ORIGINAL RESEARCH ARTICLE https://doi.org/10.58297/VBRH1890

Response of varieties under high and low input management in semi-dry rice ecosystem

Senthil Kumar G*, CR Chinnamuthu and K Ganesamurthy

*Assistant Professor (Agronomy), Department of Rice, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India.
*Corresponding author E mail: senthilkolathur@gmail.com

Received: 8th April 2021; Accepted: 29th May 2021

Abstract

A field experiment was conducted during *Rabi*, 2020-21 at Tamil Nadu Agricultural University, Coimbatore, to study the response of varieties with high and low nutrient levels under semi-dry rice system. The experiment was laid out in split plot design with varieties in main plot *viz.,* Anna 4, PMK 3, TKM 12, CO 51, CO 53 and three graded nutrient levels in sub-plot *viz.,* 75 per cent recommended dose of fertilizer (60:20:30 kg NPK/ha), 100 per cent recommended dose of fertilizer (75:25:37.5 kg NPK/ha) and 125 per cent recommended dose of fertilizer (90:30:45 kg NPK/ha). The results revealed that, among the different varieties evaluated under semi-dry ecosystem, CO 53 showed higher grain yield on par with Anna 4. Among the nutrient levels, 125 per cent recommended dose of fertilizer (RDF) recorded higher grain yield at par with 100 per cent RDF. From this study it can be concluded that, short duration variety CO 53 and Anna 4 is best suitable under semi-dry system with 100 per cent recommended dose of fertilizer (75:25:37.5 kg NPK/ha) in Tamil Nadu.

Keywords: Semi-dry rice, varieties, nutrient levels, root length, yield, economics

Introduction

Rice is consumed by more than half of the world's population and India is the second largest producer of rice in the world and it is the major cereal crop of the country. Most of rice is grown by transplanting seedlings into puddled soils and is then kept flooded for most of the growing season. However, transplanting consumes large amount of labour, water and energy which are gradually becoming scarce thereby necessitating the need to shift to direct seeded rice (DSR) systems. In India, area under semi-dry rice cultivation is 17.53 m ha and production is around 36.48 per cent. Semi-dry direct seeded system is a method of cultivation of rice wherein seeds are sown in ploughed dry soil before monsoon rains similar to aerobic rice. When the monsoon becomes active the field is impounded with rainwater, canal water or borewell water and rice is continued as wet - crop. It is most common in areas where, due to late release of water timely transplantation cannot be done. This cuts down the initial water consumption up to 30 per cent by avoiding raising of seedlings in nursery, puddling and transplanting under puddled soil. Semi-dry rice system also reduces the cost of cultivation by avoiding the preparatory operations like puddling, levelling, bund formation and transplanting. In India, Tamil Nadu state has some area under rainfed and semi-dry rice with a vast scope of growing rice under aerobic conditions. The semi-dry rice is a contingent plan to command areas, anticipating the release of water in rice crop which can be established under rainfed conditions up to maximum of 45 days' duration of crop (Bhushan *et al.,* 2007). Field is converted into wet condition on receipt of canal water and nutrient management is decided according to the period of irrigation (Bouman and Lampayan, 2009). The new concept of aerobic rice entails the use of nutrient responsive different cultivars that are initially adapted to aerobic environment aiming at 70-80 % higher yields (Kumar and Ladha, 2011). Semi-dry rice cultivation refers to rice which is sown on dry seed bed as an upland crop taking advantage of monsoon rains. At 4th and 5th leaf stage, when the rainfall intensifies or

sufficient water is released from the tank or irrigation projects, the field is converted into wetland rice. Nitrogen and potassium are the key nutrients which frequently limit the rice production. In puddled rice system, the nitrogen use efficiency is approximately 30 per cent where as in upland irrigated or rainfed rice, nitrogen use efficiency would be 40 to 60 per cent (Raj *et al.,* 2014). Nitrogen and potassium are the main nutrients determining rice yield, due to their role in the photosynthesis, biomass accumulation and spikelet formation (Hasegawa *et al*., 1994: Yoshida *et al.,* 2006). Many factors are responsible for increasing yield and quality of crops. Among these, proper and balanced application of fertilizers is one of the most important factors contributing towards higher productivity (Raj *et al.,* 2014). With this background, an experiment was conducted to study the response of varieties under high and low input management in semi-dry rice ecosystem.

Materials and Methods

A field experiment was conducted during *Rabi*, 2020-21 in the department of Rice farm situated at 11^0 N latitude and 77^0 E longitude at Tamil Nadu Agricultural University, Coimbatore. The soil of the experimental field was clay in texture with a pH of 8.22, organic carbon (0.45 %), low in available nitrogen (228 kg/ha), medium in available phosphorus (21 kg/ha) and high in available potassium (483 kg/ha). The experiment was laid out in split plot design with three replications. The treatments comprised of five varieties in main plot *viz.,* Anna 4, PMK 3, TKM 12, CO 51, CO 53 and three graded nutrient levels in sub-plot *viz.,* 75 per cent recommended dose of fertilizer (60:20:30 kg NPK/ha), 100 per cent recommended dose of fertilizer (75:25:37.5 kg NPK/ha) and 125 per cent recommended dose of fertilizer (90:30:45 kg NPK/ha). Entire dose of phosphorus was applied as basal whereas N and K were applied in three splits at 20-25, 40-45 and 60-65 days after germination. Under semi-dry rice system, seeds were sown in un-puddled soil and the crop was maintained with receiving of the rainfall, while after 45^{th} day the field was converted into wet condition. Recommended pre-emergence herbicide application of pendimethalin @ 1.0 kg/ha was done 5 days after sowing on the day of receipt of soaking rain followed by one hand weeding at 30-35 days after sowing. The crop was harvested when plants turned yellow and attained maturity. Growth parameters on root length were recorded by collecting plants in sampling row using digging fork, and maximum root length was measured after careful washing of roots. Plants collected for root length were also used for recording root volume and root dry weight. The root volume $hill^{-1}$ was measured by water displacement method and expressed in cm^3 $hill^{-1}$. The root dry weight was measured by oven dry weight basis and expressed as g $hill^{-1}$. The border rows of all around the plots were harvested first and then the plants from the net plots were harvested and threshed. The yield was expressed in kg/ha and the grain weight was expressed in 14 % moisture basis (Yoshida *et al*.,1976). 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 as per the method suggested by Gomez and Gomez (1984).

Results and Discussion

Growth attributes

Rice varieties exhibited significant influence on root length, root volume and root dry weight under different nutrient levels in semi-dry rice ecosystem. Among the rice varieties, CO 53 and Anna 4 exhibited higher root length (14.9 and 14.3 cm) and root volume (32.8 and 31.2 g/cc), respectively. The root dry weight was also higher in CO 53 (5.3 g/hill) and Anna 4 (5.2 g/hill) compared to other varieties evaluated under semi-dry system. The varieties with short duration, short stature, intermediate plant height, long roots, rapid shoot and root growth, long mesocotyles and coloeoptiles, have the ability to withstand stress during early stages (Farooq *et.al.,* 2011). Among the nutrient levels, 125 per cent recommended dose of NPK level exhibited higher root length, root volume and root dry weight on par with 100 per cent recommended dose of NPK level **(Figure 1 & 2, Table 1).**

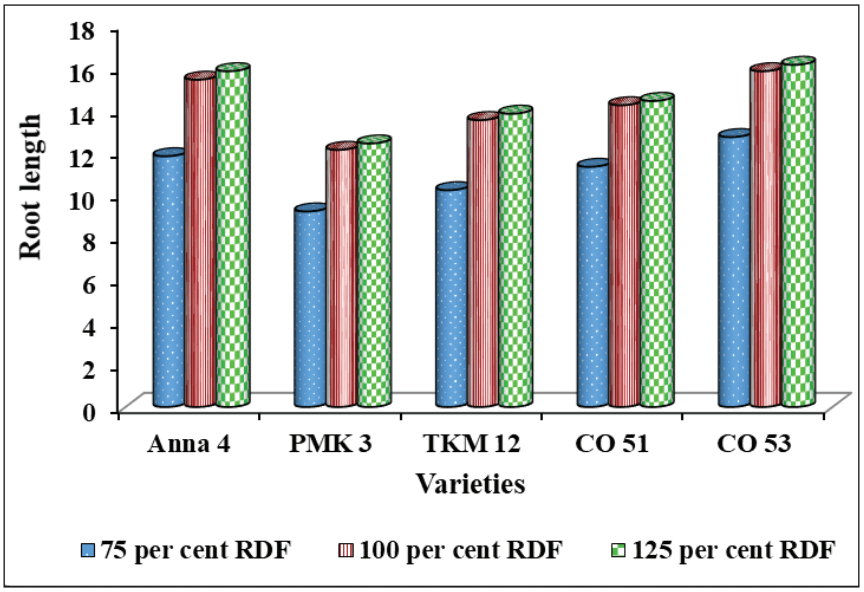

Figure 1. Response of varieties and nutrient levels on root length (cm) of rice under semi dry ecosystem

Table 1. Response of varieties and nutrient levels on root volume (g/cc) of rice under semi-dry system

Treatments	Anna 4	PMK 3	TKM 12	CO 51	CO 53	Mean
75 per cent RDF (60:20:30 kg NPK/ha)	24.7	21.4	20.3	24.4	25.2	23.2
100 per cent RDF (75:25:37.5 kg NPK/ha)	34.2	27.1	25.6	33.1	36.5	31.3
125 per cent RDF (90:30:45 kg NPK/ha)	34.6	27.7	26.2	33.7	36.8	31.8
Mean	**31.2**	**25.4**	**24.0**	**30.4**	**32.8**	
	N	**V**	**N x V**	**V x N**		
S.Ed	0.8	0.7	1.4	1.5		
CD (0.05)	1.8	1.6	3.1	3.2		

(*RDF – Recommended Dose of Fertilizer)

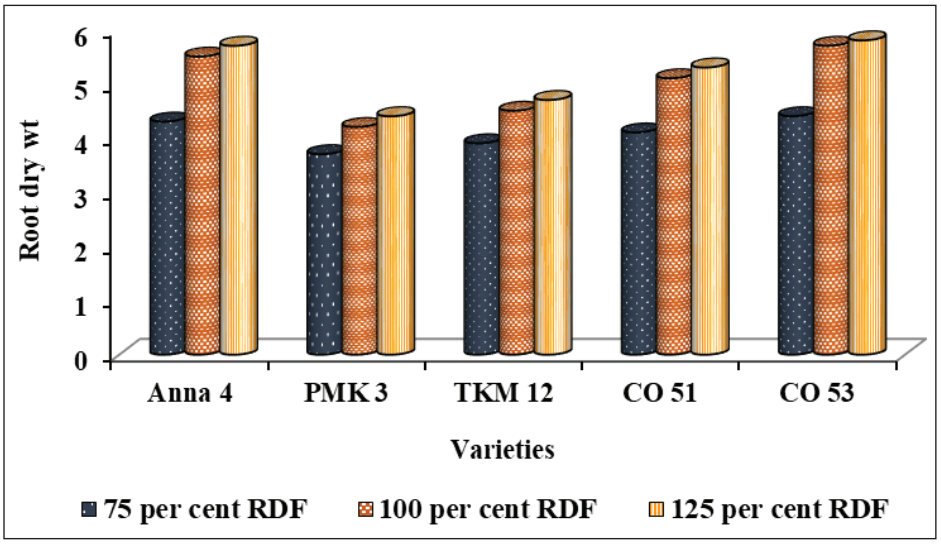

Figure 2. Response of varieties and nutrient levels on root dry weight (g) of rice under semi dry system

Table 2. Response of varieties and nutrient levels on number of productive tillers/m² of rice under semi-dry system

Treatments	Anna 4	PMK 3	TKM 12	CO 51	CO 53	Mean
75 per cent RDF (60:20:30 kg NPK/ha)	243	188	206	213	221	214
100 per cent RDF (75:25:37.5 kg NPK/ha)	338	287	304	311	326	313
125 per cent RDF (90:30:45 kg NPK/ha)	342	294	317	324	340	322
Mean	**308**	**256**	**276**	**283**	**296**	
	N	V	N x V	V x N		
S.Ed	8	7	13	12		
CD (0.05)	16	14	24	22		

Higher number of productive tillers/m² was observed in Anna 4 (308) and was at per with CO53 **(Table 2).** Among the different varieties evaluated under semi-dry ecosystem, CO 53 showed higher grain yield (4774 kg/ha) and was on par with Anna 4 **(Table 3).** The varieties which are early and with rapid growth rate, higher tiller number, high biomass accumulation at early stages and erect leaves have increased crop growth rate during the reproductive phase and prolonged ripening phase. They also exhibit, resistance to lodging and more grains in primary panicle contributing to their better performance under semi-dry ecosystem (Farooq *et.al.,* 2011). The higher grain yield is also because of higher number of panicles and lower sterility percentage (Jagmohan Kaur and Avtar Singh, 2017). Among the nutrient levels, 125 per cent RDF recorded higher grain yield of 4588 kg/ha which was on par with 100 per cent RDF (4516 kg/ha, **Table 3**).

Table 3. Response of varieties and nutrient levels on grain yield (kg/ha) of rice under semi-dry system

Treatments	Anna 4	PMK 3	TKM 12	CO 51	CO 53	Mean
75 per cent RDF (60:20:30 kg NPK/ha)	4036	3071	3322	3856	4122	3681
100 per cent RDF (75:25:37.5 kg NPK/ha)	4866	3836	4127	4685	5067	4516
125 per cent RDF (90:30:45 kg NPK/ha)	4921	3922	4233	4732	5132	4588
Mean	**4608**	**3610**	**3894**	**4424**	**4774**	
	N	**V**	**N x V**	**V x N**		
S.Ed	135	130	152	173		
CD (0.05)	280	265	485	436		

Economics

Variety CO 53 under 100 per cent recommended dose of fertilizer regime yielded higher net return of Rs. 38,005/- with benefit: cost ratio of 2.00 followed by the variety Anna 4 with net return of Rs. 34,990/- and benefit: cost ratio of 1.91**(Table 4 & Figure 3).** Application of 125 per cent RDF resulted in lesser net return and B:C ratio compared to 100 per cent RDF.

Table 4. Response of varieties and nutrient levels on economics of rice cultivation under semi-dry system

Treatments	Gross return (Rs./ha)					BCR				
	Anna 4	PMK 3	TKM 12	CO 51	CO 53	Anna 4	PMK 3	TKM 12	CO 51	CO 53
75 per cent RDF	60540	46065	49830	59340	61830	1.64	1.25	1.35	1.60	1.67
100 per cent RDF	72990	57540	61905	71775	76005	1.91	1.51	1.63	1.88	2.00
125 per cent RDF	73815	58830	63495	72480	76980	1.89	1.50	1.62	1.86	1.97

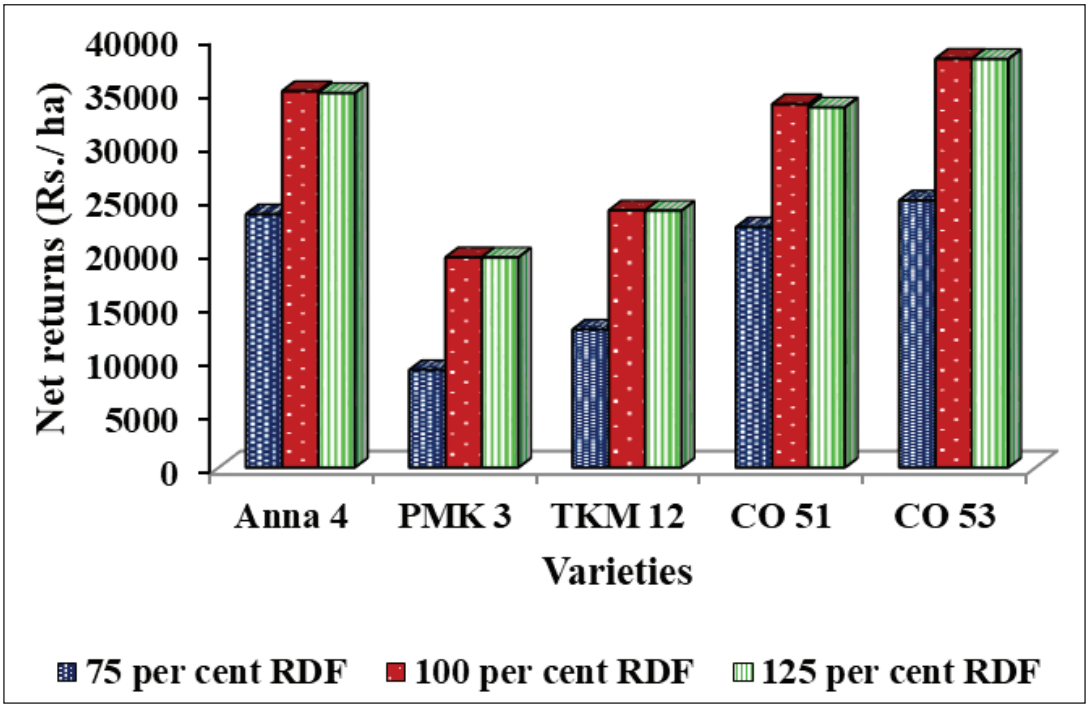

Figure 3. Response of varieties and nutrient levels on net retiurns (Rs./ha) of rice cultivation under semi dry system

Conclusion

From this study it can be concluded that, short duration variety CO 53 and Anna 4 are best suitable under semi-dry system and nutrient level of 100 per cent recommended dose of fertilizer (75:25:37.5 kg NPK/ ha) is recommended for semi-dry rice cultivation in Tamil Nadu.

References

Bouman BAM and Lampayan RM. 2009. *Aerobic Rice* 1 & 2. International Rice Research Institute, Philippines.

Bhusahan L, Ladha JK, Gupta RK, Singh S, Tirol-Padre A, Saharawat YS and Pathak MGH. 2007. Saving of water and labour in rice – wheat system with no-tillage and direct seeding technologies. *Agronomy Journal*, 99: 1288-1296.

Farooq M, Kadambot HM, Siddique HM, Rehman H, Aziz T, Done-JinLee and Wahid A. 2011. Rice direct seeding: Experiences, challenges and opportunities. *Soil & Tillage Research*, 111: 87-98.

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

Hasegawa T, Koroda Y, Seligman NG and Horie T. 1994. Response to spikelet number of plant nitrogen concentration and dry weight in Paddy. *Agronomy Journal,* 86:673-676.

Kaur J and Singh A. 2017. Direct seeded rice: Prospects, problems / constraints and researchable Issues in India. *Current Agriculture Research Journal*, 5(1): 1-30.

Kumar V and Ladha JK. 2011. Direct seeded rice: Recent development and future research needs. *Advances in Agronomy,* 111:297-313.

Miller BC, Hil JE and Roberts SR. 1991. Plant population effects on growth and yield in water seeded rice. *Agronomy Journal*, 83:291-297

Raj SK, Bindhu JS, Girijadevi L. 2014. Nitrogen availability and uptake as influenced by time of application and N sources in semi-dry rice (*Oryza sativa*). *Journal of Crop and Weed, 10* (2):295-302.

Yoshida S, Forno DA, Cock JH and Gomez KA. 1976. Laboratory manual for physiological studies of rice. IRRI, Los Banos, Philippines, 83p.

Yoshida H, Horie T and Shiraiwa T. 2006. A model explaining genotypic and environmental variation of rice spikelet number per unit area measured by cross -locational experiments in Asia. *Field Crops Research*, 97(3): 378-393.