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Genetic variability and characters association among quality traits of medium duration rice under island conditions

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ABSTRACT

Rice is the staple food of the people of Andaman and Nicobar Islands and improving its productivity with quality traits by the genetic selection is crucial. Twenty eight genotypes of medium duration rice were analysed for various grain quality traits viz., grain length (mm), grain breadth (mm), grain length/breadth ratio, 1000 grain weight (g), kernel length (mm), kernel breadth (mm), kernel length/breadth ratio, 1000 kernel weight (g), grain elongation and hulling (%). The high genotypic coefficient of variation (30.93) was recorded for grain elongation, while low for kernel breadth and hulling (%). Grain elongation, 1000 grain weight and grain length showed high heritability coupled with high genetic advance. Rice hulling (%) was positively and significantly correlated with grain breadth, 1000 grain weight and 1000 kernel weight. On the other hand, 1000 kernel weight, kernel breadth, kernel length/breadth ratio and grain breadth had the positive direct effects on hulling percent. Based on overall magnitudes of heritability, genetic advance, correlation and path analysis, grain/kernel test weight is the most desirable trait for improving the hulling (%) of medium duration rice under island conditions.

Key words: *Lowland rice, genotypes, heritability and characters association*

Rice being the staple food is consumed as a whole grain by the peoples of Andaman and Nicobar Islands. Therefore, the grain quality is very important for good market pricing and customer preference. The rice grain with medium slender grain type, intermediate amylose content is preferred by the consumers, fetch high price in the market. Development of good quality rice, selection of parents with best grain quality characters in rice breeding program is crucial. The knowledge about variability, characters association among different quality characters helps the breeder in choosing suitable parents for further breeding studies. Grain quality characters are interrelated among themselves which decides the final cooking and eating characteristics. Therefore, the present study was undertaken to study the different genetic parameters and their association among various quality attributes in medium duration high yielding pre-release lines of rice.

The rice breeding experiment was conducted with 28 rice genotypes at experimental farm station of Central Agricultural Research Institute, Port Blair, Andaman and Nicobar Islands, India during rainy season 2008-09. Twenty five days old seedlings were transplanted in randomized block design with three replications and the net individual plot consisted of 8 rows with 5 m long and row to row and plant to plant distances of 20 and 15 cm with recommended agricultural practices. After harvesting, seed samples were collected with 14% moisture and were analysed for ten qualitative characters *viz.*, grain length (mm), grain breadth (mm), grain length breadth ratio, 1000 grain weight (g), kernel length (mm), kernel breadth (mm), kernel length breadth ratio, 1000 kernel weight (g) and grain elongation and hulling (%). Data observed for each character were subjected to the analysis of variance, mean and ranges of each character. Genetic parameters such as phenotypic and genotypic coefficient of variation (PCV and GCV), heritability broad sense (H^2) and genetic advance as percent over mean (genetic gain) were estimated as suggested by Johanson *et al*. (1955). Genotypic (rg) and phenotypic (rp) correlation coefficient were estimated by the formula of Miller *et al.* (1958). Path coefficient analysis was done according to Dewey and Lu (1959).

The analysis of variance revealed that significant differences were observed for all the traits under study (Table 1). The extent of variability in ten characters of different genotypes measured in terms of range, generation mean, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) along with the amount of heritability (h^2), genetic advance and genetic advance percent over mean are given Table 2. The range of variation were higher for 1000 grain weight (32.99-16.95 g) followed by 1000 kernel weight (26.48-16.19 g), hulling percentage (81.83-74.00 %) and grain length (12.33-7.33 mm). The phenotypic coefficient of variation was higher than the genotypic coefficient of variation indicated that the appearance of variation is not only due to genotypes but also due to influence of environment. The difference between genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for grain breadth, grain length breadth ratio, kernel length, kernel length breadth ratio and grain length were moderate which indicate that the environment had no effect on these characters. Value of GCV and PCV were almost equal or very close for grain length, 1000 grain weight, 1000 kernel weight, grain elongation and hulling percentage, these traits can be considered stable. Low genotypic coefficient of variation for kernel breadth and hulling percentage indicates unstable nature of these characters. A similar result on genotypic coefficient of variation and phenotypic coefficient of variation has also been reported by Vanaja *et al*. (2006).

The genotypic coefficient of variation provides a measure to compare the genetic variability present in the various traits. The high genotypic coefficient of variation (30.933) was recorded for grain elongation. The characters like grain length, 1000grain weight, length breadth ratio and 1000kernel weight gave comparatively

Table 1. Analysis of variance for various qualitative characters in rice

Source	DF	GL (mm)	GB (mm) (g)	L/B ratio	1000 BW	KL (mm)	KB (mm) (g)	K L/B ratio	1000 KW	GE	Hulling (%)
Replication	2	1.39	0.07	11.69	13.69	5.04	0.38	0.05	5.76	5.76	34.73
Treatment	27	120.19**	6.02**	12.02**	1730.92**		44.55**	1.79**	16.05**	632.89**	632.89**
443.31**											
Error	54	1.77	1.59	10.06	20.68	10.03	0.97	3.77	7.69	7.69	26.66

**Significant at 1% level

Where, GL= Grain length, GB= Grain Breadth, L/B ratio= Length Breadth ratio, 1000 GW= 1000 Grain weight, KL= Kernel length, KB= Kernel Breadth, K L/B ratio= Kernel length Breadth ratio, 1000 KW= 1000 Kernel weight and GE= Grain elongation

Table 2. Estimation of genetic components for quality characteristics of rice

Characters	Mean	Range	GCV	PCV	h^2	GA	GA % over mean
GL (mm)	9.45	12.33 - 7.33	12.832	12.974	97.828	2.473	26.146
GB (mm)	2.74	3.53 - 2.43	8.816	11.779	56.011	0.374	13.591
L/B ratio	3.24	4.11 - 2.83	8.558	16.778	26.015	0.292	8.991
1000 GW (g)	24.72	32.99 - 16.95	18.639	18.807	98.228	9.410	38.055
KL (mm)	7.02	8.50 - 5.50	9.884	11.818	69.947	1.195	17.028
KB (mm)	2.20	2.50 - 2.00	5.751	8.375	47.146	0.179	8.134
K L/B ratio	3.21	4.25 - 2.42	13.026	15.409	71.460	0.728	22.683
1000 KW (g)	20.98	26.48 - 16.19	13.279	13.401	98.200	5.689	27.108
GE	1.08	1.42 - 0.23	30.933	31.079	99.063	0.689	63.424
Hulling (%)	79.15	81.83 - 74.00	2.910	3.043	91.463	4.539	5.734

Where, GL= Grain length, GB= Grain Breadth, L/B ratio= Length Breadth ratio, 1000 GW= 1000 Grain weight, KL= Kernel length, KB= Kernel Breadth, K L/B ratio= Kernel length Breadth ratio, 1000 KW= 1000 Kernel weight and GE= Grain elongation high genotypic coefficient of variation. The high value clearly indicated high degree of genotypic variability and the finding is general agreement with those recorded by Tomar *et al*. (1987) and Tejpal *et al*. (1987) in rice.

Phenotypic coefficient of variation which measure total variation was higher for grain elongation, followed by 1000 grain weight and grain length breadth ratio. Grain elongation had highest heritability (99.06%) followed by 1000 kernel weight, 1000 grain weight, grain length, and hulling percentage. Whereas, grain breadth, kernel length, kernel breadth, kernel length breadth ratio had moderate heritability. The high heritability of above characters indicated that the influence of the environment on these characters is negligible or very low. Hence, plant breeder may use these traits in their lowland rice improvement programme. The estimation of heritability alone is not very much useful in predicting resultant effect of selecting the best individuals, because it includes the effect of both additive gene as well as non-additive gene. High genetic advance occurs only due to additive gene action (Panse 1957). So, heritability estimates coupled with the genetic advance would be more useful. The estimates of genetic advance expressed as percent over mean for different traits are given in Table 2. It was observed that grain elongation had the highest genetic advance as percent over mean (63.42), followed by 1000 grain weight (38.05) and grain length (26.14). The remaining characters showed moderate to low values when both heritability and genetic advance is considered. It is observed that grain elongation; 1000 grain weight and grain length showed high heritability coupled with high genetic advance. Similar high estimate of heritability and genetic advance has been reported earlier by Vanaja *et al*. (2003) and Tejpal *et al*. (1987).

The result obtained in the present study revealed that the general genotypic correlation coefficients (gr) were higher than the phenotypic correlation coefficient (pr) (Table 3). The low variation in phenotypic correlation coefficient might be due to masking or modifying effect between characters. At genotypic and phenotypic level, hulling percentage was positively and significantly correlated with grain breadth (0.320**, 0.473**), 1000 grain weight (0.259**, 0.279**) and 1000 kernel weight (0.510**, 0.548**). While, grain length breadth ratio, kernel breadth and

Table 3. Phenotypic (pr) and genotypic (gr) correlation coefficients for grain quality characters in rice

Characters		GL (mm)	GB (mm)	L/B ratio	1000 BW (g)	KL (mm)	KB (mm)	K L/B ratio	1000 KW (g)	GE	Hulling (%)
GL (mm)	pr	1.000									
	gr	1.000									
GB (mm)	pr	0.026	1.000								
	gr	0.006	1.000								
L/B ratio	pr	0.625**	-0.139	1.000							
	gr	1.251**	-0.365**	1.000							
1000 GW (g)	pr	0.538**	0.067	0.313**	1.000						
	gr	0.551**	0.098	0.595**	1.000						
KL (mm)	pr	0.571**	-0.052	0.377**	0.642**	1.000					
	gr	0.697**	-0.124	0.997**	0.762**	1.000					
KB (mm)	pr	-0.218*	-0.110	-0.381**	-0.080	-0.222*	1.000				
	gr	-0.305**	-0.145	-0.516**	-0.112	-0.371**	1.000				
K L/B ratio	pr	0.556**	-0.000	0.473**	0.517**	0.849**	-0.672**	1.000			
	gr	0.662**	-0.051	0.983**	0.605**	0.920**	-0.712**	1.000			
1000 KW (g)	pr	0.507**	0.244*	0.255*	0.808**	0.537**	-0.071	0.428**	1.000		
	gr	0.524**	0.323**	0.473**	0.827**	0.633**	-0.099	0.505**	1.000		
GE	pr	0.386**	-0.070	0.182	0.266*	-0.104	-0.002	-0.063	0.158	1.000	
	gr	0.390**	-0.090	0.350**	0.270*	-0.131	0.026	-0.092	0.161	1.000	
Hulling (%)	pr	0.094	0.320**	-0.042	0.259*	0.116	-0.065	0.112	0.510**	-0.031	1.000
	gr	0.085	0.473**	-0.025	0.279*	0.172	-0.098	0.166	0.548**	-0.030	1.000

*-Significant at 5% level **-Significant at 1% level
Where, GL= Grain length, GB= Grain Breadth, L/B ratio= Length Breadth ratio, 1000 GW= 1000 Grain weight, KL= Kernel length, KB= Kernel Breadth, K L/B ratio= Kernel length Breadth ratio, 1000 KW= 1000 Kernel weight and GE= Grain elongation

Table 4. Direct (diagonal) and indirect (off diagonal) effects of different quality characters on hulling percent

Characters	GL (mm)	GB (mm)	L/B ratio	1000 BW (g)	KL (mm)	KB (mm)	K L/B ratio	1000 KW (g)	GE	Correlation coefficient
GL (mm)	**-0.627**	-0.003	-0.785	-0.345	-0.437	0.191	-0.415	-0.328	-0.245	0.085
GB (mm)	0.002	**0.492**	-0.179	0.048	-0.060	-0.071	-0.024	0.159	-0.044	0.473**
L/B ratio	-0.131	0.038	**-0.105**	-0.062	-0.105	0.054	-0.103	-0.049	-0.036	-0.025
1000 GW (g)	-0.541	-0.096	-0.584	**-0.983**	-0.749	0.109	-0.595	-0.813	-0.265	0.279*
KL (mm)	-0.315	0.055	-0.450	-0.344	**-0.451**	0.167	-0.415	-0.285	0.059	0.172
KB (mm)	-0.293	-0.139	-0.496	-0.107	-0.356	**0.763**	-0.686	-0.095	0.025	-0.098
K L/B ratio	0.975	-0.102	0.989	0.950	0.970	0.994	**0.792**	0.990	-0.185	0.166
1000 KW (g)	0.447	0.276	0.404	0.706	0.540	-0.084	0.431	**0.854**	0.137	0.548**
GE	0.205	-0.047	0.183	0.141	-0.068	0.013	-0.048	0.084	**0.525**	-0.030

*- significant at 5% level **- Significant at 1% level

Where, GL= Grain length, GB= Grain Breadth, L/B ratio= Length Breadth ratio, 1000 GW= 1000 Grain weight, KL= Kernel length, KB= Kernel Breadth, K L/B ratio= Kernel length Breadth ratio, 1000 KW= 1000 Kernel weight and GE= Grain elongation

grain elongation negatively and non significantly correlated with hulling percentage at both the levels. This kind of inverse relationship has also been reported by Shivani *et al*. (2007), Chauhan *et al*. (1995) and Tejpal (1987).

The path analysis revealed that the 1000 kernel weight, kernel breadth, kernel length breadth ratio and grain breadth had the positive direct effect on hulling percentage (Table 4). However, 1000 kernel weight had also high heritability with appreciable value of genetic advance, percent over mean and genetic coefficient of variation. Naturally, this character could be used as one of the most important criteria in selection for yield in rice. While, the grain length, grain length breadth ratio, 1000 grain weight and kernel length had negative direct effect on hulling percentage. Although, 1000 grain weight had negative direct effect on hulling percentage but it had positive and significant correlation with hulling percentage. It might be due to this trait which had positive direct effect on hulling percentage via other characters. Similar results were also reported by Malik, (1989) and Chauhan *et al*. (1995). The residual effect (0.474) suggested that there are possible, more and quite important components traits effecting brown rice yield which have not been covered in the present study and it would be worthwhile to include these characters for further study.

From this study, it can be concluded that sufficient variability exists in most of the components. High heritability and genetic advance for 1000 grain weight and grain length demonstrates the possibility of improvement through selection. Evaluation of yield components indicated that the traits grain breadth, 1000 grain weight and 1000 kernel weight are the major attributes through which high yielding genotypes may be selected. The results of path analysis at the genotypic level indicated that 1000 kernel weight, kernel breadth, kernel length breadth ratio and grain breadth were the important characters determining the hulling percentage. These characters may be considered as an important criteria for selection in rice and it will enhance selection and subsequent breeding work towards the development of improved rice varieties.

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