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Inter-relationship Among Grain Quality Traits of Rice (*Oryza sativa* L.)

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Abstract: The analysis of variance indicated highly significant differences among the genotypes for all the traits studied except thickness of the grain. Covariance studies reflected significant to highly significant as well as negative differences among majority of character combinations. Broad sense heritability estimates for length breadth ratio and length of the grain ranged from 46.20 to 49.10. Genotypic correlation of 1000 grain weight and breadth of the grain with grain quality were significant, while non significant association were observed between length of the grain, length breadth ratio and rice quality index at genotypic level. Among the characters studied, breadth of the grain depicted the highest direct contribution of 2.239 and 1000 grain weight showed highest indirect contribution of 1.143 towards grain quality. Path coefficient analysis demonstrated that for better grain quality breadth of the grain, 1000 grain weight and length of the grain should be maximized.

Key words: Path analysis, heritability, genotypic and phenotypic correlation, quality index, rice

Introduction

Rice is one of the major food crops of the world and especially of most Asian countries like Bangladesh, China, India, Japan, Korea, Pakistan and Vietnam (FAO, 2000). It strengthens our national economy through its exports. Acceptability of rice cultivars mainly depends on the productivity and fineness of the grain. Pakistan is enjoying its monopoly in fine quality in international market. The local type Basmati-370 is considered as world's best quality rice. Unfortunately in Pakistan average yield of rice is far less as compared to other rice growing countries of the world. The prevailing situation in Pakistan in view of its quality and yield level demands the continuous genetic improvement of rice to feed over increasing human population and to earning through its exports. The grain quality can be improved genetically through the improvement of grain quality components. Xu (1985) and Morales (1986) observed that 1000 grains weight and percentage of filled grains were important yield components. Grain traits have a positive association with grain yield per plant (Deshmukh and Chau, 1992). Genotypic correlation among grain quality and its components provide the information about the plant performance traits and their genetic association with one another. Path analysis enables breeders to rank the genetic attributes according to their contribution (Dewey and Lu, 1959).
The present studies had been undertaken to find the selection criteria for rice quality. This would also help to select the genotypes possessing plant traits with maximum contribution to grain yield and grain quality.

Materials and Methods

The investigation for the determination of inter-relationship of grain quality traits was carried out in the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. The breeding material was composed of fourteen different fine quality genotypes and one standard variety (Basmati-385) as mentioned in Table 2. The nursery of the experimental material was collected from Rice Research Institute, Kala Shah Kaku. Two seedlings of each genotype were transplanted in earthen pots (30x30 cm^2) filled with normal soil. The experiment was conducted in a completely randomized design with three repeats. Each replication consisted of ten plants in five pots for each genotype. During the growth period, recommended agronomic practices were applied to all the genotypes. Data for statistical analysis was collected from each plant at the time of maturity for the following morphological traits: 1000 – grain weight (gm), length of grain (mm), breadth of grain (mm), thickness of grain (mm), length breadth ratio, rice quality index. The grains from all the plants of a genotype in each repeat were bulked and thousand well filled grains at random were counted from this lot and weighed. The information was recorded in grams and mean for each genotype per repeat was calculated. Five grains per panicle were selected randomly and their length breath was measured with the help of vernier caliper. Then average was computed for each genotype in a repeat. Data were than averaged for each genotype and for each repeat. Five already selected grains were also used for the measurement of thickness. Thickness was measured with the help of vernier caliper. Data was then averaged for each genotype in each repeat. Length breadth ratio and rice quality index was computed by the formula.

Statistical analysis: Statistical analysis was computed by the procedure of Steel and Torrie (1980) for analysis of variance and co variance. "Duncan's New Multiple Range Test" was utilized for the pair wise comparison of genotypic means. The method of Burton and Devane (1953) was used for assessment of heritability (Broadsence) as an index of transmissibility associated with various plant performance traits. Kwon and Torrie (1964) were followed for correlation analysis. Genetic correlation was tested for their statistical significance following Lothrop *et al.* (1985). Standard error for heritability was computed according to the method proposed by Reeve (1955) and Robertson (1959). Path coefficient analysis for grain quality traits and its components was performed according to Dewey and Lu (1959).

Results and Discussion

Analysis of variance and heritability: The results of analysis of variance, genotypic and phenotypic coefficients of variability and heritability estimates for grain quality are presented in Table 1. The results revealed that the genotypic differences among genotypes were highly significant for all the characters except thickness of the grain. Length of the grain and length breadth ratio showed moderate heritability of 49.10 % and 46.20 % respectively. Duncan's New Multiple Range Test was used to compare the mean performance of genotypes for all the traits studied and results are summarized in Table 2 indicating that the mean values for 1000-grain weight, length of the grain, breadth of the grain, length breadth ratio and rice quality index ranged from 17.81 to 20.61 gm, 6.78 to 7.46 mm., 1.743 to 2.0 mm., 3.48 to 4.00 mm and 2.00 to 2.577 mm respectively. The data revealed a tremendous scope for improvement of grain quality. Maximum 1000-grains weight was recorded in genotype 41025 (20.61 gm). Maximum length was recorded in genotype 40083 closely followed by genotype 41025 and both of these genotypes were significantly different from Basmati-385. Genotype 41026 had maximum breadth of the grain (2.003 mm) closely followed by genotype 41025. The minimum breadth of the grain was recorded in the genotype 41011. It is indicated that genotypes were the most consistent in performance for breadth of the grain by virtue of the least coefficients of genotypic as well as phenotypic variability. The highest value for length breadth ratio, was recorded in genotype 41011 (4.003) followed by genotypes 40097 (3.990) and 40084 (3.970) and these three genotypes were significantly different from Basmati-385. Genotype 40086 had maximum value for rice quality index was recorded in genotype 41011, which is significantly different from Basmati-385. Minimum rice quality index, moreover genotypic as well as phenotypic coefficients of variability are high. From this discussion it was concluded that genotype 41011 is superior in performance due to desirable levels of 1000-grains weight, length breadth ratio and rice quality index.

Table 1: Mean squares, heritability (broad sense) and coefficients of variability estimates for quality index and its components in rice (*Oryza sativa* L.)

	Mean squares		Coefficient variability		Heritability ± Standard error
Traits	Treatment	Error	Genotypic G.C.V.	Phenotypic P.V.C.	h^2 ± S.E
1000 grains weight	1.439**	0.663	2.668	5.036	0.281 ± 0.219
Length of grain	0.144**	0.037	2.666	3.806	0.491 ± 0.773
Breadth of grain	0.019**	0.007	3.334	5.529	0.363 ± 1.997
Thickness of the grain	0.007NS	0.015	---	---	---- ---
Length breadth ratio	0.100**	0.028	4.138	6.091	0.462 + 0.915
Rice quality index	0.058**	0.024	4.651	6.212	0.321 + 1.116

Treatment degree of freedom = 14, Error degree of freedom = 30, ** Highly significant NS: Non-significant

Table 2: Mean performance of various genotypes and their statistical significance for quality index and its components in rice (*Oryza sativa* L)

Genotype	1000 grains weight	Length of the grains (mm)	Breadth of the grains (mm)	Length breadth ratio	Rice quality index
40083	19.96ab	7.467a	1.910a-c	3.913ab	2.353ab
40084	18.70ab	7.340ab	1.850a-d	3.970a	2.360ab
40086	17.81c	7.257ad	1.973ab	3.680a-e	2.000c
40097	18.89bc	7.047b-e	1.770cd	3.990a	2.420ab
41004	19.15a-c	6.970c-e	1.843a-d	3.787a-e	2.423ab
41011	18.96bc	6.977c-e	1.743ad	4.003a	2.577a
41012	19.19a-c	6.933c-e	1.913a-d	3.623b-e	2.310ab
41013	19.65ab	6.947c-e	1.820b-d	3.820a-d	2.383ab
41016	19.31a-c	6.780e	1.947ab	3.480e	2.180ab
41024	18.27a	6.957c-e	1.870a-d	3.720a-e	2.197bc
41025	20.61bc	7.453a	1.990a	3.747a-e	2.250bc
41026	18.27a-c	6.990b-e	2.003a	3.490e	2.143bc
41028	19.28ab	6.930c-e	1.950ab	3.557c-a	2.283a-c
41030	19.55bc	7.300a-c	1.890a-d	3.860a-e	2.197bc
Basmati 385	18.6bc	6.893de	1.977ab	3.520de	2.253bc

Means followed by a common letter are not significantly different from each other at 5 % level by DMRT

Table 3: Mean products for analysis of covariance for quality index and its components in all possible combinations in rice (*Oryza sativa* L.)

Traits	Source of variations (S.O.V)	d.f	1000 grains weight	Length of the grains	Breadth of the grains
Number of	Treatment	14	0.143**		
the grains	Error	30	0.002		
Breadth of the	Treatment	14	-0.003N.S	0.006*	
grains	Error	30	-0.008	0.002	
Length: Breadth	Treatment	14	0.074**	0.061**	-0.035**
Ratio	Error	30	0.014	0.115	-0.011
Rice quality	Treatment	14	0.100**	-0.009	-0.024**
index	Error	30	-0.29	0.002	-0.005

NS: Non-significant., *Significant; ** Highly significant

Table 4: Genotypic and phenotypic correlation coefficients among rice quality index and its components in rice (*Oryza sativa* L.)

Traits	Correlation (r)	1000 grains weight	Length of the grain	Breadth of the grain	Length: Breadth ratio
Length of	Genotypic	0.487 ± 0.598			
the grain	Phenotypic	0.19*			
Breadth of	Genotypic	0.050 ± 1.460	0.113 ± 2.053		
he grain	Phenotypic	-0.066	0.127		
Length:	Genotypic	0.252 ± 823	0.518 ± 0.15	-0.80 ± 0.818	
Breadth ratio	Phenotypic	0.156	00.491	-0.794**	
Rice quality	Genotypic	0.71 ± 0.436	-0.190 ± 1.56	0.48 ± 0.311	0.745 ± 0.826
Index	Phenotypic	0.079	-0.029	-0.588*	0.571*

*, Statistically significant; **, Statistically highly significant

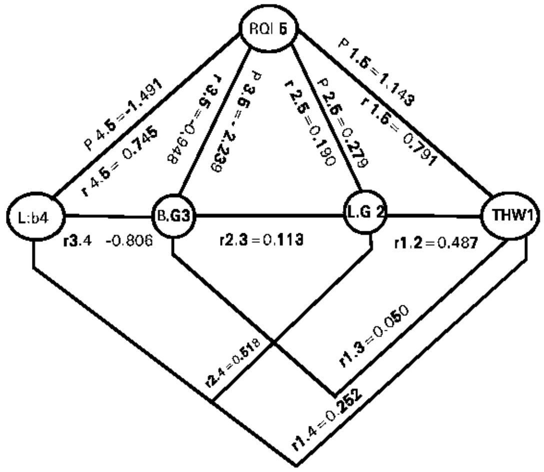
Table 5: Direct and indirect effects of various plant traits to number of grains per panicle in rice (*Oryza sativa* L.)

Traits	1000-grains	Length of weight	Breadth of the grain	Length breadth the grain	Genotypic correlation ratiowith R. Q. I
1000-grains weight	1.143	0.136	-0.112	-0.376	0.791
Length of the grain	0.557	0.279	-0.253	-0.772	0.190
Breadth of the grain	-0.057	-0.032	2.239	-1.202	0.948
Length breadth ratio	0.288	0.144	1.804	-1.491	0.748

R.Q.I, Rice quality index

Covariance analysis: The mean products for analysis of covariance for grain quality and its components in all possible combinations were significant to highly significant except that of 1000- grain weight with breadth of the grain (Table 3). Covariance of breadth of grain with 1000- grain weight and rice quality index is negative. Similarly length of the grain showed negative correlation with breadth of the grain and rice quality index.

Correlations: The association of grain quality with other characters was estimated by genotypic and phenotypic correlation coefficient (Table 4). Non-significant correlations both at genotypic and phenotypic levels between 1000-grains weight on one hand and length of the grain, breadth of the grain and length breadth ratio on the other hand 1000-grains weight was positively and significantly associated with rice quality index on genetic basis, phenotypically positive and non-significant correlation appeared between these two traits. According to the findings of Prasad *et al*. (1988), Tahir *et al*. (1988), Suarez *et al*. (1989), Deshmukh and Chau (1992), these two traits had significant positive correlation. Length of the grain had positive and non-significant correlation both at genotypic and phenotypic levels with breadth of the grain and length breadth ratio, while length of the grain has negative and non-significant correlation both at genotypic and phenotypic levels with rice quality index. Breadth of the grain had a negative and significant genotypic correlation while negative and highly significant phenotypic correlation with length breadth ratio. Breadth of the grain also had a positive and significant genotypic correlation while negative and significant phenotypic correlation with rice quality index. The fore going discussion revealed that rice quality index can be improved by decreasing the breadth of the grain.



Path diagram

THW= 1000 grain weight
BG=Breadth of the grain
RQI= Rice quality index
LG= Length of the grain
LB= Length: breadth ratio

Path analysis: Path coefficient analysis as an effort to assess the magnitude of contribution of various agro morphological characters to quality in the form of cause and effect is discussed here under. The direct effect of 1000 – grains weight to rice quality index was 1.143. A positive indirect effect through length of grain was observed to grain quality (Table 5). Although indirect effects through breadth of the grain and length breadth ratio was negative to grain quality but due to high positive direct effect a positive and highly significant genotypic correlation was observed between the said traits. So it is suggested that to improve grain quality, 1000 grain weight should increase through increase in length of grain. Negative correlation (- 0.190) was present between length of the grain and grain quality, while the direct effect of length of the grain and indirect effect through 1000- grains weight were positive to grain quality. These positive effects seemed to counter balance the negative association. Indirect effects through breadth of the grain and length breadth ratio were negative and these negative indirect effects might be the cause of negative correlation between the length of the grain and path diagram grain quality. In spite of these negative indirect effect and association rice grains quality might be improved due to the presence of high positive direct mentioned components viz. 1000 grain weight, length of grain and length breadth ratio was negative. It is clear that highly significant positive association was presented between the pre- mentioned traits, which might be the result of this positive direct effect. So this positive direct effect and correlation indicated that with the increase in breadth of the grain there would be increase in the grain quality. So breadth of grain should made selection criteria. A significant and positive genotypic correlation (0.745)
between length breadth ratio and grain quality is evident from Table 5. Direct effect of length breadth ratio was negative (-1.491). But indirect effects through 1000-grains weight length and breadth of the grain were positive. These positive indirect effects counter balance the negative direct effect and results a positive and significant genetic correlation between two said traits. During selection of good quality rice length breadth ratio might useful through its indirect effects.

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