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Genetic Variability, Correlation and Path-Coefficient Analysis in Early Rice Genotypes

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Abstract

Thirty-four early rice genotypes comprised 28 advanced breeding lines and six check varieties were evaluated for 11 metric characters. High heritability (> 80%) coupled with high expected genetic gain (>20%) was found in respect of traits, viz. panicle number/meter length, grain number tiller, 1,000-grain weight (g), panicle exertion (cm), flag leaf area (sq cm), harvest index (%), and grain yield (q/ha) indicating additive gene action. Larger genotypic variation (>15%) were observed in panicle number/meter length, grain number / tiller, panicle exertion (cm), flag leaf area (sq cm), harvest index (%) and grain yield (q/ha) indicating less influence of environmental fluctuations and thus can be considered as indices to selection. Flag leaf area (sq cm) and harvest index (%) showed significant positive association with grain yield (q/ha). Highest direct contribution to yield (q/ha) was manifested by harvest index (%). Plant height (cm), flag leaf area (sq cm) and harvest index (%) were uniformly found to exert positive effects on yield, hence can be considered as desirable units of selection in high yielding genotypes of early rice.

Key words : Character association, Path-coefficient, Genetic variability, Rice.

Rice is considered as a semi-aquatic annual plant grown in varied agro-ecosystem under wide range of soil-water regimes, from a prolonged period of flooding in deep water to dry land on hilly slopes. In *kharif* season the early rice varieties are generally grown under rainfed direct seeded condition which gives low yield. In Orissa it covers 4.43 m ha, with a production and productivity of 4.61 million tonnes and 1,041 kg/ha respectively. The productivity is less than national productivity of 1,913 kg/ha. The rainfed uplands in Orissa, in particular contribute about 20% of the total rice growing area in *kharif* season, where this crop is subjected to different biotic and abiotic stresses, in different stages of crop growth, resulting in tremendous yield fluctuations. To assess the yield potential of upland rice genotypes in the direct seeded condition 34 rice genotypes comprised 28 advanced breeding lines and six check varieties were evaluated under upland condition at the Rice Research Station, Department of Plant Breeding and Genetics, OUAT, Bhubaneswar, during *kharif* of 2001.

Methods

Thirty-four early rice genotypes were direct seeded on 20 July, 2001. The trial was laid out in a randomized block design with two replications. The plot size was 4.8 m^2 with 8 lines of three meter length with a line spacing of 20 cm. The recommended fertilizer dose of 60 : 30 : 30 kg of N, P, K / ha was used to raise the crop. The entire P was applied as basal, entire N as top dress and half of the K as basal and rest as top dress. The other recommended crop management practices were followed, including need based plant protection to raise a normal crop. Observations were recorded on five competitive plants in each replication in respect of eight metric traits i.e. plant height (cm), panicle length (cm), grain number / tiller, fertility (%), 1,000-grain weight, panicle exertion (cm), flag leaf area (sq cm) and harvest index (%). Observations with respect to traits viz. days to 50% flowering, panicle number/meter length and grain yield per plot (q/ha) were recorded on plot basis. The genotypic and phenotypic coefficients of variation were calculated (1). Genetic advance was estimated (2) to have an insight into the extend of genetic gain under selection. Path coefficient analysis was undertaken (3) to study the direct and indirect contribution of characters towards yield.

Results and Discussion

Thirty-four early rice genotypes exhibited con-

Table 1. Genetic parameters of yield and component traits in early rice genotypes.

Characters	Mean	Range	GCV (%)	PCV (%)	CV (%)	h^2 (bs) (%)	GA (at 20%)	GA % over mean
Days to 50 % flowering	63.47	54.00—75.00	6.71	6.92	1.69	94.00	8.51	13.40
Plant height (cm)	79.98	69.50—97.80	8.17	8.53	2.44	91.80	12.90	16.12
Panicle length (cm)	20.97	17.30—24.60	6.16	7.44	4.17	68.50	2.20	10.49
Panicle number/meter length	76.66	50.50—118.50	17.00	17.85	5.44	90.70	25.57	33.35
Grain number/tiller	71.50	49.50—103.50	19.12	19.69	4.68	94.30	27.36	38.26
Fertility (%)	77.79	60.65—90.35	9.19	9.58	2.70	92.00	14.13	18.16
1000-grain weight (g)	22.59	16.10—27.40	11.16	11.51	2.80	94.10	5.04	22.31
Panicle exertion (cm)	4.74	1.75—8.75	39.75	42.56	15.22	87.20	3.63	76.58
Flag leaf area (sq cm)	21.34	11.45—31.75	19.92	21.99	9.31	82.10	7.94	37.20
Harvest index (%)	42.17	24.90—54.10	15.40	16.09	4.65	91.60	12.81	30.38
Grain yield (q/ha)	24.64	15.50—37.65	21.21	22.90	8.63	85.80	9.97	40.46

siderable variations in traits. All the characters studied had coefficients of variation less than 20% which reflected a good deal of experimental precision in evaluating the genotypes. The coefficient of variation estimate more (> 15%) only in panicle exertion (cm) which indicated vulnerable nature of the character. The estimates of phenotypic coefficients of variation were as usual higher than genotypic coefficients of variation for all characters, indicating significant role of the environment in the expression of the characters. The genotypic coefficients of variation ranged from 6.16% in panicle length (cm) to 39.75% in panicle exertion (cm). Larger genotypic coefficients of variation (> 15%) were observed in panicle number/meter length, grain number/tiller, panicle exertion (cm), flag leaf area (sq cm), harvest index (%), and grain yield (q/ha) (Table 1). So these characters are likely to be less influenced by environmental conditions and thus can be considered as indices to selection. Results on variability studies in rice are amply available and the findings in the present study were in close agreement with the published reports (4—6). The phenotypic coefficients of variation ranged from 6.92% in days to 50% flowering to 42.56% in panicle exertion (cm). Results have been obtained by the other rice worker (7) which indicated that the characters had interacted with the environment to some degree for their expression. However, the degree of influence of environment varied with the character and the environment in which the genotypes have been evaluated. All the characters showed high heritability (> 60%) and genetic advance in percentage of mean was found to be as high as 76.58% for panicle exertion (cm). Characters like days to 50% flowering, plant height (cm), panicle number / meter length, fertility (%), 1,000-grain weight and harvest index (%) showed high heritability (> 90%). Similar results have been obtained by the previous workers (8, 9). Contradictory results have also been found in some cases which might be due to the number of genotypes studied, variability present in the population and the type of environment in which the genotypes were evaluated. High heritability values indicated that criteria for selection might be chosen from among these characters on the basis of phenotypic performance.

The genetic advance in percentage of mean was high (> 20%) in panicle number/meter length, grain number/tiller, 1,000-grain weight (g), panicle exertion (cm), flag leaf area (sq cm), harvest index (%), and grain yield (q/ha) and thus points to the predominance of additive effects (10) and can be taken as unit characters for effective selection. High genetic advance for one or more of these characters have also been reported earlier (11, 12).

High heritability (>80%) coupled with high expected genetic advance (> 20%) was found in panicle number/meter length, grain number/tiller, 1,000-grain weight (g), panicle exertion (cm), flag leaf area (sq cm), harvest index (%), and grain yield (q/ha) which indicated the presence of additive gene effects for these characters. Days to 50% flowering showed high heritability with moderate genetic advance reflecting the presence of both additive and non-

Table 2. Estimates of genotypic (r_g) and phenotypic (r_p) correlation coefficients among various characters in early rice genotypes. *and** significant at 5 and 1% respectively.

Characters		Days to 50% flowering	Plant height (cm)	Panicle length (cm)	Panicle number/ meter length	Grain number/ tiller	Fertility (%)	1000-Grain weight (g)	Panicle exertion (cm)	Flag leaf area (sq cm)	Harvest index (%)	Grain yield (q/ha)
Days to 50% flowering	r_g		0.360*	0.084	–0.130	0.280	– 0.088	–0.001	–0.228	– 0.336	–0.356*	– 0.158
	r_p		0.353*	0.047	–0.120	0.261	– 0.055	–0.001	–0.214	– 0.305	–0.339*	– 0.125
Plant height (cm)	r_g			0.450*	–0.178	0.408*	0.015	0.155	0.034	0.162	–0.293	0.170
	r_p			0.415*	–0.152	0.396*	0.026	0.155	0.030	0.165	–0.250	0.163
Panicle length (cm)	r_g				–0.134	0.424*	– 0.296	–0.045	0.229	0.348*	–0.473**	0.038
	r_p				–0.092	0.381*	– 0.237	–0.037	0.224	0.277	–0.387*	0.046
Panicle number/ meter length	r_g					– 0.376*	0.262	–0.317	–0.041	– 0.286	0.085	0.090
	r_p					– 0.335	0.245	–0.290	–0.027	– 0.232	0.080	0.081
Grain number/ tiller							0.153	–0.149	0.237	0.319	0.044	0.159
	r_p						0.148	–0.149	0.221	0.304	0.044	0.162
Fertility (%)	r_g							0.041	0.455**	– 0.180	0.339*	0.053
	r_p							0.031	0.424*	– 0.199	0.301	0.048
1000-Grain weight (g)	r_g								0.070	0.213	0.109	0.328
	r_p								0.064	0.174	0.101	0.298
Panicle exertion (cm)	r_g									0.372*	0.216	0.193
	r_p									0.331	0.214	0.142
Flag leaf area (sq cm)	r_g										0.267	0.519**
	r_p										0.264	0.406*
Harvest index (%)	r_g											0.599**
	r_p											0.503**

additive gene effects. Similar reports like high heritability coupled with high genetic advance have also been reported (9, 13) in early rice genotypes.

High heritability values coupled with moderate to high genetic advance for yield and its components characters like days to 50% flowering, plant height (cm), panicle number/meter length, grain number/tiller, 1,000-grain weight (g), panicle exertion (cm), flag leaf area (sq cm), harvest index (%) and grain yield (q/ha) revealed substantial genetic variability and ample scope for selection, since variability is a prerequisite for success in the selection of productive genotypes (14).

The genotypic correlations (r_g) were higher in magnitude than the phenotypic correlations (r_p) (Table 2). Days to 50% flowering exhibited significant positive association with plant height but significant negative association with harvest index both at genotypic and phenotypic levels. Plant height (cm) exhibited highly significant positive association with panicle length (cm) at genotypic level, but it exhibited only a significant association with grain number/ tiller at 5% probability level. At phenotypic level, it exhibited a positive significant association with both panicle length (cm) and grain number/tiller. At both phenotypic and genotypic levels significant positive association was observed between panicle length with grain number / tiller and plant height (cm). Panicle length exhibited significant negative association with harvest index at genotypic level and at phe-

Table 3. Direct (diagonal) and indirect effects of component traits on grain yield at the phenotypic level in early rice genotypes. Residual effect = 0.5075.

Traits	DF	PH	PL	PN	GN	FT (%)	GW	PE	FLA	HI (%)	Correlation with yield
Days to 50% flowering	**0.024**	0.057	0.004	–0.035	0.041	0.008	0.000	0.006	– 0.050	–0.180	–0.125
Plant height (cm)	0.008	**0.163**	0.036	–0.044	0.063	– 0.004	0.048	– 0.001	0.027	–0.133	0.163
Panicle length (cm)	0.001	0.068	**0.086**	**–**0.027	0.060	0.036	–0.012	–0.006	0.046	–0.206	0.046
Panicle number/ meter length	–0.003	– 0.025	–0.008	**0.292**	**–**0.053	– 0.038	–0.090	0.001	– 0.038	0.043	0.081
Grain number/ tiller	0.006	0.064	0.033	–0.098	**0.159**	**–** 0.023	–0.046	– 0.006	0.050	0.023	0.162
Fertility (%)	–0.001	0.004	– 0.020	0.071	0.023	– **0.154**	0.010	– 0.012	– 0.033	0.160	0.048
1000-grain weight (g)	0.000	0.025	– 0.003	–0.085	–0.024	– 0.005	**0.309**	**–** 0.002	0.029	0.054	0.298
Panicle exertion (cm)	– 0.005	0.005	0.019	–0.008	0.035	– 0.065	0.020	– **0.028**	0.055	0.114	0.142
Flag leaf area (sq cm)	– 0.007	0.027	0.024	– 0.068	0.048	0.031	0.054	– 0.009	**0.165**	0.141	0.406
Harvest index (%)	–0.008	– 0.041	– 0.033	0.023	0.007	– 0.046	0.031	– 0.006	0.044	**0.532**	0.503

notypic level it showed negative association only at 5% level. Panicle number / meter length exhibited a negative association with grain number, but it was significant at genotypic level. Fertility (%) showed strong positive significant association with panicle exertion (cm) at genotypic level, but at phenotypic level, it was significant only at 5% level. Panicle exertion (cm) exhibited positive association with fertility (%) at both the levels (r_g and r_p), but with flag leaf area (sq cm) it was significant at 5% in genotypic level. Flag leaf area (sq cm) was found to bear highly positive significant association with grain yield at genotypic level, but at phenotypic level, it was signifi-cant only at 5% level. It also exhibited positive association with panicle length and panicle exertion at genotypic level which was significant. The grain yi-eld exhibited significant association only with harvest index and flag leaf area both at phenotypic and genotypic levels.

In the present investigation, genotypic correlations (r_g) were higher in magnitude than phenotypic correlations (r_p) which indicates that the environmental cause of correlation has affected the genetic cause. Flag leaf area (sq cm) had significant positive association with grain yield. So selection on the basis of this component would be reliable for improving grain yield. Similar observation has also been reported earlier (15). Harvest index (%) had a significant positive

association with grain yield. In addition to flag leaf area (sq cm), harvest index (%) can also be taken as a component for selecting high yielding genotypes in rainfed upland condition. This confirms the previous observation (16). Days to 50% flowering showed negative association though not significant with yield. As stated earlier (4) the rapid phenological development under upland moisture stress condition might be the main cause for such type of relationship.

The phenotypic correlation (r_p) of the traits with grain yield was partitioned into direct and indirect effects on yields (Table 3). Positive and direct effects of harvest index (%), 1,000-grain weight (g), panicle number / meter length and flag leaf area (sq cm) were observed in that order and were partially nullified by the negative indirect effects of other characters. The direct effect of harvest index (%) on grain yield (q/ha) was highest and positive. The indirect effects of harvest index (%) via other characters were negligible. The direct effect of days to 50% flowering on grain yield was positive and low, but it was masked by the greater negative effect via harvest index (%), thus causing negative correlation. Panicle length (cm) bears highest positive direct effect on yield (q/ha) followed by indirect effects via plant height (cm), grain number/tiller, flag leaf area (sq cm), fertility (%) and days to 50% flowering. Direct effect of grain number/tiller with yield (q/ha) was positive and it was almost equal with the correlation value, the indirect effects being negligible and were both in the positive and negative directions. Flag leaf area (sq cm) being positive along with higher indirect effect via harvest index (%) contributed mainly to the yield (q/ha), other indirect effects being negligible and in both the positive and negative directions. The direct effect of harvest index (%) contributed maximum to the yield.

Thus the highest direct contribution to yield (q/ha) was manifested by harvest index. The path coefficients worked out in different sets of characters (8, 17) showed remarkable differences in direct and indirect effects of different component characters on grain yield (q/ha) in upland rice genotypes. Direct effect of harvest index (%) on yield (q/ha) (16, 18) and of plant height (cm) (17, 19) has been reported. Though days to 50% flowering had a positive direct effect on yield (q/ha), the other indirect effects exerted substantial negative effects, causing negative correlation with yield (q/ha). Hence this character should not be taken into consideration for improving yield in upland rice genotypes. Plant height (cm), flag leaf area (sq cm) and harvest index (%) were uniformly found to exert positive effects on yield (q/ha), hence can be considered as desirable units of selection in high yielding genotypes.

References

1. Bruton G. W. 1952. Quantitative inheritance in grasses. Proc. 6th Int. Grass Land Cong. 1 : 277—283.
2. Johnson H. W., H. F. Rabinson and R. E. Comstock. 1955. Estimates of genetic and environmental variability in soybean. Agron. J. 47 : 314—318.
3. Dewey D. R. and H. U. Lu. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agron. J. 51 : 515—518.
4. Roy A. and M. K. Kar. 1992. Heritability and correlation studies in upland rice. Oryza 29 : 195—199.
5. Chaubey P. K. and A. K. Richharia. 1993. Genetic variability, correlations and path coefficients in indica rices. Indian J. Gen. and Pl. Breed. 53 : 356—360.
6. Chauhan J. S. 1996. Genotypic and phenotypic correlations between grain yield and other associated characters in very early duration elite breeding cultures of rice. Oryza 33 : 26—30.
7. Singh S. and B. S. Choudhuary. 1996. Variability, heritability and genetic advance in cultivars of rice (*Oryza sativa* L.). Crop Res. Hisar 12 : 165—167.
8. Balan A., A. R. Muthaih and SNMR Boopathi. 1999. Genetic variability, correlation and path coefficient analysis in upland rice genotypes. Madras Agric. J. 86 : 7—9.
9. Shivani D. and N. S. R. Reddy. 2000. Variability heritability and genetic advance for morphological and physiological in certain rice hybrids. Oryza 37 : 231—233.
10. Panse G. V. 1957. Genetics of quantitative characters in relation to plant breeding. Indian J. Gen. and Pl. Breed. 17 : 318—328.
11. Chaubey P. K. and R. P. Singh. 1994. Genetic variability, correlation and path analysis of yield components in rice. Madras Agric. J. 81 : 468—470.
12. Roy A., D. V. S. Panwar and R. N. Sharma. 1995. Genetic variability and causal relationship in rice. Madras Agric. J. 82 : 251—255.
13. Yadav R. K. 2000. Studied on genetic variability for some quantitative characters in rice (*Oryza sativa* L.). Adv. in Agric. Res. in India 13 : 205—207.
14. Dhankodi C. V. and M. Sbramanian. 1994. Genetic variability for yield and its component characters in rice. Madras Agric. J. 81 : 150—151.
15. Reddy C. D. R. and D. Ramachandraiah. 1990. Genotypic correlation of components of yield in parents

and their F_{28} in rice (*Oryza sativa* L.). Orissa J. Agric. Res. 3 : 136—142.

16. Kavitha S. and N. S. R. Reddi. 2001. Correlation and Path analysis of yield components in rice (*Oryza sativa* L.). Andhra Agric. J. 48 : 311—314.
17. Janardhanam V., N. Nadarajan and S. Jebaraj. 2001. Correlation and path analysis in rice (*Oryza sativa* L.). Madras Agric. J. 88 : 719—720.
18. Rao T. P., P. Gomathinayagam and G. Sundarpandian. 1996. Genetic variability and character association studies in semi dry rice. Madras Agric. J. 83 : 185—188
19. Ramakrishnayya G., R. N. De, N. K. Mahana and D. P. Bhattacharjee. 1991. Direct and indirect effect of some characters on grain yield in low land rice (*Oryza sativa* L.). Oryza 28 : 117—118.