directly seeded BPT 5204 sown on same date, among treatments and varieties transplanted (Fig. 1a and 1b). Two fields sown directly with BPT 5204 on same date registered differences in NDVI values even with RDF (a blanket recommendation) indicating differences in management practices and/or inherent differences in soils or combination of both.



(a) Directly sown fields **(b) Transplanted fields**

Figure 1. NDVI obtained from experimental fields

Among transplanted ones because of differences in dates of transplantation and duration of stay in nursery, there were differences in NDVI values on all dates except in 8th October 2019 where the transplantation of CO 50 was not done yet. NDVI registered on 22nd December 2019 in all plots was the maximum except in plots with NE based fertilisation transplanted with ADT 46 and BPT 5204 where the NDVI obtained from 27nd November 2019 was the largest value. There was a relatively bigger drop in the value of NDVI registered on 22nd December 2019 in the plot with NE treatment cultivated with BPT 5204. All the curves were more or less bell shaped although the available satellite data was acquired not in regular intervals. By 13th February 2020 all the fields were harvested hence the less NDVI values in 15th February 2020. But in the fields transplanted with ADT 46 and BPT 5204, the NDVI was more even in 15th February 2020 image because of fallow pulse crop from which the signal was picked by the satellite sensors. Harvesting in almost all fields was delayed for want of mechanical harvesters and the dates shown were certainly beyond the physiological maturity. Available literature indicated that there would be saturation in NDVI after 0.7 and hence soil adjusted vegetation index (SAVI) was also worked out to represent the health of vegetation, which gave yet another pattern that was described in main text.

Conclusion

This was a learning experience to monitor the multi-locational yield maximisation trial using freely available Sentinel-2 data, though it was a post-event analysis. The Copernicus program of the European Space Agency guaranteed the supply of Sentinel data up to 2030 (Murthy *et al*., 2022). This experience helps in developing forewarning about crop conditions for corrective steps by pixel level analysis (Rao *et al*., 2022). It also gave a scope for developing various vegetative indices using the band combinations of Sentinel – 2 data using SNAP. This kind of application can possibly be included in AICRPs subjected to the availability of cloud free data. However, it is seen that there were certain windows to get cloud free images in a season.

References

Clerici N, CAV Caldero´n and JM Posada. 2017. Fusion of Sentinel-1A and Sentinel-2A data for land cover mapping: a case study in the lower Magdalena region, Colombia. Journal of Maps, 13(2): 718–726.

https://scihub.copernicus.eu

https://step.esa.int

Murthy CS, MK Poddar, KK Choudhary, V Pandey, P Srikanth, S Ramasubramanian and GS Kumar. 2022. Paddy crop insurance using satellite-based composite index of crop performance. Geomatics, Natural Hazards and Risk, 13(1): 310-336 DOI: 10.1080/19475705.2021.2025155.

Rao DVKN, J Badri, AVSR Swamy, K Surekha and RM Sundaram. 2022. Temporal observation of NDVI and SAVI of rice derived from Sentinel 2 bands. Extended Summaries: National Seminar on Sustainable Food Production Systems for Self-reliant and Climate Resilient Agriculture, 16-18 June 2022: 170-171.

Tucker CJ. 1979, Red and photographic infrared linear combinations for monitoring vegetation. Remote Sensing of Environment, 8(2): 127–15.

ICSCI 2022/T5/02

Impact of high yielding varieties of finger millet, *Eleusine coracana* cultivation doubled the farmers farm profit in Sarpanpally and Jaidhupally villages of Vikarabad District, Telangana State, India

Subbarayudu, B.; Ravikumar, S.; Shyamprasad, G.; Kalaisekar, A.; Nandini Priya Yadav, B.; Kannababu, N.; Venkateswarlu,R.; Srinivasbabu, K; and Mukesh, P

ICAR-Indian Institute of Millets Research
Rajendranagar, Hyderabad-500 030, India
Email : subbarayudu@millets.res.in

Revival of finger millet, *Eleusine coracana* cultivation through high grain yielding varieties and development of its entrepreneurial skills among the farmers/ youth of Vikarabad district of Telangana state, India. Improved high yielding varieties of finger millet seeds (KMR 30 and GPU 28) and also local ragi cultivar (Ratna) distributed to the 200 farmers in the National Bank for Agriculture and Rural Development (NABARD) sponsored project site villages, Sarpanpally and Jaidhupally of Vikarabad district, Telangana state in two successive kharif seasons of 2018 and 2019. Outreach programmes were successfully carried out in the project site villages throughout project period to create awareness on cultivation, production, productivity and value addition to increase farmers farm profit. All finger millet growers were adopted improved seed to seed packages. The monitoring of finger millet crop was carried out throughout the crop seasons. The data showed that by cultivation of high yielding grain yielding varieties (KMR 301 and GPU 28), growers obtained the grains yields of 25 quintals/ha in comparison to that of local cultivar (cv. Ratna) with the grains yields of 12.5 q/ha.

Overall, improved varieties (KMR 30 and GPU 28) of finger millet cultivation doubled the farm profits with the Cost Benefit (C: B) ratio of (1 : 3) and local cultivar (Ratna) cultivated farmers obtained the C : B ratio of 1 : 1.5. It was noticed that the youth and farmers got motivation in finger millet cultivation. Further, finger millet growers also acquainted with seed to plate technologies. Finger millet growers of the project site villages established small millets processing unit at Sarpanpally village and also led to start up in youth, seed to plate technologies which enabled the farmers to process the crop produce so that additional value can be added to finger millet growers. Finally, it was observed that improved varieties of finger millet cultivation resulted the revival of its cultivation in and around project site villages in a big way.

ICSCI 2022/T5/04

Socio-economic impact of different rice establishment methods

Asheesh Chaurasiya, R. K. Sohane, R. N. Singh, Vinod Kumar
Bihar Agricultural University, Sabour, Bhagalpur, 813210 Bihar (India)
Email: asheeshagro@gmail.com

Introduction

Transplanted rice being a highly labour- intensive and costly method, could be substituted with direct seeding (Singh et al., 2019), which could reduce labour needs by more than 20% in terms of working hours (Nagargade et al., 2018). Nursery raising needs additional care and expenditure and in case a nursery is damaged or transplanted delayed due to aberrant weather conditions or pest problems, the whole crop will suffer. Under such circumstances DSR economical. DSR not only provides more turn over around period for double cropping due to reduction in crop duration but also beneficial to maintain the granular crumb structure of the soil. Keeping the view on economic and climate change in mind a project i.e. Climate resilient agriculture programme was launched by Bihar Government. At present labour is not only costly but, also scarce and the problem becomes more acute during the peak period of uprooting and transplanting. Moreover, the laborers also prefer other job than the arduous job of transplanting as it involves lot of drudgery. With the adequate availability of irrigation water direct seeding of rice is a viable and profitable alternative to transplanted rice in this area as well as whole country. In this paper we assessed the separate and layered potential benefits of both the establishment method, economical sustainability and also assessing the sustainability of the novel practice of rice cultivation.

Methodology

Project was implemented during Rabi season, 2019 involving various methods of crop establishment, tillage practices in rice-wheat crop rotation. Study site was located in 5 villages namely, Tarchha, Laugain, Damuchak, Godra and Kasimpur village of Goradih block in Bhagalpur District of Bihar (India). In this farmer's participatory approach most of the farmers having marginal land holding size. To study the economics, we selected 10 farmers from each site (total 50 farmers) who sown both the technologies. The climate of the site is characterized by hot and humid summers and cold winters with an average annual rainfall of 1344 mm, and 70% of which is received between July to September. All economic activities and expenditure of both the establishment methods of rice i.e. puddled transplanted rice (PTR) and direct seeded rice (DSR) were discussed and recorded with the farmer on every aspect. The economics of the cultivation and production system were calculated over variable cost of cultivation only

Results

The economics of cultivation is a great deal with local condition, yield levels, input supply and physical amenities. The economics of production of DSR should not be judge only from the net return point of view, but other advantages must also be taken into consideration at a time.

In an analysis of the economics of rice production of DRS and PTR, the cost of cultivation of PTR/ha comes to Rs. 21610/- which was 32.07% more than the DSR (table 2). In both the establishment methods i.e., DSR and PTR, maximum expenditure was recorded in harvesting and threshing but if we talk about other component second most expensive activity was transplanting of seedling (19.4%)

and irrigation (18.5%) in PTR whereas in DSR second most expensive component was irrigation (18.3%). After discussion with farmers it was concluded that among the all kinds of expenditure money was saved in DRS during the nursery raising, land preparation transplanting if seedling, irrigation water, where they expense 3.3%, 9.8%, 4.7% 4.9% as compare to PTR, 5.8%, 13%, 19.4, and 18.5%, respectively. Farmers also stated that the main difficulty in DSR was weed management where they expend more money (16.3%) as compare to PTR (7.4%) (table 2) and efforts. Some farmers also mentioned that they sprayed herbicide twice due to again weed germination problem because of irrigation water was not continuously standing in field. Maximum expense was observed in harvesting and threshing in both the methods of crop establishment (table 2). Above calculated cost of cultivation is based on farmer's perspective including all parameters, shows that cost of cultivation in transplanted rice is Rs. 21610/- whereas, in DSR it is Rs. 16362/-. So, the DSR saved Rs. 5248/- as compare to PTR which is 24.3% less. The factors limiting grain yield of DSR are different under different situations explained by farmers. They stated that under upland condition problems are different and under low land conditions problems are different. The various difficulties experienced and explained by farmers are given below.

Table 1. Comparison of cost of cultivation for direct seeded rice (DSR) and PTT (Unit- one acre or 4000 m^2)

				Cost (Rs.)	
S. No.	**Particulars**	**Amount/hrs/man-days (DSR & PTR)**	**Rate/particular**	**DSR**	**PTR**
1.	**Nursery raising (area for planting 1-acre land)**				
a)	Land preparation	30 min	Rs. 800/hrs	-	400
b)	Irrigation	2 irrigations	Rs. 1000/acre (Rs. 50/irrigation in nursery)	-	100
c)	Seed	12 kg/acre (DSR) & 15 kg/ acre (PTR)	Rs.45/kg	540	675
d)	Fertilizer	2.5 kg DAP	Rs. 30/kg	-	75
2.	**Field preparation and transplanting**				
a)	Land preparation	Tractor -2 hrs	Rs. 800/ hrs	1600	1600
b)	Bund formation	4-man days	300/labour	-	1200
c)	Irrigation for puddling	-	Rs. 1000/acre	-	1000
d)	Nursery Uprooting	8-man days	Rs. 300/labour	-	2400
3.	Transplanting or sowing	Tractor operation - 1 hr & 12-man days	Rs. 800/acre & Rs. 150/labour	800	1800
4.	Fertilizer	Urea- 70kg, DAP-40 kg, MOP-20 kg	Urea- Rs. 8/kg., DAP- Rs. 30/kg, MOP- Rs. 20/kg	2160	2160
5.	Irrigation	3 irrigations	Rs. 1000/acre	3000	3000
6.	**Weed control**				
a)	Herbicide	Bispyribac sodium (100 ml), Pyrazosulfuron (80g) (DSR) & 1 lit. (2,4-D)	(Bispyribac sodium Rs. 540/100g & Pyrazosulfuron Rs. 272/ 80 g) and 2,4-D-Rs. 400/lit	812	400
b)	Manual weeding	12-man days (DSR), & 8-man days	Rs. 150/labour	1800	1200
c)	Plant protection	Strpetocyclin- 6 g/acre	Rs. 50/6 gm	50	-
7.	**Harvesting and post-harvest**				
a)	Crop cutting	12-man days	Rs. 150/labour	1800	1800

b)	Bundle tying	8-man days	Rs. 150/labour	1200	1200
c)	Threshing and transportation			2600	2600
	Total COC Rs.			**16362**	**21610**

Table 2. Comparison of component wise expenditure in DSR and puddle transplanted rice (2020)

Particular	DSR		Transplanted rice	
	Expenses	**% Expenditure (Rs.)**	**Expenses**	**% Expenditure (Rs.)**
Seed for DSR/Nursery Raising	540	3.3	1250	5.8
Land Preparation/field levelling for DSR	1600	9.8	2800	13.0
Transplanting/ seed sowing in DSR	800	4.7	4200	19.4
Irrigation	3000	4.9	4000	18.5
Fertilizer	2160	18.3	2160	10.0
Weed control	2662	16.3	1600	7.4
Harvesting and threshing	5600	34.2	5600	25.9
Total	**16362**	**100.0**	**21610**	**100.0**

Conclusion

So, from economics and efforts point of view I would like to recommend and advice to the farmers to adopt the DSR Technology because with the saving of lots of money planting method also saving the lots of hard work, irrigation water, less emission of greenhouse gases like methane, increasing soil organic carbon and biological activity consequently improving soil health. This climate resilient agriculture programme is very important step taken by Government of Bihar for his farmers as well as assisting in stop changing climate. In comparison with DSR, the PTR involved more cost of cultivation due to additional labour and irrigation water cost. The net returns per rupee invested were found to be lower with transplanting than DSR though grain and straw yield were higher with transplanted rice. The net profit and net return per rupee invested again suggest that the DSR pays more per unit investment made and it is easy, cheap and a less time consuming method of cultivating rice even in areas with high physical amenities.

References

Nagargade, M., Singh, M. K., & Tyagi, V. (2018). Ecologically sustainable integrated weed management in dry and irrigated direct-seeded rice. Adv. Plants Agric. Res, 8, 319-331.

Singh, S. P., Paikra, K. K., & Aditya, S. (2019). Direct seeded rice: prospects, constraints, opportunities and strategies for aerobic rice (Oryza sativa L) in Chhattisgarh-a review. Int. J. Curr. Microbiol. Appl. Sci, 8(9), 889-912.

ICSCI 2022/T5/05

Enhancing nutritional and livelihood security of the Coastal farmers in an Integrated fish farming system

SelvarasuT and Velvizhi. S
M.S. Swaminathan Research Foundation
Fish for All Research and Training Centre, Poompuhar -609105, Tamil Nadu, India
Email: selvarasu@mssrf.res.ins

Introduction

The coastal crop production enterprises are subject to a high degree of risk and under training due to various natural calamities (tsunami, flood, salinization and drought). To identified as one of the major farming villages of the Sirkali and Sembanarkovil block in Mayiladuthurai district of Tamil Nadu. These two blocks of farmers constitute of 72 percent of marginal and small-scale farmers. Indian Meteorological Department, Chennai reported that during the period 1891 and 2017, nearly 32 per cent of cyclones that formed in the Bay of Bengal struck the coast of Tamil Nadu; of which 61 severe cyclones crossed the Mayiladuthruai region mostly during the months of October to November in addition of frequent cyclone, mid-season drought, floods and water logging due to the flat topography and improper/disturbed drainage systems make the region more vulnerable. One of the options for addressing the issue is economically and ecologically sustainable development of farming systems, which can be achieved by integrating aquaculture and agriculture. Integrating appropriate farming components in fish culture requiring lesser input, space and time for ensuring higher productivity of the system is the only alternative option. Such integrated farming systems can contribute to the alleviation of food insecurity, malnutrition and poverty through the provision of food of high nutritional value, income and employment generation, decreased risk of production, improved access to water, sustainable resource management and increased farm sustainability. The integration of diverse components in the farming system ensures increased returns, sustainable farming and further it prevents the migration of farmers from farming sector. Since then, 30 integrated farming systems has been established scientifically and its economics in terms of the components integrated has been studied.

Methodology

The study was conducted in two blocks namely Sirkali and Sembanrkovil of Mayiladuthurai district of Tamilnadu. The questionarnaire used for base line data consisting of farmers profile, fish farming, integration of farming activities, source of irrigation and associated issues, accessibility of government schemes etc. The collected data from Primary and secondary sources from farmers and line departments have been entered into the tabulation data sheet and maintain the, individual farmers. The study was conducted during 2019- 2021.

Results

Productivity of systems: The system productivity varied widely between the models. The model involving, the components like fish, poultry, fodder crop, Horticulture crops and azollaculture recorded the highest system yield and productivity during 2019 to 2021 with Rs.11,0369/ha. Similar findings were reported by Bhatnagar et al. (2005) and Rangasamy et al. (1988). The system productivity per day was higher in IFS (42.6kg/ha/day) compared to conventional (18.2kg/ha/day). The substantial additional income could be generated by practicing different enterprise combinations based on the location specificity and capabilities of farmers were reported by Murugan and Kathiresan, 2005.

Table: 1. Increased productivity (yield in kg)

Components integrated in IFS	Baseline data	End line data
Fish culture	4668	10926
Vegetable cultivation	1328	5210
Fodder cultivation	0	20000
Fruit crops	2500	8750
Tree crops	Approx. value: 2.5 lakh	10 lakhs
Azolla culture	0	5400

Economics of systems: Among the different IFS model studied, the system fish + livestock + poultry + fodder crop +Horticulture crops + azolla registered the maximum gross income of Rs.110369/ha net income of 77658 /ha. In spite of clear scientific knowledge on fish culture, out of 12 interventions a farmer obtained 2375 kg, of fish/ha/10months. Similar results reported by Jayanthi et al., (2003), Channabasavanna et al., (2009), Ugwumba et al., (2010) and Singh *et al*., (2009).

Table2: Enhanced Income

Components integrated in IFS	Before intervention (Rs)	After Intervention (Rs)
Fish culture	6,06,960	11,62,000
Vegetable cultivation	39,840	47,950
Fodder cultivation	0	20,000
Fruit crops	1,25,000	4,37,500
Tree crops	2,50,000	10,00,000
Azolla culture	0	10,800

Employment generation and LRI: Fish + poultry + fodder crop +Horticulture crops and azolla culture. IFS system generated more employment opportunities of 1383 man days/year/ha-1. The aforesaid system also registered the highest LRI of 45.7%.

Conclusion

Sustainable development in fish culture to promote the integrated farming system can only be achieved through optimum utilization of the natural resources. A favorable will have to be provided and a socio-economic and technical constraint needs to be addressed in order to enable the fish culture farmers for integrated farming system (IFS) development.

References

Bhatnagar,P.R., Harris,A.A., and Sikka,A.K.2005. Feasibility of rice – fish culture on water logged lands in canal command. Journal of Farming System Research and Development.11:88-91.

Channabasavanna, A.S., Biradar, D.P., Prabhudev, K.N. and Mahabhaleswar Hegde 2009. Development of profitable integrated farming system model for small and medium farmers of Tungabhadra project area of Karnataka. Karnataka Journal of Agriculture Science 22 (1): 25-27.

Jayanthi, C., Baluswamy, M., Chinnusamy, C. and Mythily, S., 2003. Integrated nutrient supply system of linked components in lowland integrated farming system. Indian Journal of Argonomy48: 241-246.

Murugan,G. and Kathiresan,R.M. (2005). Integrated rice farming system. Indian Farming,55 (5):4-6

Rangasamy,A.,Budhar,M.N.,Venkitasamy,R.,and Palaniappan,S.P.1988.Integrated farming systems for wetlands. Abstract of National seminar on farming systems for semiarid Tropices, Indian Council of Agricultural Research and Tamilnadu Agriculture University, Coimbatore, P.16.

Ugwumba, C.O.A., Okoh, R.N., Ike, P.C., Nnabuife, E.L.C. and Orji E.C 2010. Integrated Farming System and its Effect on Farm Cash Income in Awka South Agricultural Zone of Anambra State, Nigeria. American-Eurasian Journal of Agriculture & Environmental Science 8 (1) : 01-06.

ICSCI 2022/T5/06

Type II Diabetes in India: An Anthropological Perspective

Andrew Ashley, P.Muthuraman, B .Nirmala and P. Jayakumar
ICAR- Indian Institute of Rice Research
Hyderabad- 500030

High Diabetes rates have been prevalent throughout the southern states of India and among the Telugu-, Kannada-, Malayalam-, and Tamil-speaking Indian diaspora in USA. This is not entirely new. Over 100 years ago, Dr. Krishnamurti Aiyer noted incredibly high rates of diabetes in the then-Madras Presidency, leading to a belief at the time that diabetes might be a 'tropical disease.' He cited the root causes as being 1.) hereditary, 2.) sedentary lifestyle, 3.) a rice-heavy diet. In other words, though rates are significantly rising, rates of diabetes have always been proportionally high in South India particularly among the rice eating population. Yet, despite this long history in the region, in the past few decades South India has seen a meteoric rise of Type II diabetes. Various reasons have been attributed to the severe health problem, such as genetic predisposition (or epigenetic factors from the Colonial period); increasing consumption of highly polished white rice; taking too much sugar; dietary shifts since the 90s liberalization; the vagaries of urban existence and fast-food/no-time culture; the sedentary life style, and lack of physical work or exercise; the stresses of career and familial commitments; air pollution and increasingly toxic environments ravaging kidneys and pancreases. In short, we have no consensus on what causes Type II diabetes. Instead of looking at 'risk factors,' and causes, medical anthropology asks us to look at lived experiences.

What does it mean to be diabetic in Hyderabad today or in the South Indian diaspora of the United States? The ongoing research project looks at the experiences of diabetes today in Hyderabad and among South Indians living in the United States. Data will be collected from around 200 diabetic patients (currently 20 ethnographic interviews have been conducted in Hyderabad of people living with Type II diabetes along with previous interviews in the United States), scores of diabetologists (endocrinologists), and plant breeders and agricultural scientists contemplating what is best for us to cultivate and to eat in the future.

The results emanate from the present study shall be providing answers to the following pertinent questions viz., what does health look like in the wake of metabolic changes? What does it mean to give up the pleasures of fruits like mango, banana, grapes, custard apple, sappota, jackfruit? Is life altered when one gives up the social atmosphere of a tea break? Equally, what do 'cures' look like? Is it managing your sugar and insulin levels? Is it 'reversing' diabetes, as has recently been the trend? Is it a return to a 'normal self' before the diagnosis? How do the indigenous medicines solve the problems of poor people in India? How far will physical exercise will reduce the dependence on insulin? These are the sorts of questions medical anthropology hopes to illuminate through anthropological research.

Acknowledgements

The financial assistance received from Research and Development Fund of National Bank for Agriculture and Rural Development (NABARD) towards publication of proceedings of the Conference is gratefully acknowledged.

Organized by

Society for Advancement of Rice Research

Hyderabad, Telangana, India