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Genetic variability and character association of agro-morphological and quality characters in rice

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ABSTRACT

Genetic variability and character association were estimated for twelve agro-morphological and quality characters in 40 rice genotypes during dry season 2007-08. High estimates of heritability coupled with high genetic advance as per cent of mean were recorded for most of the characters indicating the presence of additive gene effects in them. The genotypic and phenotypic coefficient of variation were maximum for grain yield plant^{-1} followed by 1000-grain weight and plant height. The correlation analysis revealed strong positive association of kernel length, panicle length, plant height, number of productive tillers plant^{-1}, 1000-grain weight, days to maturity and number of grains panicle^{-1} with grain yield. Path analysis revealed that kernel length, number of grains panicle^{-1}, plant height, number of productive tillers plant^{-1} and panicle length were the important characters contributing for grain yield.

Key words: *rice, genetic variability, heritability, genetic advance, correlation analysis*

Rice is the most important staple food crop in the world particularly in South East Asia. The presence of adequate genetic variability is regarded as the fundamental pre-requisite to launch any crop improvement programme and the success depends on its magnitude in a given species. The genotypic coefficient of variation indicates the range of variability present in different characters, while the phenotypic coefficient of variation measures the role of environment on the genotypes. Selection for yield *per se* is not reliable and indirect selection through component characters becomes important for the ultimate output. Hence, studies on character association not only helps to understand the nature of physical linkage but also provides information on the nature and direction of association existing between the traits. The present investigation was undertaken to study the different genetic parameters and their association among different agro-morphological and quality characters in 40 rice genotypes.

MATERIALS AND METHODS

The experimental material consisted of 40 diverse rice genotypes. All the 40 rice genotypes were grown in a randomized block design with three replications at the wetland farm of S.V. Agricultural College, Tirupati during dry season 2007-08. Twenty one days old seedlings of each genotype were transplanted in three rows of each 3 m length with a spacing of 20 cm x 15 cm. Observations on 12 important agro-morphological and quality characters were recorded based on five randomly selected plants in each genotype in each replication. The mean data was used for calculating the phenotypic and genotypic coefficient of variation using the formulae given by Burton (1952). Heritability was estimated as per the formula given by Lush (1940) and genetic advance was estimated by formula given by Johnson *et al.* (1955). The genotypic and phenotypic correlation coefficients were calculated using the method given by Johnson *et al.* (1955), while genotypic and phenotypic path coefficients were worked-out as suggested by Wright (1921) and as described by Dewey and Lu (1959).

RESULTS AND DISCUSSION

In general, the estimate of phenotypic coefficients of variation (PCV) were higher than the genotypic coefficients of variation (GCV) indicating the effect of

Table 1. Variability and genetic parameters for 12 agro-morphological and quality characters in Rice

Character	Mean	Range	Phenotypic co-efficient of variation	Genotypic co-efficient of variation	Heritability in broad sense (h^2b)	Genetic advance	Genetic advance as % of mean
Days to 50% flowering	93.87	64.33-114.00	12.19	12.07	98.1	23.13	24.64
Days to maturity	127.50	90.66-142.33	7.15	7.02	96.6	18.14	14.23
Plant height (cm)	102.32	70.45-156.08	21.52	21.19	96.9	43.97	42.97
Number of productive tillers plant^{-1}	11.73	7.15-17.63	19.53	16.17	68.6	3.23	27.60
Panicle length (cm)	22.85	18.45-26.30	9.45	8.82	87.2	3.88	16.98
1000-grain weight (g)	21.55	12.13-33.27	23.35	22.59	93.6	9.70	45.02
Number of grains panicle^{-1}	138.68	91.00-199.93	21.31	21.17	98.7	60.11	43.34
Grain yield plant^{-1} (g)	27.94	8.83-46.29	32.99	27.81	71.1	13.50	48.32
Kernel length (mm)	5.91	5.00-6.95	7.91	7.58	91.9	0.88	14.98
Kernel breadth (mm)	2.25	1.87-2.85	12.09	11.82	95.6	0.53	23.82
Kernel L/B ratio	2.64	2.08-3.31	13.80	13.60	97.1	0.72	27.60
Kernel Elongation Ratio	1.45	1.30-1.59	5.89	5.25	79.5	30.53	35.37

environment on different characters. High PCV and GCV was recorded for grain yield plant^{-1}, 1000-grain weight and plant height indicating the presence of large variation among the genotypes for these characters (Table 1). Therefore, simple selection can be practiced for further improvement of these characters. Niranjan Murthy (1999) also observed high PCV and GCV for grain yield plant^{-1}. On contrary, moderate PCV and GCV was observed for the traits viz., days to 50% flowering, number of productive tillers plant^{-1}, kernel breadth and kernel L/B ratio. Sarkar *et al.* (2007) found high GCV and PCV for kernel breadth and kernel L/B ratio. However, the remaining characters viz., days to maturity, panicle length, kernel length and kernel elongation ratio registered low estimates of PCV and GCV in the present study.

High heritability was observed for almost all the traits under the study (Table 1). High heritability coupled with high genetic advance as per cent of mean was recorded for plant height, 1000-grain weight, number of grains panicle^{-1} and grain yield plant^{-1} indicating that these traits are mainly under the influence of additive gene effects as such, selection would be effective for improvement of these traits. Borbora and Hazarika (1998) reported high heritability and high genetic advance as per cent of mean for 1000-grain weight, plant height and grain yield plant^{-1} which corroborates the findings of the present study.

The correlation analysis of yield and its components revealed the strong positive association of kernel length, panicle length, plant height, number of productive tillers plant^{-1}, 1000-grain weight, days to maturity and number of grains panicle^{-1} with grain yield (Table 2). Similar kind of associations were revealed by Krishna Naik *et al.* (2005) for days to maturity, number of productive tillers plant^{-1}, panicle length and number of grains panicle^{-1}. The characters such as kernel breadth, days to 50% flowering and kernel L/B ratio had positive but non significant association with grain yield. On contrary, Kernel elongation ratio had negative and non significant association with grain yield. Most of the grain quality characters had non significant positive association with grain yield which is suggestive of improved germplasm base of the breeding material employed in the present study.

Days to maturity was positively and significantly correlated with kernel length, panicle length, plant height and 1000-grain weight. This was in conformity with the results of Krishna Naik *et al.* (2005). The character plant height was positively and significantly associated with 1000-grain weight, kernel breadth, panicle length and number of productive tillers plant^{-1}.

Similarly, number of productive tillers plant^{-1} had significant and positive correlation with kernel length and 1000-grain weight. Panicle length had significant positive association with 1000-grain weight, kernel breadth and kernel length. The trait 1000-grain weight had significant positive association with kernel breadth

Table 2. Phenotypic (r_p) and genotypic (r_g) correlation coefficients among grain yield and its components and quality characters in rice

Characters		Days to maturity	Plant height	Number of productive tillers plant^{-1}	Panicle length	1000-grain weight	Number of grains panicle^{-1}	Kernel length	Kernel breadth	Kernel L/B ratio	Kernel Elongation Ratio	Grain yield plant^{-1}
Days to 50% flowering	r_p	0.7802**	0.1213	-0.2298*	0.1290	0.0338	0.1406	0.1183	0.0659	0.0701	-0.1736	0.1083
	r_g	0.7834	0.1203	-0.2986	0.1340	0.0354	0.1430	0.1325	0.0662	0.0735	-0.2073	0.1061
Days to maturity	r_p		0.2198*	0.0143	0.2425**	0.1806*	0.1004	0.2582**	0.1153	0.0992	-0.2422**	0.2504**
	r_g		0.2168	-0.0087	0.2639	0.1876	0.1019	0.2790	0.1113	0.1038	-0.2851	0.2558
Plant height	r_p			0.1983*	0.4645**	0.6159**	-0.1535	0.1032	0.5353**	-0.3731**	-0.1082	0.3365**
	r_g			0.2335	0.4964	0.6479	-0.1543	0.1137	0.5569	-0.3840	-0.1332	0.3485
Number of productive tillers plant^{-1}	r_p				0.0392	0.1894*	-0.1410	0.2555**	0.0008	0.1528	-0.2021*	0.3024**
	r_g				0.0391	0.2444	-0.1659	0.3505	-0.0128	0.1935	-0.2142	0.2935
Panicle length	r_p					0.4017**	-0.0510	0.2438**	0.2664**	-0.0934	-0.1311	0.3928**
	r_g					0.4539	-0.0578	0.2819	0.2758	-0.0832	-0.1523	0.4443
1000-grain weight	r_p						-0.1635	0.4041**	0.6959**	-0.3714**	-0.2562**	0.2698**
	r_g						-0.1722	0.4335	0.7445	-0.3953	-0.3033	0.3056
Number of grains panicle^{-1}	r_p							-0.0103	-0.0847	0.0569	-0.0716	0.2173*
	r_g							-0.0113	-0.0892	0.0600	-0.0869	0.2291
Kernel length	r_p								0.1007	0.4913**	-0.6559**	0.4355**
	r_g								0.0984	0.5006	-0.6946	0.5233
Kernel breadth	r_p									-0.7917**	-0.1717	0.1600
	r_g									-0.8026	-0.1780	0.1760
Kernel L/B ratio	r_p										-0.2744	0.1002
	r_g										-0.2858	0.1187
Kernel Elongation Ratio	r_p											-0.2562
	r_g											-0.3421

*, ** Significant at 5% and 1% level, respectively.

Table 3. Phenotypic (P) and genotypic (G) path co-efficient analysis among grain yield and its components and quality characters in rice

Characters		Days to 50% flowering	Days to maturity	Plant height	Number of productive tillers plant^{-1}	Panicle length	1000-grain weight	Number of grains panicle^{-1}	Kernel length	Kernel breadth	Kernel L/B ratio	Kernel Elongation Ratio	Correlation with Grain yield plant^{-1}
Days to 50% flowering	P	0.0044	0.0533	0.0333	-0.0541	0.0286	-0.0074	0.0389	0.0822	-0.0195	-0.0325	-0.0189	0.1083
	G	0.0663	0.0460	0.0629	-0.0213	0.0206	-0.0174	0.0308	0.3247	-0.1739	-0.2383	0.0056	0.1061
Days to maturity	P	0.0034	0.0683	0.0604	0.0034	0.0537	-0.0394	0.0278	0.1794	-0.0342	-0.0459	-0.0263	0.2504**
	G	0.0520	0.0588	0.1135	-0.0006	0.0406	-0.0925	0.0220	0.6836	-0.2925	-0.3366	0.0077	0.2558
Plant height	P	0.0005	0.0150	0.2747	0.0466	0.1028	-0.1345	-0.0425	0.0717	-0.1588	0.1727	-0.0118	0.3365**
	G	0.0080	0.0127	0.5233	0.0167	0.0763	-0.3196	-0.0333	0.2786	-1.4635	1.2457	0.0036	0.3485
Number of productive tillers plant^{-1}	P	-0.0010	0.0010	0.0545	0.2352	0.0087	-0.0413	-0.0390	0.1775	-0.0002	-0.0707	-0.0220	0.3024**
	G	-0.0198	-0.0005	0.1222	0.0714	0.0060	-0.1205	-0.0358	0.8589	0.0336	-0.6277	0.0058	0.2935
Panicle length	P	0.0006	0.0166	0.1276	0.0092	0.2213	-0.0877	-0.0141	0.1694	-0.0790	0.0432	-0.0143	0.3928**
	G	0.0098	0.0155	0.2598	0.0028	0.1537	-0.2239	-0.0125	0.6906	-0.7247	0.2699	0.0041	0.4443
1000-grain weight	P	0.0001	0.0123	0.1692	0.0445	0.0889	-0.2183	-0.0453	0.2807	-0.2065	0.1719	-0.0279	0.2698**
	G	0.0023	0.0110	0.3390	0.0174	0.0698	-0.4933	-0.0371	1.0622	-1.9564	1.2823	0.0082	0.3056
Number of grains panicle^{-1}	P	0.0006	0.0069	-0.0422	-0.0332	-0.0113	0.0357	0.2769	-0.0071	0.0251	-0.2630	-0.0078	0.2173**
	G	0.0095	0.0060	-0.0808	-0.0118	-0.0089	0.0849	0.2157	-0.0277	0.2345	-0.1946	0.0024	0.2291
Kernel length	P	0.0005	0.0176	0.0283	0.0601	0.0540	-0.0882	-0.0028	0.6946	-0.0299	-0.2274	-0.0713	0.4355**
	G	0.0088	0.0164	0.0595	0.0250	0.0433	-0.2139	-0.0024	2.4501	-0.2585	-1.6238	0.0189	0.5233
Kernel breadth	P	0.0003	0.0079	0.1470	0.0002	0.0590	-0.1519	-0.0234	0.0699	-0.2967	0.3664	-0.0187	0.1600
	G	0.0044	0.0065	0.2914	-0.0009	0.0424	-0.3672	-0.0192	0.2410	-2.6278	2.6037	0.0048	0.1790
Kernel L/B ratio	P	0.0003	0.0068	-0.1025	0.0359	-0.0207	0.0811	0.0157	0.3413	0.2349	-0.4628	-0.0298	0.1002
	G	0.0049	0.0061	-0.2009	0.0138	-0.0128	0.1950	0.0129	1.2265	2.1092	-3.2438	0.0078	0.1187
Kernel Elongation Ratio	P	-0.0008	-0.0165	-0.0297	-0.0475	-0.0290	0.0560	-0.0198	-0.4556	0.0510	0.1270	0.1088	-0.2562
	G	-0.0137	-0.0168	-0.0168	-0.0153	-0.0234	0.1496	-0.0187	-1.7018	0.4679	0.9270	-0.0272	-0.3421

Residual effect (phenotypic) = 0.7415 Bold:Direct effects * Significant at P = 0.05 level
Residual effect (Genotypic) = 0.6095 Normal:Indirect effects ** Significant at P = 0.01 level

and kernel length. The character kernel length also had significant positive association with kernel L/B ratio.

Among all the characters, kernel length, number of grains panicle^{-1}, plant height, number of productive tillers plant^{-1}, panicle length, days to maturity and days to 50% flowering have exerted positive direct effects on grain yield (Table 3). Thus, direct selection for these traits will be rewarding for yield improvement. Negative direct effects were exerted by kernel L/B ratio, kernel breadth and 1000-grain weight on grain yield indicating the negative contribution of these traits for grain yield. These results were in conformity with the findings of Krishna Naik *et al.* (2005) for kernel L/B ratio and observed the negative contribution of this trait with grain yield.

The character, kernel length exerted high positive indirect effects on grain yield via number of productive tillers plant^{-1} and panicle length which resulted in significant positive correlation with grain yield. Further, it also had high positive direct effect on grain yield. These results were in agreement with the findings of Madhavilatha (2000) who observed indirect effect of kernel length through number of productive tillers plant^{-1}. Panicle length had its positive indirect effects on grain yield via kernel length, plant height, kernel L/B ratio and days to maturity indicating low magnitude of its indirect contribution to grain yield. It also expressed significant positive correlation with grain yield. Similarly, plant height exhibited its indirect effects on grain yield through kernel L/B ratio, panicle length, kernel length, number of productive tillers per plant and days to maturity in the decreasing order of the effects which in turn resulted in its significant positive correlation with grain yield. These results were in agreement with the findings of Ramesh Babu (1999) who reported positive indirect effects of plant height on grain yield via, kernel L/B ratio, and kernel length. The remaining characters had low indirect effects on grain yield through panicle length and kernel length.

In the present study, kernel length, panicle length, plant height, number of productive tillers plant^{-1}, 1000-grain weight and number of grains panicle^{-1} are the important yield components that showed significant positive association with grain yield and may be important in formulating selection criteria for genetic improvement of grain yield in rice. Path analysis revealed that kernel length, number of grains panicle^{-1}, plant height, number of productive tillers plant^{-1} and panicle length were the major contributors of grain yield in rice.

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