Variability and Association Studies for Yield Components and Quality Parameters in Rice Genotypes

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Abstract

Direct selection based on crop yields is often a paradox in breeding programmes because yield is a complex polygenically inherited character, influenced by its component traits. Breeding programmes should, therefore, take into consideration character association of various component traits with yield and among themselves. In this study, seventy rice (*Oryza sativa* L.) genotypes were assessed for genetic variability and correlations between yield and yield components and quality parameters. A wider genetic variability was observed among the genotypes for most of the characters studied. Days to 50 per cent flowering, productive tillers per plant, panicle length, Head Rice Recovery (HRR) and volume expansion ratio manifested significant positive association with grain yield indicating that simultaneous improvement of all the characters is possible. Productive tillers, panicle length, kernel breadth and L/B ratio manifested positive direct effect on grain yield per plant. The relative contribution of characters towards variability and results of correlation and path coefficient indicated the importance of days to 50per cent flowering, ear bearing tillers and panicle length.

Key words: Rice, correlation, path analysis, grain yield, quality parameters.

Rice (*Oryza sativa* L.) is the staple food for about 3.0 billion world's population which may escalate to 4.6 billion by 2050. Rice fulfills the nutritional requirements of half of the world's population. In India, rice is a major food crop supplying 30% of the calorie requirement to the Indian population (Maclean, 2002). The estimation of character association could identify the relative importance of independent character (s) that may be useful as indicator(s) for one or more characters. Similarly, path coefficient analysis partitions the genetic

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correlation between yield and its components into direct and indirect effects. The present study is an attempt for assessing rice genetic variability, and association of various physico-chemical quality characters with yield components and grain yield to provide basis for selection and yield improvement.

Materials and Methods

Seventy genotypes collected from various research stations were evaluated in a randomized block design with two replications during *kharif* 2010 at Rice Research Unit, Bapatla. Each genotype was raised in two rows of five meter length with a spacing of 20x15cm between and within the rows respectively. Observations were recorded on five randomly selected plants from each replication for six yield components *viz.*, days to 50 per cent flowering, plant height, productive tillers, panicle length, test weight and grain yield per plant. The quality parameters *viz.*, head rice recovery, kernel length, kernel breadth, L/B ratio, kernel length after cooking, elongation ratio, water uptake, volume expansion ratio and amylose content were estimated replication-wise on plot basis as per the standard procedures delineated by Murthy and Govinda Swamy (1967), Juliano (1971) and Little *et al.*, (1958). The mean values were utilized for the estimation of genetic parameters and genotypic correlations as per the standard statistical procedures. The correlations were partitioned into direct and indirect effects by path coefficient analysis using the technique outlined by Dewey and Lu (1959).

Results and Discussion

The analysis of variance revealed significant difference among the genotypes for all the characters studied indicating the existence of variation among genotypes for traits under study. Coefficient of variation truly provides a relative measure of variance among the different traits. GCV (Table 1) was found to be highest for water uptake (26.28) followed by grain yield per plant (26.18) and test weight (20.35). As suggested by Subramanian and Menon (1973) the remaining characters were categorized into low and moderate groups with a range of 3.42 (panicle length) to 16.96 (productive tillers/plant). Similar trend was observed for PCV also. Close relationship between GCV and PCV was found in all the characters and PCV values were slightly greater than GCV, revealing very little influence of environment for their expression. Similar results were obtained by Sharma and

Sharma (2007) and Binse *et al.* (2006). Except water uptake, all the quality traits recorded low to moderate variability estimates which corroborate with the results of Kumar *et al.* (2006) and Prasad *et al.* (2009).

Heritability and genetic advance

Heritability plays a vital role in deciding the suitability and adopting breeding strategy for improvement of a particular character. As per Johnson *et al.* (1955) classification, all the fifteen characters under study exhibited high values for broad sense heritability ranging from 97.8% (days to 50% flowering) to 62.8% (volume expansion ratio) except panicle length (34.3%) and amylose content (56.1%) which recorded low values. Although, the presence of high heritability values indicates the effectiveness of selection on the basis of phenotypic performance, it does not show any indication to the amount of genetic progress for selecting the best individuals which is possible by using the estimates of genetic advance. The estimates of genetic advance as per cent of mean was high for grain yield (52.23) followed by water uptake (49.12) and test weight (41.14) while the remaining characters manifested low to moderate values. Similar results were earlier reported by Sharma and Sharma (2007), Bhavana (2003) and Veni *et al.* (2006). High heritability coupled with high genetic advance and high GCV were observed for grain yield per plant, water uptake followed by test weight and productive tillers per plant indicating the preponderance of additive gene action and such characters could be improved through selection. The characters, panicle length and amylose content recorded low estimates for all variability parameters studied suggesting the role of non-additive gene action.

Association analysis

Complete knowledge on interrelationship of plant character like grain yield with other characters is of paramount importance to the breeder for making improvement in complex quantitative character like grain yield for which direct selection is not much effective. Hence, association analysis was undertaken to determine the direction of selection and number of characters to be considered in improving grain yield. Days to 50 per cent flowering, productive tillers per plant, panicle length, head rice recovery and volume expansion ratio manifested significant positive association with grain yield (Table 2) indicating that simultaneous improvement of all the characters is

possible. Sharma and Sharma (2007), Krishna *et al.* (2008) also reported similar findings. Days to 50 per cent flowering also exhibited a significant positive correlation with plant height (0.2709) and ear bearing tillers per plant (0.4728) while its association with L/B ratio is significantly negative. Plant height and productive tillers manifested positive and significant correlation with panicle length. The results are in corroboration with the findings of Kumar and Kannan Bapu (2005) and Krishna *et al.* (2009). Ear bearing tillers and panicle length exhibited significant positive association with head rice recovery. Kernel length (-0.2944), kernel breadth (-0.3755) and elongation ratio (0.3026) manifested significant negative association with grain yield/plant. Among quality traits, kernel length manifested significant positive association with L/B ratio (0.6244) and kernel length after cooking (0.6514) while kernel breadth exhibited significant negative correlation with L/B ratio. Significant positive correlation was observed between L/B ratio and kernel length after cooking and between kernel length after cooking and elongation ratio. Similar results were previously reported by Veni *et al.* (2006). Significant positive correlation was observed between elongation ratio and volume expansion ratio while significant negative relationship was manifested between volume expansion ratio and amylose content.

Path-coefficient analysis using grain yield as dependent variable and other characters as independent variables is presented in Table 3. Productive tillers (0.5687) manifested the maximum direct effect (0.5687) on grain yield /plant followed by kernel breadth (0.2809), L/B ratio (0.2689), KLAC (0.2286) and panicle length (0.1428). Test weight (-0.3035) and kernel length (-0.3285) exhibited negative direct effect on grain yield per plant. The results were in agreement with the previous findings of Krishna *et al.* (2008), Veni *et al.* (2003).Productive tillers manifested positive indirect effect on grain yield/plant through days to 50 per cent flowering (0.2689), panicle length (0.3147), head rice recovery (0.2353) and volume expansion ratio (0.2635). Panicle length and test weight expressed positive indirect effects through days to 50 per cent flowering, plant height and Productive tillers. Among quality traits, kernel length exhibited negative indirect effects through test weight, L/B ratio and kernel length after cooking and its correlation with grain yield/plant is also negative. The association of kernel breadth

with grain yield is significantly negative but its direct effect is positive, under such conditions restricted simultaneous selection is advocated for utilization of their positive indirect effects.

The genetic architecture of grain yield is based on the balance or overall net effect produced by various yield components interacting with one another. Based on the studies on genetic variability and correlation analysis, it may be concluded that productive tillers, panicle length and days to 50 per cent flowering exhibited positive direct effect on grain yield per plant coupled with significant positive association with grain yield per plant. Hence, utmost importance should be given to these characters during selection for single plant yield improvement. Selection of plants on the basis of these traits would certainly lead to improvement in grain yield.

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Table 1: Mean, range and variability parameters for 15 yield components and quality parameters in 70 genotypes of rice

Character	Mean	Range	PCV	GCV	Heritability	Genetic advance as % of mean
DFF (days)	106.95	89-133	11.98	11.84	97.8	24.12
PH (cm)	96.88	74.5-148.0	11.33	11.12	96.3	22.48
EBT	10.42	6.75-15.52	20.02	16.96	71.7	29.59
PL (cm)	22.82	19.2-24.5	5.85	3.42	34.3	4.13
TW (g)	19.71	13.41-32.29	20.73	20.35	96.3	41.14
HRR (%)	59.72	50.3-67.1	7.11	6.31	78.7	11.52
KL (mm)	5.62	3.72-6.97	11.80	11.21	90.3	21.96
KB (mm)	1.99	1.57-2.66	12.59	11.03	76.8	19.91
L/B	2.83	1.99-3.64	13.02	11.41	76.8	20.59
KLAC (mm)	8.88	5.65-12.18	15.54	13.99	81.1	25.95
ER	1.62	1.21-2.06	12.39	10.32	69.4	17.70
WU (ml)	199.26	90.0-347.5	28.97	26.28	82.3	49.12
VER	4.19	2.90-4.80	15.92	12.62	62.8	20.61
AC (%)	24.19	19.36-26.65	7.53	5.64	56.1	8.69
Grain yield/plant (g)	17.85	8.96-28.27	27.04	26.18	93.8	52.23

Significant at 5% level Significant at 1% level

DFF: Days to 50% Flowering; PH: Plant Height; EBT: Ear Bearing Tillers; PL: Panicle Length;TW: Test Weight; HRR:Head Rice Recovery; KL: Kernel Length; KB: Kernel Breadth;L/B: Length/Breadth Ratio; KLAC: Kernel Length after Cooking; ER: Elongation Ratio; WU: Water Uptake; VER: Volume Expansion Ratio; AC: Amylose Content

Table 2: Genotypic correlation coefficients of grain yield with yield components and quality parameters in rice

Character	DFF	PH	EBT	PL	TW	HRR	KL	KB	L/B	KLAC	ER	WU	VER	AC	GY
DFF	1.000	0.2709*	0.473**	0.132	-0.0530	0.1361	-0.4191**	-0.0008	-0.4086**	-0.2110	0.1704	0.1970	0.0055	0.2273	0.3254*
PH		1.000	-0.118	0.299*	-0.0569	-0.3114*	-0.2144	0.0558**	-0.2396	-0.2495*	-0.1243	0.0918	0.0552	-0.0518	-0.0953
EBT			1.000	0.553**	-0.2926*	0.4137**	-0.3185*	-0.4009**	-0.0101	-0.2036	0.1566	0.0481	0.4633**	-0.0823	0.7970**
PL				1.000	-0.1369	0.5146**	-0.3886**	-0.1113	-0.3012*	-0.2106	0.0242	0.2662*	0.0777	-0.5109**	0.4679**
TW					1.000	-0.1687	0.5181**	0.6785**	-0.0599	0.4634**	-0.0097	0.1216	-0.1729	0.4305**	-0.3540*
HRR						1.000	-0.2601*	-0.2338	-0.1020	0.1522	0.4933**	0.1333	0.3340**	-0.1090	0.5195**
KL							1.000	-0.4090**	0.6224**	0.6514**	-0.1765	0.1025	-0.1331	0.0862	-0.2944*
KB								1.000	-0.4582**	0.3297**	-0.0380	0.1824	-0.3805**	0.3854**	-0.3755**
L/B									1.000	0.3319**	0.1648	-0.0313	0.1666	-0.2619*	-0.0093
KLAC										1.000	0.5117**	0.1484	0.2273	0.0035	-0.0272
ER											1.000	0.0264*	0.5217**	-0.0697	0.3026*
WU												1.000	0.0082	0.2246	0.2253
VER													1.000	-0.4775**	0.4991**
AC														1.000	-0.1852

* Significant at 5% level ** Significant at 1% level

DFF: Days to 50% Flowering; PH: Plant Height; EBT: Ear Bearing Tillers; PL: Panicle Length; TW: Test Weight; HRR:Head Rice Recovery; KL: Kernel Length; KB: Kernel Breadth; L/B: Length/Breadth ratio; KLAC: Kernel Length After Cooking; ER: Elongation Ratio; WU: Water Uptake; VER: Volume Expansion Ratio; AC: Amylose Content

Table 3: Path coefficient analysis of grain yield with yield components and quality parameters in rice genotypes

Character	DFF	PH	EBT	PL	TW	HRR	KL	KB	L/B	KLAC	ER	WU	VER	AC
DFF	**0.0023**	0.0006	0.0011	0.0003	-0.0001	0.0003	0.0010	0.000	-0.0010	-0.0005	-0.0004	0.0005	0.0000	0.0005
PH	-0.0144	**-0.0533**	0.0063	-0.0159	0.0030	0.0166	0.0114	-0.0030	0.0128	0.0133	0.0066	-0.0049	-0.0029	0.0028
EBT	0.2689	-0.0669	**0.5687**	0.3147	-0.1664	0.2353	-0.1811	-0.2280	-0.0057	-0.1158	0.0891	0.0274	0.2635	-0.0468
PL	0.0188	0.0426	0.0790	**0.1428**	-0.0195	0.0735	-0.0555	-0.0159	-0.0430	-0.0301	0.0035	0.0380	0.0111	-0.0729
TW	0.0161	0.0173	0.0888	0.0416	**-0.3035**	0.0512	-0.1573	-0.2060	0.0182	-0.1407	0.0029	-0.0369	0.0525	-0.1307
HRR	0.0095	-0.0216	0.0288	0.0358	-0.0117	**0.0695**	-0.0181	-0.0163	-0.0071	0.0106	0.0343	0.0093	0.0232	-0.0076
KL	0.1377	0.0704	0.1046	0.1277	-0.1702	0.0854	**-0.3285**	-0.1343	-0.2044	-0.2140	0.0580	-0.0337	0.0437	-0.0283
KB	-0.0002	0.0157	-0.1126	-0.0313	0.1906	-0.0657	0.1149	**0.2809**	-0.1287	0.0926	-0.0107	0.0512	-0.1069	0.1083
L/B	-0.1099	-0.0644	-0.0027	-0.0810	-0.0161	-0.0274	0.1674	-0.1232	**0.2689**	0.0893	-0.0443	-0.0084	0.0448	-0.0704
KLAC	-0.0482	-0.0570	-0.0465	-0.0481	0.1059	0.0348	0.1489	0.0754	0.0759	**0.2286**	0.1170	0.0339	0.0519	0.0008
ER	-0.0081	0.0059	-0.0075	-0.0012	0.0005	-0.0236	0.0084	0.0018	0.0079	-0.0244	**-0.0477**	0.0013	-0.0249	0.0033
WU	0.0232	0.0108	0.0057	0.0313	0.0143	0.0157	0.0121	0.0215	-0.0037	0.0175	-0.0031	**0.1177**	0.0010	0.0264
VER	0.0011	0.0112	0.0937	0.0157	-0.0350	0.0676	-0.0269	-0.0770	0.0337	0.0460	0.1055	0.0017	**0.2023**	-0.0966
AC	0.0287	-0.0065	-0.0101	-0.0644	0.0543	-0.0137	0.0109	0.0486	-0.0330	0.0004	-0.0088	0.0283	-0.0602	**0.1260**

DFF: Days to 50% Flowering; PH: Plant Height; EBT: Ear Bearing Tillers; PL: Panicle Length;TW: Test Weight; HRR:Head Rice Recovery; KL: Kernel Length; KB: Kernel Breadth;L/B: Length/Breadth Ratio;KLAC: Kernel Length After Cooking; ER: Elongation Ratio; WU: Water Uptake; VER: Volume Expansion Ratio; AC: Amylose Content.

The values in **bold** and diagnolly represented are direct effects and all others are indirect effects.