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Genetic Analysis and Character Association of Yield Traits in Rainfed Rice (*Oryza sativa* L.)

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Abstract

The experiment comprised with 38 improved rice cultures obtained from different research organizations. The analysis of variance revealed that all the treatments are highly significant for various characters under studied *i.e.* days to 50% flowering, plant height, number of productive tillers per plant, number of productive tillers per square metre plot area, panicle length, filled grains per panicle, grain yield and straw yield. The higher magnitude of PCV and GCV were recorded for number of productive tillers per square metre plot area, number of filled grains per panicle and straw yield. Days to 50% flowering, number of productive tillers per square metre, panicle length, number of filled grains per panicle and grain yield showed high broad sense heritability. High heritability coupled with high genetic advance was recorded for number of productive tillers per square metre, number of filled grains per panicle, straw yield and grain yield indicated the major role of additive gene action in the inheritance of these characters. The trait number of productive tillers per plant expressed high direct effect and straw yield and days to 50% flowering had moderate direct effect on grain yield. Thus, these characters may serve as effective selection parameters during breeding programme in the rainfed rice ecosystem.

Key words: variability, heritability, genetic advance, association, rainfed rice.

Introduction

Rice (*Oryza sativa* L.) is the major food crop of more than half of the global population and will continue to occupy the pivotal place in global food and livelihood security systems. In India, rice is grown in an area of 43.5 million ha (23% of gross cropped area) with an annual production of 110 million tons. The population growth in most of the Asian countries, except China, continues to be around 2% per year. Hence, it is very pertinent to critically consider whether the rice production can be further increased to keep pace with population growth. With the current green revolution technologies, it is estimated that by 2020 at least 115-120 million tons of milled rice is to be produced in India to maintain the present level of self-sufficiency. Yield is a complex character, which is highly influenced by the environment, hence direct selection for yield alone limit the selection efficiency and ultimately results in limited success in yield improvement. Genetic variability studies are important in selection of parents for hybridization because crop improvement depends upon magnitude of genetic variability in base population (Adebisi *et al.*, 2001). Once genetic variability has been ascertained, crop improvement is possible through the use of appropriate selection method and increasing total yield would be made easier by selecting for yield components because they are more often easily inherited than total yield itself. An idea on the extent of association between traits conferring higher yield will be much helpful to decide upon the traits to be given importance in selection process. Path coefficient analysis assists plant breeders in identifying traits on which selection pressure should be given for improving yield. An attempt was made in the present investigation to assess the variability, heritability, genetic advance and association of some quantitative characters in rainfed rice.

Materials and methods

The experimental material comprised with 38 improved rice cultures received from various research organizations which were evaluated in a randomized block design with three replications at Agricultural Research Station, Tamil Nadu Agricultural University, Paramakudi during Rabi 2017-18. The experimental site is located at 9” 21’ N latitude, 78” 22’ E longitudes and an altitude of 242 m above mean sea level with average annual rainfall of 840 mm. This site has clay loam soil texture with pH of 8.0. Each genotype was raised in 5x2 m plot keeping 15 x 10 cm spacing. The recommended agronomic practices followed to raise good crop stand. The data were recorded on 10 randomly selected plants from each replication for various quantitative traits studied *viz*, days to 50% flowering, plant height (cm), number of productive tillers per plant, number of productive tillers per square metre plot area, panicle length (cm), filled grains per panicle, grain yield (t/ha) and straw yield (t/ha). Mean values were subjected to analysis of variance to test the significance for each character as per methodology advocated by Panse & Sukhatme (1967). Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were calculated by the formula given by Burton (1952), heritability in broad sense and genetic advance were calculated as per Johnson *et al.,* (1955).

The genotypic correlation coefficients between yield and yield components as well as among the yield components were worked out. From the analysis of variance and covariance tables, the corresponding genotypic variances and co-variances were calculated by using the mean square values and mean sum of products as suggested by Al-Jibouri *et al*. (1958). The relative influence of seven components on yield by themselves (direct effects) and through other traits (indirect effects) was evaluated by the method of path coefficient analysis as suggested by Dewey and Lu (1959). The simple correlation coefficients already estimated at genotypic level were utilized for this purpose. By keeping yield as dependent variable and other eight traits as independent variables, simultaneous equations which express the basic relationship between path coefficients were solved to estimate the direct and indirect effects. The direct and indirect effects were classified based on the scale given by Lenka and Misra (1973).

Results and Discussion

The analysis of variance (Table 1.) revealed that for treatments are highly significant for various characters under studied. This result was in conformity with the earlier findings of Bakele *et al.* (2013) and Rashid *et al*. (2017). The perusal of coefficient of variability indicated that wide range of variability was present at both phenotypic and genotypic levels for all the characters under studied. The magnitude of phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the traits which may be due to higher degree of interaction of genotypes with the environment (Kavitha and Reddy, 2002). The differences in the magnitude of PCV and GCV for number of productive tillers per square metre plot area and straw yield were of high order. The higher magnitude of PCV and GCV were recorded for number of productive tillers per square metre plot area, number of filled grains per panicle and straw yield (Table 2.); indicating the minimal influence of environment and presence of high genetic variability for these traits in the experimental material. Hence, selection on the basis of phenotype can also be effective for improvement of these traits. Coefficients of variability for various characters observed in the present study were in agreement with the findings of Babu *et al*. (2012) and Sameera *et al* (2016).

Table 1: Analysis of variance for different traits in rainfed rice

Source of variation	Degrees of freedom	Days to 50% flowering	Plant height	Productive tillers per plant	Productive tillers per square metre	Panicle length	Filled grains per panicle	Straw yield per plot	Grain yield per plot
Replication	2	20.17	148.29	2.17	272.60	2.28	76.88	0.41	0.04
Treatment	37	122.58*	218.31*	2.73*	668.31*	11.14*	148.41*	5.15*	0.63*
Error	74	2.73	42.80	1.23	49.79	1.69	64.69	1.05	0.01

*significant at P=0.05 level

Table 2: Estimates of mean, variability, heritability and genetic advance in rainfed rice

Traits	Mean ± SE	PCV	GCV	h^2	GA	GA as % of mean
Days to 50% flowering	82.41 ± 0.95	7.92	7.67	93.61	12.59	15.29
Plant height	67.33 ± 3.78	14.95	11.36	57.75	11.97	17.78
Productive tillers per plant	6.56 ± 0.63	18.83	8.35	19.67	0.50	7.63
Productive tillers per square metre	177.73 ± 12.88	28.46	25.55	80.55	83.95	47.23
Panicle length	19.22 ± 0.75	11.45	9.23	65.03	2.95	15.34
Filled grains per panicle	98.89 ± 4.64	23.45	21.99	87.97	42.03	42.50
Straw yield per plot	5.32 ± 0.59	29.22	21.94	56.35	1.81	33.92
Grain yield per plot	2.39 ± 0.07	19.62	18.87	92.50	0.90	37.38

SE=Standard Error; PCV=Phenotypic Co-efficient of Variation; GCV=Genotypic Co-efficient of Variation; h^2=Heritability (Broad sense); GA=Genetic Advance

High heritability is not enough to make efficient selection in the advanced generations unless it is accompanied by substantial amount of genetic advance. Burton (1952) pointed out that the heritability in combination with intensity of selection and amount of variability present in the population influences gains to be obtained from selection. Thus, genetic advance is yet another important selection parameter which although independent, represents the expected genetic advance under selection. It measures the differences between the mean genotypic values of the selected lines and the mean genotypic values of original population from which these were selected. According to Panse (1957) if a character is governed by non-additive gene action, it may give high heritability but low genetic advance, whereas, if it is governed by additive gene action, high heritability along with high genetic advance provided good scope for further improvement. In the present study, high broad sense heritability estimates were obtained for days to 50% flowering, number of productive tillers per square metre, panicle length, number of filled grains per panicle and grain yield (Table 2.), indicating the major role of additive gene action in inheritance of these traits. The broad sense heritability of these characters is in accordance with those of Babu *et al*. (2012), Sameera *et al* (2016) and Rashid *et al*. (2017).

High heritability alone does not guarantee large gain from selection unless sufficient genetic advance (GA) attributed to additive gene action is present. High heritability coupled with high genetic advance was recorded for number of productive tillers per square metre, number of filled grains per panicle, straw yield and grain yield (Table 2.). It indicates that most likely the heritability is due to additive gene effects and selection may be effective. This finding is in close agreement with the findings of Bakele *et al.* (2013) Sameera *et al* (2016) and Rashid *et al*. (2017). Low heritability coupled with low genetic advance was recorded for number of productive tillers per plant (Table 2.). It indicates that this trait is highly influenced by environmental effects and selection would be ineffective.

In the present investigation, grain yield exhibited positive and significant association with productive tillers per plant, productive tillers per square metre and straw yield (Table 3) indicating an increase in grain yield with an increase in these characters. Therefore, priority should be given to these traits, while making selection for yield improvement. This was in conformity with the findings of Babu *et al*. (2012), Vanisree *et al.* (2013) , Islam *et al*. (2015) and Sameera *et al* (2016). Knowledge on inter relationship between yield traits may facilitate breeder to decide upon the intensity and direction of selection pressure to be given on related traits for the simultaneous improvement of these traits. In the present study, straw yield had positive and significant association with plant height, number of panicles per square metre and panicle length; suggesting that selection based on straw yield is highly fruitful in developing high yielding genotypes under rainfed condition, as it will bring simultaneous improvement of these traits. Similarly positive and significant relationship was observed between number of filled grains per panicle, days to 50% flowering and panicle length. The traits, panicle length and number of productive tillers per square metre showed positive and significant association with plant height and number of productive tillers per plant respectively. Similar results were reported by Vanisree *et al.* (2013), Islam *et al*. (2015) and Sameera *et al* (2016). Number of filled grains per panicle had nagative and significant correlation with number of productive tillers per square metre. This was in conformity with the findings of Vanisree *et al.* (2013) and Sameera *et al* (2016).

Path analysis gives an idea about how a trait influences grain yield directly and indirectly *via* other traits. This is very important in giving due weightage to major yield contributing traits while selection. In the present investigation, the trait number of productive tillers per plant expressed high direct effect and straw yield and days to 50% flowering had moderate direct effect on grain yield (Table 4). This was in conformity with the findings of Babu *et al*. (2012), Vanisree *et al.* (2013), Islam *et al*. (2015) and Sameera *et al* (2016). Genotypic residual effect (0.82) indicates that traits under study contribute 18% to the variability in grain yield. It indicates that many other traits which have not been studied here, need to be included to account fully for the variation in grain yield.

Table 3: Genotypic correlation coefficients for yield related traits and grain yield.

Characters	Days to 50% flowering	Plant Height	Productive tillers per plant	Productive tillers per square metre	Panicle length	Filled grains per panicle	Straw yield per plot	Grain yield per plot
Days to 50% flowering	1.000	-0.220	-0.034	-0.176	-0.084	0.464**	-0.227	0.049
Plant Height		1.000	-0.010	-0.128	0.679**	0.144	0.446**	0.107
Productive tillers per plant			1.000	0.273*	-0.188	-0.179	0.064	0.404**
Productive tillers per square metre				1.000	-0.162	-0.264*	0.431**	0.342*
Panicle length					1.000	0.333*	0.276*	-0.030
Filled grains per panicle						1.000	-0.118	-0.146
Straw yield per plot							1.000	0.363**
Grain yield per plot								1.000

*Significance at 5% level; ** Significance at 1 % level

Table 4: Direct and indirect effects of yield related traits on grain yield

Characters	Days to 50% flowering	Plant Height	Productive tillers per plant	Productive tillers per square metre	Panicle length	Filled grains per panicle	Straw yield per plot	Grain yield per plot
Days to 50% flowering	**0.227**	-0.018	-0.011	-0.025	0.001	-0.059	-0.064	0.049
Plant Height	-0.050	**0.084**	-0.003	-0.018	-0.013	-0.018	0.126	0.107
Productive tillers per plant	-0.007	-0.001	**0.328**	0.039	0.003	0.022	0.018	0.404**
Productive tillers per square metre	-0.040	-0.010	0.089	**0.144**	0.003	0.033	0.122	0.342*
Panicle length	-0.019	0.057	-0.062	-0.023	**-0.019**	-0.042	0.078	-0.030
Filled grains per panicle	0.105	0.012	-0.058	-0.038	-0.006	**-0.127**	-0.033	-0.146
Straw yield per plot	-0.051	0.037	0.021	0.062	-0.005	0.015	**0.283**	0.363**

*Significance at 5% level; ** Significance at 1 % level; Residual effect = 0.82; Diagonal values (in bold) denote the direct effects

A perusal of the results thus emphasized the need for selection based on number of productive tillers per plant, number of productive tillers per square metre, number of filled grains per panicle, straw yield for improvement of grain yield in rainfed rice eco system.

References

Adebisi MA, Ariyo OJ and Kehinde OB. 2001. Variation and Correlation studies in quantitative characteristics in soybean. In: Proceedings of the 35th Annual conference of the Agricultural Society of Nigeria held at the University of Agriculture, Abeokuta September; 16 – 20 Pp 121 – 125.

Al-Jibouri HR, Miller PA and Robinson HF. 1958. Genotypic and environmental variances and covariances in an upland cotton cross of interspecific origin. *Agronomy Journal*. 50: 633-636.

Babu VR, Shreya K, Dangi KS, Usharani G and Nagesh P. 2012. Genetic Variability Studies for Qualitative and Quantitative traits in Popular Rice (*Oryza sativa* L.) Hybrids of India. *International Journal of Scientific and Research Publications.* 2(6): 1-5.

Bekele BD, Naveen GK, Rakhi S and Shashidhar HE. 2013. Genetic evaluation of recombinant inbred lines of rice (*Oryza sativa* L.) for grain zinc concentrations, yield related traits and identification of associated SSR markers. *Pakistan Journal of Biological Sciences.* 16(23): 1714–1721.

Burton GW. 1952. Quantitative inheritance of grasses. In : *Proc 6th Int, Grassland Congress*, 1:277-283.

Dewey DR and Lu KH. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal*. 51: 515-518.

Islam MA, Raffi SA, Hossain MA and Hasan AK. 2015. Character association and path coefficient analysis of grain yield and yield related traits in some promising early to medium duration rice advanced lines. *Int. J. Expt. Agric.* 5(1), 8-12.

Johnson HW, Robinson HF and Comstock RE. 1955. Estimates of genetic and environmental variability in soyabeans. *Agronomy Journal.* 47:314-318.

Kavitha S and Reddy SR. 2002. Variability, heritability and genetic advance of some important traits in rice (*Oryza sativa* L.). *The Andhra Agriculture Journal*. 49(3-4):222-224.

Lenka D and Misra B. 1973. Path co-efficient analysis of yield in rice varieties. *Ind. J. Agric. Sci.* 43: 376-379.

Panse VG, Sukhatme PV. 1967. *Statistical methods for agricultural workers*. ICAR New Delhi, 2nd Edition, pp.381.

Panse VG. 1957. Genetics of quantitative characters in relation to plant breeding. *Indian J Genet.* 17:318-328.

Rashid MM, Nuruzzaman M, Hassan L and Begum SN. 2017. Genetic variability analysis for various yield attributing traits in rice Genotypes. *J. Bangladesh Agril. Univ.* 15(1): 15–19.

Sameera SK, Srinivas T, Rajesh AP, Jayalakshmi V and Nirmala PJ. 2016. Variability and path co-efficient for yield and yield components in rice. *Bangladesh J. Agril. Res.* 41(2): 259-271.

Vanisree S, Swapna K, Raju D, Raju S and Sreedhar M. 2013. Genetic variability and selection criteria in rice. *J. biological and scientific opinion.* 1(4): 341-346.