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Genetic analysis and character association of quality in rice

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ABSTRACT

Studies on association and path analysis for ten grain quality characters of 30 pre-released cultures and high yielding varieties of rice revealed that head rice recovery had highly significant positive association (r=0.86) with milling percentage and significant negative association with elongation ratio (-0.39). The relationship between head rice recovery and kernel length after cooking was negative and significant (-0.41). Alkali spreading value exhibited positive and significant association with kernel length after cooking (0.40). Grain quality characters viz., kernel length, alkali spreading value and elongation ratio manifested positive correlation with kernel length after cooking. The quality characters viz., alkali spreading value and elongation ratio also showed high positive direct effect on kernel length after cooking.

Key words: *rice, quality characters, correlation path analysis, genetic parameters*

Rice, the predominant cereal crop is consumed as a whole grain, Therefore, physical, cooking and nutritional qualities are very important for the consumers. In Tamil Nadu, rice grain with medium slender grain type, intermediate amylose content, intermediate gelatinization temperature, medium gel consistency are preferred by consumers. Hence varieties with these qualities fetch high price in the market. In a rice breeding programme for evolving good quality rice, selection of parents with best grain quality characteristics is important. Knowledge about variability, character association among different quality traits helps the breeder in choosing suitable parents for hybridization. Grain quality characters are interrelated among themselves which in turn decides the final cooking and eating characteristics. Therefore, the present investigation was undertaken to study the different genetic parameters and their association among different quality attributing characteristics in selected high yielding pre-released cultures and varieties.

MATERIALS AND METHODS

The experimental materials consisted of 30 genotypes of rice namely, CB 98002, CB 98004, CB 98006, CB 99007, CB 99016, CB 99019, CB 99174, CB 20026, CB 20035, CB 20054, CB 20058, CB 20080, CB 20090, CB 20072, CB 20092, CB 20011, CB 2001104, CB 200123, CB 200191, CB 200161, CB 200182, CB 20093, CB 2001105, CO 47, IR 64, CR 1009, ASD 16, ADT 43, Improved White Ponni, CO 43 which were raised at Tamil Nadu Agricultural University, Coimbatore, in a randomized block design with three replications. Twenty five days old seedlings were transplanted at a spacing of 20 x 15 cm and recommended package of practices were followed. After harvest seed samples were collected with 14% moisture and were analyzed for milling percentage (MP), head rice recovery (HRR), kernel length (KL), kernel breadth (KB), length/breadth (L/B) ratio, alkali spreading value (ASV), elongation ratio (ER), amylose content (AC), gel consistency (GC) and kernel length after cooking (KLAC). The quality characters were estimated by standard procedures as suggested by Hussain *et al*. (1987). Amylose content and alkali spreading value were estimated following the methods of Juliano (1971). Analysis of variance, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h^2) in broad sense and genetic advance (GA) as percentage of mean were calculated following the method of Singh and Choudary (1985). The genotypic and phenotypic correlations

were determined as per the method suggested by Johnson *et al*. (1955). Path coefficient analysis was done as suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the 30 genotypes for all the quality characters indicating sufficient scope for further improvement (Table 1). The mean values for milling percentage (73.95), head rice recovery (69.92) and kernel length (5.22mm) were good, indicating that the genotypes were of superior quality. Generally intermediate values are preferred for alkali spreading value (4-5) and amylose content (20-25%) in rice. In the present study, all the genotypes recorded mean amylose values (24.6%) and alkali spreading value (4.77) in the desirable range. Amylose content of the rice grain affects the cooking and gelatinization properties of cooked rice.

In general, the values of phenotypic coefficient of variation were high, when compared to genotypic coefficients of variation, but the differences were low suggesting the less environmental influence on these traits. The quality traits *viz*., alkali spreading value, kernel length after cooking, elongation ratio and length/ breadth ratio registered high variability estimates both at genotypic and phenotypic level (Table 2). The lowest genotypic coefficient of variation was observed in kernel length (6.515), head rice recovery (5.580), milling percentage (5.078) and amylose content (4.973). Chauhan *et al*. (1992) noted that amylose content exhibited least variation, which is in accordance with the present result.

High heritability was observed in all the traits. Heritability gives information on the nature of inheritance of characters and when the character is highly heritable it indicates that the phenotype strongly reflects the genotype. The heritability estimates were high ranging from 95.60 to 100 percent. Moderately

Table 1. Analysis of variance for physico-chemical quality traits of rice

Source	DF	MP	HRR	KL	KB	L/B	ASV	ER	Amy	GC	KLAC
Replication	2	1.882	1.907	1.884	1.875	1.877	1.875	1.875	2.164	4.900	1.884
Genotype	29	42.363	45.718	0.351	0.100	0.218	8.302	0.174	4.674	53.041	5.655
Error	58	0.058	0.055	0.004	0.001	0.003	0.368	0.001	0.182	1.289	0.008

DF – Degrees of Freedom MP – Milling Percentage HRR – Head Rice RecoveryKL – Kernel Length KB – Kernel BreadthL/B – Length/ Breadth ratio ASV – Alkali Spreading Value ER – Elongation Ratio Amy – Amylose content GC – Gel Consistency KLAC – Kernel Length After cooking

Table 2. Estimates of genetic components for physico-chemical quality characteristics of rice

Quality trait	Mean	GCV	PCV	h^2broad sense	GA	GA % over mean
MP	73.950(%)	5.078	5.082	1.000	7.731	10.454
HRR	69.918(%)	5.580	5.583	1.000	8.032	11.488
KL	5.220(mm)	6.515	6.557	0.988	0.696	13.337
KB	1.957(mm)	9.300	9.343	0.991	0.373	19.071
L/B	2.673	10.026	10.092	0.987	0.548	20.518
ASV	4.767	34.118	34.999	0.956	3.275	68.709
ER	1.585	15.189	15.216	0.997	0.495	31.235
Amylose	24.603(%)	4.973	5.073	0.961	2.471	10.043
GC	51.050	8.136	8.237	0.976	8.451	16.555
KLAC	8.230(mm)	16.672	16.683	0.999	2.825	34.321

GCV – Genotypic Coefficient of VariationPCV – Phenotypic Coefficient of Variation; h^2 – heritability in broad sense GA – Genetic advance; DF – Degrees of Freedom MP – Milling Percentage HRR – Head Rice RecoveryKL – Kernel Length KB – Kernel BreadthL/ B – Length/Breadth ratio; ASV – Alkali Spreading Value ER – Elongation Ratio Amy – Amylose Content GC – Gel Consistency KLAC – Kernel Length After cooking

high to very high heritability estimates for kernel length, kernel breadth and length/breadth ratio were reported earlier by many investigators. Chauhan (1998) and Krishnaveni *et al*. (2006) reported high estimates of heritability for kernel length, kernel breadth while high heritability for length/breadth ratio was observed by Chauhan *et al*. (1992) and Lalitha and Sreedhar (1999). Pathak and Sharma (1996) and Krishnaveni *et al*. (2006) reported high heritability estimates for kernel length, kernel breadth, length/breadth ratio, elongation ratio and alkali spreading value which were in agreement with the present results. In the present study, amylose content also showed high heritability estimates, confirming the findings of Lalitha and Sreedhar (1999) and Krishnaveni *et al*. (2006).

Characters *viz*., alkali spreading value, kernel length after cooking, elongation ratio and L/B ratio recorded high genetic advance as percentage of mean while milling percentage, head rice recovery, kernel length, kernel breadth, amylose content and gel consistency exhibited moderate genetic advance. Krishnaveni *et al*. (2006) observed high genetic advance as percentage over mean for amylose content and alkali spreading value. The estimates of heritability and genetic advance in combination are more important than of heritability alone (Panse, 1957). High heritability with high genetic advance as percentage of mean was observed for L/B ratio, alkali spreading value, elongation ratio and kernel length after cooking, which indicated the prevalence of additive gene action for gene expression. High heritability with moderate genetic advance as percentage of mean was recorded for head rice recovery, milling percentage, kernel length, kernel breadth and amylose which indicated both additive as well as dominant gene action might be involved in controlling these traits.

Knowledge on association will help in selection of characters during breeding programme. Milling percentage showed highly significant positive correlation with head rice recovery (r = 0.86) and significant negative association with elongation ratio (-0.39) (Table 3 and 4). The direct effect of milling percentage was moderate on kernel length after cooking. Head rice recovery exhibited negative but non significant association with grain L/B ratio. This kind of reverse relationship has also been reported by Malik, 1989 and Sarkar *et al*., 2007. Head rice recovery exhibited negative but significant association with elongation ratio (r=-0.56). Its direct effect was also low. Head rice recovery showed highly significant positive association with milling outturn (r = 0.86). Similar association was reported by Mahmuda Khatun *et al*. (2003), Sarkar *et al*. (2007) and Shivani *et al*. 2007.

Kernel length had highly significant positive correlation with elongation ratio (r = 0.49) and significant positive correlation with kernel length after cooking (r = 0.40). This was similar to the result reported by Mahmuda Khatun *et al*. (2003). Kernel length showed significant negative association with gel consistency (r =-0.46). Christopher *et al*. (2000) observed high direct effect of cooked kernel length and cooked L/B ratio along with positive association with kernel elongation index and highlighted the importance of these traits for quality improvement in rice. Sarkar *et al*. (2007) reported that direct positive effect imparted on kernel elongation index was highest by cooked kernel length followed by brown kernel breadth and cooked kernel L/B ratio. Kernel breadth exhibited a highly significant negative correlation with L/B ratio (r=-0.79). This was similar to the result of Mahmuda Khatun *et al*. (2003) and Sarkar *et al*. (2007).

Alkali spreading value exhibited positive and significant association with kernel length after cooking (0.40) and it also showed positive and direct effects (0.32). This character exhibited positive correlation with elongation ratio, amylose content and gel consistency. Elongation ratio showed positive and highly significant correlation and positive high direct effect with kernel length after cooking (Sarkar *et al*., 2007). This character also influences kernel length with high positive indirect effect and head rice recovery, through negative indirect effect. Results indicated that there was a negative correlation between amylose content and gel consistency (Tang *et al*., 1989 and Mahmuda Katun *et al*., 2003). Negative correlation between amylose content and gel consistency indicated that improvement of these two quality traits can be made with the selection of each trait separately.

Grain quality characters *viz*., kernel length, alkali spreading value, elongation ratio manifested positive correlation with kernel length after cooking, while head rice recovery exhibited negative association. The characters *viz*., alkali spreading value and

Table 3. Corrleation coefficient for grain quality characters in rice

	MP	HRR	KL	KB	L/B	ASV	ER	Amy	GC	KLAC
MP	1.0000	0.8632**	-0.1887	0.1926	-0.3290	-0.2157	-0.3942*	-0.0895	0.1779	-0.2219
HRR		1.000	-0.3169	-0.0933	-0.1306	-0.2100	-0.5606**	-0.0400	0.0995	-0.4112*
KL			1.000	0.2875	0.2928	-0.0910	0.4941**	-0.2418	-0.4655**	0.4024*
KB				1.000	-0.7915**	-0.0897	0.2249	-0.2451	-0.3590*	0.2793
L/B					1.000	0.0531	0.0183	0.0662	0.0523	-0.0636
ASV						1.000	0.1952	0.2107	0.2383	0.3968*
ER							1.000	0.1333	0.0857	0.7462**
AMY								1.000	-0.0076	0.0104
GC									1.000	0.1119
KLAC										1.000

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

MP – Milling Percentage HRR – Head Rice RecoveryKL – Kernel Length KLAC- Kernel Length After Cooking KB – Kernel BreadthL/B – Length/Breadth ratio ASV – Alkali Spreading Value ER – Elongation Ratio Amy – Amylose Content GC – Gel consistency

Table 4. Direct (diagonal) and indirect (off diagonal) effects of different quality characters on kernel length after cooking

	MP	HRR	KL	KB	L/B	ASV	ER	Amy	GC	Correlation coefficient
MP	**0.2192**	0.1892*	-0.0414	0.0422	-0.0721	-0.0473	-0.0864	-0.0196	0.0390	-0.2219
HRR	-0.1253	**-0.1451***	0.0460	0.0135	0.0190	0.0305	0.0814	0.0058	-0.0144	-0.4112*
KL	-0.0127	-0.0213	**0.0673**	0.0193	0.0197	-0.0061	0.0333	-0.0163	-0.0313	0.4024*
KB	0.0113	-0.0055	0.0168	**0.0585**	-0.0463	-0.0052	0.0132	-0.0143	-0.0210	0.2793
L/B	0.0022	0.0009	-0.0019	0.0052	**-0.0065**	-0.0003	-0.0001	-0.0004	-0.0003	-0.0636
ASV	-0.0682	-0.0664	-0.0288	-0.0284	0.0168	**0.3163**	0.0617	0.0666	0.0754	0.3968*
ER	-0.2585*	-0.3676**	0.3240**	0.1475*	0.0120	0.1280*	**0.6558**	0.0874	0.0562	0.7462**
AMY	0.0088	0.0039	0.0239	0.0242	-0.0065	-0.0208	-0.0132	**-0.0987**	0.0007	0.0104
GC	0.0014	0.0008	-0.0036	-0.0028	0.0004	0.0018	0.0007	-0.0001	**0.0077**	0.1119

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

MP – Milling Percentage HRR – Head Rice RecoveryKL – Kernel Length KB – Kernel BreadthL/B – Length/Breadth ratio ASV – Alkali Spreading Value ER – Elongation Ratio Amy – Amylose Content GC – Gel consistency

elongation ratio also showed high positive direct effect on kernel length after cooking. Hence selection for the above characters will effectively improve the grain quality in rice. The genotypes having good grain quality characters viz., high head rice recovery, intermediate amylose content, intermediate gelatinization temperature and good elongation ratio along with high yielding potentials can be selected for breeding programme to develop the best hybrids/varieties.

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