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Genetic Variability and Character Association in Rice (*Oryza sativa* L.) Under Organic Fertilizer Management

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ABSTRACT

Estimates of genetic parameters and correlation of fourteen quantitative traits including the grain yield were studied in thirty two rice genotypes under organic fertilizer management. Characters like number of grains per panicle, grain yield per plant, number of effective tillers per plant, plant height and harvest index had high estimates of PCV, GCV and broad sense heritability. High heritability coupled with high genetic advance as per cent of mean were recorded for days to 50 % flowering, days to maturity, number of effective tillers per plant, plant height, number of grains per panicle, harvest index, kernel L/B ratio, 1000-grain weight and grain yield per plant. Grain yield per plant exhibited highly significant and positive correlation with number of grains per panicle, harvest index, panicle length, days to 50 % flowering, number of effective tillers per plant and days to maturity suggesting that the improvement in grain yield could be effective under organic fertilizer management, if selection is based on these component characters.

Key words : Correlation coefficient, Heritability, Organic rice,Variability.

Rice (*Oryza sativa* L.), one of the important staple food crops of India, is widely grown in different farming situations. Though India had achieved self-sufficiency in rice production through green revolution in the shortest span of time, our traditional agrosystem
suffered a great setback, especially owing to the indiscriminate use of fertilizers that created the problem of serious environmental consequences. Organic farming is a holistic farm management approach believed to maintain soil productivity and pest control by enhancing natural processes and cycles in harmony with the environment. Farmers are also showing interest due to high premium price for organic produce. But the major constraint is the lack of suitable varieties specifically bred for organic farming which necessitated the need for specific varieties in rice that respond well under the target environment. Any crop improvement programme mainly depends on the magnitude of genetic variability and the extent to which the desirable characters are heritable. Further the expression of grain yield depends upon the interplay of a number of complex component attributes. Knowledge of correlation between grain yield and other characters is helpful in selection of suitable plant type as it provides a measure of association between characters and helps to identify important characters to be considered while making selection. Though several workers extensively investigated about the genetic variation and association analysis for grain yield and its contributing traits under lowland rice condition, such studies under organic fertilizer management are very limited. Hence, the present investigation was undertaken to study the nature and extent of genetic variability along with association among grain yield and its components in thirty two rice genotypes under organic fertilizer management.

MATERIAL AND METHODS

The experiment was conducted employing thirty two rice genotypes at wetland farm, S.V. Agricultural College, Tirupati during late *rabi* season 2011, in randomized block design with three replications for each genotype. The size of each plot was 4 m x 0.6 m comprising of three rows with inter and intra-row spacing of 20 x 15 cm. The recommended dose of 120 kg N was added through FYM (50 %) and neem cake (50 %) in the experimental trial without application of inorganic fertilizers. The observations were recorded on five randomly selected plants from central row of each variety in each replication for twelve characters

viz., days to 50 % flowering, days to maturity, number of effective tillers per plant, plant height, panicle length, number of grains per panicle, harvest index, kernel length, kernel breadth, kernel L/B ratio, kernel length after cooking, kernel elongation ratio, 1000-grain weight and grain yield per plant. Whereas, the data on days to 50 % flowering and days to maturity were considered on plot basis. The data generated on all fourteen characters were subjected to analysis of variance (Panse and Sukhatme, 1961). Genotypic and phenotypic coefficients of variation were calculated using the formula suggested by Burton (1952). The heritability estimates in the broad sense were calculated by the method proposed by Lush (1940). The expected genetic advance at 5 % selection intensity, genetic advance as per cent of mean and genotypic and phenotypic correlations were determined as per the formula suggested by Johnson *et al*. (1955).

RESULTS AND DISCUSSION

The analysis of variance showed highly significant differences among the genotypes for all the characters studied, indicating inherent genetic variability in the material taken up for this study. The range, mean, genotypic and phenotypic coefficients of variation, broad sense heritability and genetic advance as per cent of mean for all the characters studied were presented in Table 1. The difference between phenotypic and genotypic coefficient of variation was very small for all the characters, suggesting that these traits were least affected by the environment and selection for these traits on phenotypic values would be rewarding under organic fertilizer management in rice.

A close examination of experimental results (Table 1) revealed a high estimates of phenotypic and genotypic coefficient of variation for number of grains per panicle followed by grain yield per plant, number of effective tillers per plant, plant height and harvest index indicating the presence of ample variation among the genotypes for these traits. These results were in conformity with the findings of Halil Ahmad *et al*. (2010) for grain yield per plant, number of effective tillers per plant and harvest index. Therefore, simple selection could be effective for further improvement of these characters under organic fertilizer management. A moderate value of phenotypic and genotypic coefficient of variation was observed for 1000-grain weight, kernel L/B ratio and days to 50 % flowering. Similar results were also reported by Lal Mohan and Devendra (2011). Hence, direct selection for these traits might be misleading if adopted for improvement programme through these traits. However, low estimates were observed for days to maturity, kernel breadth, kernel length, kernel length after cooking, kernel elongation ratio and panicle length, indicating low range of variation found in these characters in the present genotypes under organic fertilizer management, thus offering little scope for further improvement of these characters through simple selection. Similar observations were also obtained by Nandan *et al*. (2010) for kernel quality characters and Karim *et al*. (2007) for days to maturity.

The amount of genetic variation considered alone will not be of much use to the breeder unless supplemented with the information on heritability estimates, which gives a measure of the heritable portion of the total variation. In the present study, the high estimates of heritability observed for all the characters viz., days to 50 % flowering, days to maturity, 1000-grain weight, kernel L/B ratio, kernel length, kernel breadth, kernel length after cooking, kernel elongation ratio, number of grains per panicle, plant height, grain yield per plant, harvest index, panicle length and number of effective tillers per plant ranging between 76.10 % (number of effective tillers per plant) and 99.70 % (days to 50 % flowering and days to maturity) suggested that selection would be effective for these characters. Similar results were reported by Samir (2010) in rice under organic fertilizer management.

In addition to genetic variability, heritability values along with genetic advance would also be helpful in predicting the gain under selection than heritability estimates alone. In the present study, days to 50 % flowering, days to maturity, number of effective tillers per plant, plant height, number of grains per panicle, harvest index, kernel L/B ratio, 1000-grain weight and grain yield per plant exhibited high heritability coupled with high genetic advance indicating preponderance of additive gene action. Thus, there is an ample scope for improving these characters under organic

Table 1. Mean, range, co- efficient of variation, heritability (broad sense), genetic advance and genetic advance as per cent of means for 14 characters in rice under organic fertilizer management

Sl. No.	Character	Mean	Range		Variance		Coefficient of Variation		Heritability (Broad sense) (%)	Genetic advance (GA)	Genetic advance as percent of mean (%)
			Min.	Max.	Genotypic	Phenotypic	Genotypic	Phenotypic			
1.	DF	96.08	62.00	116.00	144.16	144.64	12.52	12.50	99.70	24.69	25.70
2.	DM	126.38	89.67	146.67	153.50	153.99	9.82	9.80	99.70	25.48	20.16
3.	ETPP	10.05	5.87	14.33	4.58	6.02	24.40	21.29	76.10	3.85	38.26
4.	PH	67.52	51.03	106.83	180.65	197.43	20.81	19.91	91.50	26.49	39.22
5.	PL	22.00	17.51	24.87	2.85	3.28	8.24	7.67	86.80	3.24	14.73
6.	GPP	158.21	56.93	237.40	1361.19	1461.84	24.17	23.32	93.10	73.34	46.35
7.	HI	42.21	20.12	60.57	71.64	81.92	21.44	20.05	87.40	16.30	38.62
8.	KL	5.81	4.87	7.13	0.22	0.22	8.14	8.11	99.30	0.97	16.65
9.	KB	2.32	1.87	2.67	0.04	0.04	9.01	8.97	99.20	0.43	18.40
10.	K L/B R	2.52	1.95	3.61	0.12	0.12	13.75	13.71	99.40	0.71	28.16
11.	KLAC	8.48	7.28	9.80	0.45	0.45	7.94	7.91	99.20	1.38	16.23
12.	KER	1.46	1.29	1.70	0.013	0.013	7.79	7.71	98.10	0.23	15.74
13.	1000 GW	22.25	15.10	28.20	10.84	10.90	14.84	14.79	99.50	6.76	30.39
14.	GYPP	20.87	10.00	31.67	22.81	25.79	24.33	22.88	88.40	9.25	44.33

DF: Days to 50% flowering; DF: Days to maturity; ETPP: No. of effective tillers per plant; PH: plant height; PL: Panicle length (cm); GPP: No. of grains per panicle; HI: Harvest index; KL: Kernel length (mm); KB: Kernel breadth (mm); K L/B R: Kernel L/B ratio; KLAC: Kernel length after cooking (mm); KER: Kernel elongation ratio; 1000 GW: 1000 Grain weight; GYPP: Grain yield per plant(g)

Table 2. Phenotypic (r_p) and genotypic (r_g) correlation coefficients among grain yield per plant and its components in rice under organic fertilizer management

S	Character		DF	DM	ETPP	PH	PL	GPP	HI	KL	KB	K L/B R	KLAC	KER	1000 GW	GYPP
1	DF	r_p	1.0000	0.9676**	0.0824	-0.4418*	0.3652*	0.6789**	0.3161	-0.1323	-0.5183**	0.2586	-0.2143	-0.0897	-0.3286	0.3651*
		r_g	1.0000	0.9706	0.1081	-0.4601	0.3924	0.7021	0.3404	-0.1336	-0.5218	0.2598	-0.2152	-0.0901	-0.3298	0.3872
2	DM	r_p		1.0000	0.0932	0.4684**	0.3209	0.7125**	0.3668*	-0.1016	-0.4910**	0.2598	-0.1218	-0.0272	-0.3662*	0.3542*
		r_g		1.0000	0.1041	-0.4926	0.3450	0.7349	0.3910	-0.1015	-0.4939	0.2616	-0.1220	-0.0275	-0.3689	0.3720
3	ETPP	r_p			1.0000	-0.2294	0.1655	0.2038	-0.0283	-0.0174	-0.0632	0.0396	0.1858	0.2136	0.0700	0.3568*
		r_g			1.0000	-0.2828	0.2199	0.2516	-0.0405	-0.0187	-0.0691	0.0425	0.2053	0.2367	0.0826	0.4416
4	PH	r_p				1.0000	0.0442	-0.2813	-0.4019*	-0.0336	0.5857**	-0.3804*	-0.3560*	-0.3445*	-0.5214**	-0.1430
		r_g				1.0000	0.0306	-0.3024	-0.4470	-0.0380	0.6133	-0.3991	-0.3736	0.3589	0.5457	-0.1733
5	PL	r_p					1.0000	0.3283	0.0788	-0.0427	-0.0746	0.0477	-0.1652	-0.1167	0. 0362	0.3832*
		r_g					1.0000	0.3663	0.0617	-0.0504	-0.0787	0.0486	-0.1782	-0.1204	0.0449	0.4127
6	GPP	r_p						1.0000	0.3398*	-0.2070	-0.2769	0.0571	-0.1012	0.1118	-0.2233	0.5903**
		r_g						1.0000	0.4034	-0.2155	-0.2879	0.0590	-0.1040	0.1178	-0.2352	0.6539
7	HI	r_p							1.0000	-0.1458	-0.3726*	0.1519	0.0317	0.1860	-0.5484**	0.4492**
		r_g							1.0000	-0.1566	-0.3911	0.1587	0.0319	0.1984	-0.5884	0.4906
8	KL	r_p								1.0000	-0.2493	0.7723**	0.5506**	-0.4871**	0.0167	-0.2020
		r_g								1.0000	-0.2506	0.7727	0.5552	-0.4856	0.0168	-0.2092
9	KB	r_p									1.0000	-	-0.2547	-0.0087	0.6389**	-0.2136
		r_g									1.0000	0.7998**	-0.2561	-0.0087	0.6429	-0.2252
10	K L/B R	r_p										-0.8004	0.5130**	-0.2776	-0.3890*	0.0404
		r_g											0.5166	-0.2762	-0.3910	0.0462
11	KLAC	r_p											1.0000	0.4579**	-0.1941	-0.1059
		r_g											1.0000	0.4550	-0.1952	-0.1067
12	KER	r_p												1.0000	-0.2222	0.1131
		r_g												1.0000	-0.2252	0.1240
13	1000 GW	r_p													1.0000	-0.0739
		r_g													1.0000	-0.0785
14	GYPP	r_p														1.0000
		r_g														1.0000

*,** Significant at 5 % and 1 % level, respectively. DF : Days to 50% flowering; DM : Days to maturity; ETPP : No. of effective tillers per plant; PH : Plant height (cm); PL : Panicle length (cm); GPP : No. of grains per panicle;
HI : Harvest index; KL : Kernel length (mm); KB : Kernel breadth (mm); K L/B R : Kernel L/B Ratio; KLAC : Kernel length after cooking (mm); KER : Kernel elongation ratio; 1000 GW : 1000-grain weight (g); GYPP : Grain yield per plant (g)

fertilizer management. Similar observations were also reported in rice by Jaiswal *et al*. (2007) for number of effective tillers per plant, number of grains per panicle, days to 50 % flowering, plant height, 1000-grain weight, kernel L/B ratio and grain yield per plant in aromatic rice. On the other hand, panicle length, kernel length, kernel breadth, kernel length after cooking and kernel elongation ratio showed high heritability with moderate genetic advance indicating that both additive and non-additive gene effects were involved in the genetic control of these characters. These findings were also in agreement with those of Jaiswal *et al*. (2007) for panicle length, kernel elongation ratio and Veerabadhiran *et al*. (2009) for kernel length after cooking and kernel elongation ratio.

Besides genetic parameters, correlation coefficient is one of the important biometric tools for formulating the selection index, as it reveals the strength of relationship among the group of characters. In the present investigation, the genotypic correlation coefficients were generally higher in magnitude than their respective phenotypic correlation coefficients (Table 2) indicating a strong inherent association among these characters which might be ascribed to be low effect of environment on the character association. Grain yield per plant exhibited highly significant and positive correlations with number of grains per panicle, harvest index, panicle length, days to 50 % flowering, number of effective tillers per plant and days to maturity. Sadeghi (2011) reported similar findings for days to 50 % flowering, panicle length, number of effective tillers per plant, days to maturity and number of grains per panicle.

Considering inter-correlation between yield and yield component traits under organic fertilizer management, it was quite interesting to observe that the characters that showed significant association with grain yield were also mutually correlated with each other. Days to 50 % flowering showed significant and positive correlation with days to maturity, panicle length and number of grains per panicle. Similar results were also reported by Pal *et al*. (2011) for days to maturity and Swain and Reddy (2006) for number of grains per panicle. Days to maturity exhibited significant and positive association with number of grains per panicle and harvest index. These findings were in consonance with Sadeghi (2011). Number of grains per panicle showed significant and positive association with harvest index. Similar results were also observed by Kole *et al* (2008) in aromatic non-basmati rice. Hence, the present results indicated that inter-dependency of the characters and selection of these traits would ultimately enhance the mean performance of all the concerned interdependent characters.

By and large, the results of the present investigation revealed that the traits number of effective tillers per plant, plant height, number of grains per panicle, harvest index and grain yield per plant exhibited high heritability coupled with high genetic advance, implying predominance of additive gene selection. Hence selection for these traits based on phenotypic values would be more effective, leading to greater success in future breeding programme. From correlation analysis, it could be suggested that during selection, more emphasis should be given for the characters viz., number of grains per panicle, harvest index, panicle length, days to 50 % flowering, number of effective tillers per plant and days to maturity as these have high significant and positive association with grain yield per plant. Therefore, direct selection on the basis of these characters would be effective to develop high yielding and fine quality genotypes in rice under organic fertilizer management.

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