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Research Note

Genetic parameters of variability, correlation and path-coefficient for grain yield and physiological traits in rice (*Oryza sativa* L.) under shallow lowland situation

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Abstract:
Studies on genetic variability, character association and path-coefficient analysis were conducted on forty seven (47) rice genotypes including thirty three hybrids and fourteen parents for grain yield and some physiological traits. Analysis of variance revealed considerable variability among the genotypes for all the characters. A high genotypic and phenotypic coefficient of variation was observed for grain yield per plant, harvest index, pollen fertility (%) and spikelet fertility (%). Characters like pollen fertility (%), spikelet fertility (%), days to 50% flowering and grain yield per plant showed high value of heritability coupled with high genetic advance. Spikelet fertility (%) and harvest index showed positive and significant correlation with seed yield per plant both at genotypic and phenotypic levels. Results of path-coefficient analysis revealed that productive tillers per plant had the highest positive direct effect on grain yield followed by harvest index, spikelet fertility (%), pollen fertility (%) and plant height. The study revealed that genetic improvement of grain yield in rice is admissible by selecting characters having high positive correlation and positive direct effect.

Key words:
Genetic variability, correlations and path-coefficients, heritability, genetic advance.

The world population is expected to reach eight billion by 2030 and rice production must increase by 50 per cent in order to meet the growing demand (Khush & Brar, 2002). Genetic variability for agronomic traits is the key component of breeding programs for broadening the gene pool of rice and other crops. The genetic coefficient of variation together with heritability estimate would give the best picture of the amount of advance to be expected from selection. The amount of genetic advance under selection depends mainly on the amount of genetic variability. The basic objective of most of the crop improvement programs is to realize a marked improvement in crop yield. But yield is a complex character which is controlled by association of various characters. Thus, information on association of yield attributes and their direct and indirect effects on grain yield are of paramount significance. Hence, path analysis is of much importance in any plant breeding program. Correlation in combination with path analysis would give a better insight into cause and effect relationship between different pairs of characters.

The experimental material comprised forty seven genotypes of rice including fourteen parents and their thirty three hybrids. The set of hybrids were generated during *rabi* 2006 in line x tester pattern for the purpose and evaluated along with parents in Randomized Complete Block Design with two replications at Experimental Research Farm under rainfed shallow lowland situation during *kharif* 2007. Twenty one days old seedlings of 33 hybrids and 14 parents were transplanted in the field. A standard

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spacing of 20 x 20 cm was adopted for planting and 12 plants were maintained in a single row. Single seedling per hill was transplanted. Recommended package of practices were followed. Observations were recorded on five randomly selected plants in both the replications for thirteen traits *viz*., Days to 50% flowering, plant height, tillers per plant, productive tillers per plant, panicle length, flag leaf angle, second leaf angle, third leaf angle, flag leaf area, pollen fertility (%), spikelet fertility (%), harvest index (%) and grain yield per plant. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated by the method suggested by Singh and Chaudhary (1985). Heritability for the grain yield and yield components of hybrids were worked out in broad sense by adopting formula suggested by Hanson *et al.* (1956). Genetic advance (GA) was calculated by the method suggested by Johnson *et al.* (1955). Genotypic and phenotypic correlations were partitioned into path coefficient using the technique outlined by Dewey and Lu (1959).

Analysis of variance revealed that all the genotypes differed highly significantly for all the characters under study (Table 1), which suggests that there is ample scope for improvement in the germplasm available. A wide range for all the traits indicates the existence of variation among genotypes for different traits. Coefficient of variation truly provides a relative measure of variance among the different traits. Genotypic coefficient of variation (GCV) (Table 2) was found to be highest for grain yield per plant followed by harvest index, pollen fertility (%), productive tillers per plant and spikelet fertility (%). Similar trend was observed for phenotypic coefficient of variation (PCV). The magnitude of differences between phenotypic coefficients of variability (PCV) and genotypic coefficients of variability (GCV) was observed to be relatively low for all the traits indicating less environmental influence. High variability recorded for grain yield per plant indicated additive gene action to be important for this trait. Similar results were obtained by Mourya *et al. (*1986), Madhavilatha *et al*. (2005), Ananthi *et al*. (2006) and Patra *et al.*(2006).

Heritability plays an important role in deciding the suitability and strategy for selection of a character. All the thirteen characters under study exhibited high broad sense heritability. Highest estimate of heritability was recorded for pollen fertility (%) and spikelet fertility (%) followed by days to 50% flowering, grain yield per plant and harvest index indicating high scope of genetic improvement of these characters through selection. Similar results have been reported by Bhandarkar *et al*. (2002), Kuldeep *et al.* (2004) and Patra *et al*. (2006). Though high heritability indicates the effectiveness of selection on the basis of phenotypic performance, it does not show any indication of the amount of genetic progress for selecting the best individuals which is possible by using the estimates of genetic advance. Pollen fertility (%), spikelet fertility (%), harvest index and plant height had high heritability coupled with high genetic advance. Hence heritability with high genetic advance indicates the preponderance of additive gene action and such characters could be improved through selection. Similar findings were recorded by Singh and Singh (2005).The genotypic and phenotypic correlation coefficients among different traits are given in the Table 3. In general, the genotypic correlation coefficients were slightly higher than phenotypic correlation coefficients. But according to table 2 PCV were slightly higher than GCV. Two characters viz., spikelet fertility (%) and harvest index were found to have positive and significant correlation with grain yield per plant at both phenotypic and genotypic levels. This indicates strong association of these traits with grain yield. This is in agreement with work of Srinivasa Rao *et al*. (2001) for spikelet fertility. Rajesh Kumar *et al*. (2000) and Sarawgi *et al*. (1997) reported that spikelet fertility exhibited significantly positive correlation with grain yield. Lu *et al*. (1988) and Sarawgi *et al*. (1997) reported that harvest index had significantly positive correlation with grain yield. This reveals the importance of these components in increasing the grain yield. Characters like days to 50% flowering, tillers per plant, productive tillers per plant, flag leaf angle and pollen fertility (%) exhibited positive and non significant correlation with grain yield per plant which is as reported by Balan *et al*. (1999).

Considering their inter relationship, among yield components, plant height is positively and significantly associated with panicle length, flag leaf area and pollen fertility (%). Panicle length itself is positively correlated with flag leaf area and pollen fertility (%). Similar results for plant height association with pollen fertility (%) was reported by Eradasappa *et al*. (2007). In turn, pollen fertility was significantly and positively correlated with spikelet fertility (%) and harvest index. Selection for pollen fertility (%) indirectly increases the spikelet fertility

(%), which in turn increases the grain yield per plant. Tillers per plant was significantly and positively correlated with productive tillers per plant and this was also reported by Madhavilatha *et al*. (2005). Flag leaf angle was significantly positively correlated with second leaf angle and third leaf angle. Second leaf angle in turn was significantly correlated with third leaf angle. The correlation analysis, however, did not reveal any significant association of grain yield per plant with flag leaf area (length x breadth), flag leaf angle, second leaf angle and third leaf angle. This may be due to a high negative indirect effect via flag leaf area. Similar reports of grain yield per plant association with flag leaf area was reported by Sarawgi *et al*. (1997). The correlation studies facilitate the assessment of the chance for mutual improvement of two traits by common selection.

Path-coefficient analysis using grain yield as dependent variable and other characters as independent variables is presented in Table 4. Direct and indirect path coefficient values at genotypic level depict that harvest index, productive tillers per plant, spikelet fertility (%), pollen fertility (%), plant height, flag leaf area, third leaf area and days to 50% flowering had positive direct effect on grain yield. Positive direct effects of these traits on grain yield indicated their importance in determining this complex character and therefore should be kept in mind while practicing selection aimed at the improvement of grain yield. Similar results were also reported by Gawai *et al*. (2006) for days to 50% flowering, plant height, productive tillers per plant and harvest index, Sundaram and Palanisamy (1994) for spikelet fertility (%).

Tillers per plant registered a negative direct effect on grain yield. Plant height and third leaf angle having positive direct effect could not contribute towards grain yield per plant due to preponderance of negative indirect effect. Panicle length, flag leaf area and second leaf angle showed a low negative direct effect indicating negligible influence of this trait on grain yield.Harvest index and spikelet fertility (%) exhibited positive and significant association with grain yield mainly due to its positive direct effects. In the present study, path-coefficient analysis revealed that harvest index and spikelet fertility (%) exerted high direct influence on grain yield per plant. Selection of plants on the basis of these traits would certainly lead to improvement in grain yield.

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Table 1: Analysis of Variance (ANOVA) for grain yield and its attributing characters in rice

Source of variation	DF	Days to 50% flowering	Plant height (cm)	Tillers per plant	Productive tillers per plant	Panicle Length (cm)	Flag leaf angle	IInd leaf angle	IIIrd leaf angle	Flag leaf area (cm2)	Pollen fertility (%)	Spikelet fertility (%)	Harvest index(%)	Grain yield (gm)
Replication	1	1.313*	4.125	0.099	0.414	2.171*	4.679	8.390*	16.343*	12.093	2.500	0.313	0.063	0.009
Treatment	46	113.75**	601.99**	12.277**	12.039**	16.976**	158.547**	142.82**	102.631**	364.109**	1522.198**	1112.97**	357.765**	187.460**
Error	46	0.308	11.328	0.846	0.807	0.538	1.320	1.449	1.094	3.700	2.253	1.414	1.430	0.662

*** =significant of p=0.05 level** ****=significant of p=0.01 level**

Table 2: Variability parameters for 13 traits in 47 genotypes of rice

Traits: / Parameter:		Days to 50% flowering	Plant height (cm)	Tillers per plant	Productive tillers per plant	Panicle Length (cm)	Flag leaf angle (degree)	IInd leaf angle (degree)	IIIrd leaf angle (degree)	Flag leaf area (cm^2)	Pollen fertility (%)	Spikelet fertility (%)	Harvest index (%)	Grain yield (gm)
Range	Min.	87.50	75.35	2.66	2.00	20.05	10.84	10.84	18.17	21.05	0.01	15.61	4.00	2.50
	Max	117.00	156.43	14.84	14.66	37.50	55.50	49.33	46.11	75.68	96.88	97.07	48.17	50.50
Mean		101.39	111.73	8.59	7.32	25.77	31.33	32.06	33.27	51.92	72.54	73.22	32.31	16.29
SEm (±)		0.553	3.365	0.919	0.898	0.733	1.149	1.203	1.046	1.923	1.500	1.189	1.195	0.813
PCV (%)		7.45	15.67	29.82	34.61	11.48	28.54	26.49	21.65	26.12	38.06	32.24	41.48	59.53
GCV (%)		7.43	15.38	27.83	32.37	11.13	28.30	26.23	21.42	25.85	38.00	32.20	41.31	59.32
Heritability broad sense h^2 (%)		99.50	96.30	87.10	87.40	93.90	98.30	98.00	97.90	98.00	99.70	99.70	99.20	99.30
Genetic advance (K= 2.06)		15.47	34.74	4.69	4.57	5.72	18.11	17.14	14.52	27.37	56.71	48.50	27.39	19.84

Table 3: Estimates of genotypic (g) and phenotypic (p) correlation coefficients for different quantitative traits in 47 genotypes of rice

Traits	r	Days to 50% flowering	Plant height (cm)	Tillers per plant	Productive tillers per plant	Panical Length (cm)	Flag leaf angle (degree)	IInd leaf angle (degree)	IIIrd leaf angle (degree)	Flag leaf area (cm2)	Pollen fertility (%)	Spikelet fertility (%)	Harvest index (%)	Grain yield (gm)
Days to 50% flowering	g		-0.245	-0.024	0.008	-0.320	-0.127	-0.337	-0.147	0.079	-0.038	0.102	0.134	0.203
	p		-0.245	-0.019	0.009	-0.317	-0.124	-0.331	-0.144	0.079	-0.038	0.102	0.133	0.201
Plant height	g			-0.003	-0.116	0.717**	0.069	0.218	0.264	0.289*	0.424**	-0.049	0.026	-0.044
	p			-0.002	-0.109	0.697**	0.065	0.211	0.257	0.278	0.416**	-0.048	0.027	-0.041
Tillers per plant	g				0.980**	0.240	-0.172	-0.074	-0.125	0.152	-0.133	0.120	0.131	0.167
	p				0.955**	0.215	-0.150	-0.055	-0.101	0.145	-0.127	0.112	0.124	0.167
Productive tillers per plant	g					0.129	-0.139	-0.094	-0.160	0.132	-0.195	0.202	0.175	0.260
	p					0.105	-0.116	-0.069	-0.132	0.133	-0.185	0.189	0.166	0.252
Panical Length(cm	g						-0.076	0.182	0.086	0.350*	0.302*	-0.138	-0.102	-0.186
	p						-0.078	0.173	0.076	0.336*	0.295*	-0.132	-0.100	-0.180
Flag leaf angle (degree)	g							0.611**	0.531**	-0.149	-0.023	-0.009	-0.030	0.038
	p							0.604**	0.526**	-0.146	-0.025	-0.009	-0.028	0.037
IInd leaf angle (degree)	g								0.682**	-0.151	0.170	-0.119	-0.103	-0.188
	p								0.668**	-0.147	0.166	-0.118	-0.101	-0.184
IIIrd leaf angle (degree)	g									-0.139	0.057	-0.138	-0.101	-0.146
	p									-0.137	0.055	-0.136	-0.098	-0.143
Flag leaf area(cm2)	g										0.091	0.000	-0.051	-0.083
	p										0.089	0.000	-0.054	-0.082
Pollen fertility(%)	g											0.531**	0.431**	0.234
	p											0.530**	0.429**	0.233
Spikelet fertility(%)	g												0.804**	0.695**
	p												0.801**	0.693**
Harvest index (%)	g													0.771**
	p													0.767**

**Significant at 1 % level of significance *Significant at 5 % level of significance

Table 4: Direct (diagonal) and indirect effects of component traits to grain yield in 47 rice genotypes at genotypic level

Traits	Days to 50% flowering	Plant height (cm)	Tillers per plant	Productive tillers per plant	Panical Length (cm)	Flag leaf Angle degree	IInd leaf angle degree	IIIrd leaf angle degree	Flag leaf area(cm2)	Pollen fertility(%)	Spikelet fertility(%)	Harvest index(%)	Correlation with grain yield
Days to 50% flowering	0.051	-0.065	0.071	0.024	0.011	-0.014	0.099	-0.010	-0.011	-0.012	-0.034	0.092	0.203
Plant height(cm)	-0.012	0.266	0.010	-0.367	-0.025	0.007	-0.067	0.018	-0.041	0.129	0.016	0.018	-0.044
Tillers per plant	-0.001	-0.001	-2.901	3.096	-0.008	-0.019	0.022	-0.008	-0.021	-0.041	-0.040	0.090	0.167
Productive tillers per plant	0.000	-0.031	-2.843	3.160	-0.004	-0.015	0.028	-0.011	-0.019	-0.060	-0.067	0.120	0.260
Panical Length	-0.016	0.191	-0.696	0.407	-0.035	-0.008	-0.054	0.006	-0.049	0.092	0.046	-0.071	-0.186
Flag leaf angle degree	-0.006	0.018	0.500	-0.438	0.003	0.108	-0.179	0.036	0.021	-0.007	0.003	-0.021	0.038
IInd leaf angle degree	-0.017	0.058	0.214	-0.297	-0.006	0.006	-0.294	0.046	0.021	0.052	0.040	-0.071	-0.188
IIIrd leaf angle degree	-0.007	0.070	0.363	-0.506	-0.003	0.057	-0.200	0.068	0.019	0.017	0.046	-0.069	-0.146
Flag leaf area(cm2)	0.004	0.077	-0.442	0.418	-0.012	-0.016	0.044	-0.009	-0.140	0.028	0.000	-0.035	-0.083
Pollen fertility(%)	-0.002	0.113	0.387	-0.618	-0.011	-0.002	-0.050	0.004	-0.013	0.305	-0.176	0.297	0.234
Spikelet fertility(%)	0.005	-0.013	-0.013	-0.349	0.638	0.005	-0.001	0.035	-0.009	0.000	0.331	0.553	0.695**
Harvest index(%)	0.007	0.007	-0.380	0.553	0.004	-0.003	0.030	-0.007	0.007	0.131	-0.266	0.688	0.771**

Residual effect: 0.226