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GENETIC VARIATION OF QUANTITATIVE AND QUALITY TRAITS IN RICE VARIETIES

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Abstract

An investigation was carried out to study the genetic parameters and character association for yield, yield attributing, quality and nutritional traits of twelve rice varieties. Analysis of variance revealed significant differences for all the traits under study indicated the presence of wide genetic variability among the genotypes. Small differences between genotypic coefficient of variation and phenotypic coefficient of variation were recorded for all the characters studied which indicated less influence of environment on these characters. High heritability coupled with high genetic advance was observed for zinc content (brown) and number of chaffy grain per panicle exhibited, indicating that simple selection could be effective for improving these characters. Yield per hill had the highest positive direct effect. This study revealed that yield per hill, days to 50% flowering, days to maturity, panicle length and thousand grain weight are the most important yield contributing characters and an attempt should, therefore, be made for effective selection on these traits. Yield per hill might be considered as the most important trait due to low difference of GCV and PCV, high heritability in broad sense (h^2_b) with high genetic advance (GA) in percent of mean, significant positive correlation and high positive indirect effects. Another important trait such as days to 50% plants to flowering and thousand grain weight might also be considered due to their minimum difference of GCV and PCV values, high h^2_b with high GA in percent of mean, significant positive correlation and higher positive direct effects.

Keywords: Genetic variability, correlation coefficient, path analysis, yield components.

Introduction

Rice (*Oryza sativa* L.) is the most important cereal crop of the grass family Poaceae (formerly known as Gramineae), meeting the dietary requirements of the people living in the tropics and sub-tropics. Globally, rice is the most important crop in terms of its contribution to human diets and value of production. Quantum jump in yield improvement has been achieved in rice with the development of high yielding heterotic hybrids under commercial cultivation. However, being the staple food of the population in Bangladesh, improving its productivity has become a crucial importance (Subbaiah *et al.,* 2011). Genetic enhancement is one of the important tools to improve the productivity. High magnitude of variability in a population provides the opportunity for selection to evolve a variety having desirable characters. Many people who depends on rice as a staple food are effectively being starved of essential micronutrients such as iron, zinc and pro-vitamin A, which is called “hidden hunger” by nutritionists. Malnutrition is a

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large and growing problem in the developing world and over three billion people suffer micro nutrient malnutrition (Reddy *et al*., 2005; Welch and Graham, 2002). Iron deficiency may cause anemia and low maternal iron intake has been linked to autism spectrum disorder in offspring (Black *et al*., 2013). It is estimated that 49% of the world's population is at risk for low zinc intake (Cichy *et al*., 2005). Adequate zinc nutrient is also important for child growth, immune function and neurobehavioral development. In order to enhance the micronutrient concentration in the grain suitable breeding programs should be followed. Keeping in view the above perspectives, the present investigation is carried out to estimate genetic variability for yield, yield contributing characters, quality and nutritional traits among twelve rice varieties.

Materials and Methods

The experiment was carried out at the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur during June 2016 to November 2016. The materials comprised of twelve rice varieties (BRRI dhan53, BRRI dhan54, BRRI dhan56, BRRI dhan57, BRRI dhan62, BRRI dhan66, BRRI dhan70, BRRI dhan71, BRRI dhan72, BRRI dhan73, BU dhan1 and BU dhan2) obtained from Gene bank of Bangladesh Rice Research Institute and gene bank of BSMRAU. Thirty days old seedlings were transplanted 20cm apart between rows and 20 cm within the row. The experimental material was planted in a Randomized Complete Block Design with three replications. All necessary precautions were taken to maintain uniform plant population in each treatment per replication. All the recommended package of practices was followed along with necessary prophylactic plant protection measures to raise a good crop. Ten representative plants for each variety in each replication were randomly selected to record observations on the quantitative characters under study. Days to 50% plants to flowering were computed on plot basis. Iron and zinc content of seed samples was estimated by XRF (X-Ray Fluorescence Spectrometry) method. The treatment means for all the characters *viz*., days to 50 percent plants to flowering, days to maturity, plant height (cm), number of productive tillers per plant, panicle length (cm), number of filled grain per panicle, number of chaffy grain per panicle, 1000 grain weight (g), L/B ratio, iron content (brown) (ppm) and zinc content (brown) (ppm) and yield per hill (g) were subjected to analysis of variance technique on the basis of model proposed by Panse and Sukhatme (1961). The genotypic coefficient of variation (GCV) and phenotypic (PCV) coefficient of variation was calculated by the formulae given by Burton (1952). Heritability in broad sense [h^2 (bs)] was calculated by the formula given by Lush (1940) as suggested by Johnson *et al.* (1955). From the heritability estimates, the genetic advance (GA) was estimated by the following formula given by Johnson *et al.* (1955). Correlation coefficients and path coefficients analysis were done by using OPSTAT online software.

Results and Discussion

The analysis of variance indicated the existence of significant differences among all the varieties for all the traits studied except length breadth ratio. The results of analysis of variance are presented in Table 1. The characters studied in the present investigation exhibited low, moderate and high PCV and GCV values (Table 2). Among the characters, the highest PCV and GCV values were recorded for zinc (brown) content, followed by number of chaffy grains per panicle and the lowest PCV and GCV values were recorded for plant height. High phenotypic variations were composed of high genotypic variations and less of environmental variations, which indicated the presence of high genetic variability for different traits and less influence of environment. Therefore, selection on the basis of phenotype alone can be effective for the improvement of these traits. Similar results were observed by Kumar *et al.* (1994), Chaudhary and Singh (1994), Pathak and Sharma (1996), Sarvanan and Senthil (1997), Rather *et al*. (1998), Satya *et al.* (1999), Shivani and Reddy (2000), Iftekharudduala *et al.* (2001) and Sao (2002). Coefficients of variation studies indicated that the estimates of PCV were slightly higher than the corresponding GCV estimates for all the traits studied indicating that the characters were less influenced by the environment. Therefore, selection on the basis of phenotype alone can be effective for the improvement of these traits.

The estimates of heritability act as predictive instrument in expressing the reliability of phenotypic value. Therefore, high heritability helps in effective selection for a particular character. The characters studied in the present investigation expressed moderate to high heritability estimates ranging from 72.21 to 99.28 percent (Table 2). Among the characters, the highest heritability was recorded by number of filled grains per panicle (99.28), followed by days to 50% flowering, plant height, days to maturity, whereas, length breadth ratio recorded the lowest heritability

Table 1. Analysis of variance (ANOVA) for 12 characters of 12 rice varieties

Source of variation	df	Mean sum of square											
		50%F	DM	PH (cm)	NET/H	PL (cm)	NFG/P	NCG/P	L/B	1000GW (gm)	Fe(B) (ppm)	Zn(B) (ppm)	Y/H (g)
Replication	2	0.44	1.36	2.44	1.06	0.46	28.77	6.29	0.05	1.64	0.62	1.89	5.63
Genotype	11	279.6**	289.3**	135.1**	8.32**	16.84**	495.10**	381.3**	1.19	36.86**	6.39**	847.19**	44.15**
Error	22	1.51	1.73	0.75	0.19	0.35	1.19	1.85	0.13	0.88	0.15	3.70	1.88

*and** indicate significance at 5% and 1% levels, respectively, df-degrees of freedom

50% F= Days to Fifty Percent Plants to Flowering, DM= Days to Maturity, PH= Plant Height(cm), NET/H= Number of Effective Tillers per Hill, PL= Panicle Length (cm), NFG/P= Number of Filled Grain per Panicle, NCG/P= Number of Chaffy Grain per Panicle, L/B= Length Breadth ratio, 1000GW= Thousand Grain Weight (g), Fe(B)= Iron at brown condition (ppm), Zn(B)= Zinc at brown condition(ppm), Y/H= Yield per Hill (g).

Table 2. Genetic variability parameters for 12 characters of 12 rice varieties

Traits	Range	Mean	GCV	PCV	h^2_b(%)	GA	GA (% of mean)
50%F	68.67-102.33	84.64	11.38	11.47	98.40	19.68	23.25
DM	101.33-136.00	119.19	8.21	8.29	98.23	19.99	16.77
PH(cm)	101.73-124.87	114.54	5.84	5.89	98.34	13.67	11.93
NET/H	7.83-13.13	10.02	16.42	17.01	93.21	3.27	32.66
PL(cm)	22.40-29.69	25.85	9.07	9.36	94.00	4.68	18.12
NFG/P	85.40-131.10	116.77	10.99	11.03	99.28	26.34	22.55
NCG/P	10.13-46.73	30.57	36.78	37.05	98.55	22.99	75.23
L/B	3.38-5.29	4.08	14.54	17.11	72.21	1.04	25.45
1000GW(gm)	15.27-29.60	23.98	14.44	14.97	93.10	6.88	28.70
Fe(B)(ppm)	10.95-15.17	12.76	11.31	11.71	93.24	2.87	22.50
Zn(B)(ppm)	25.25-81.80	37.35	44.88	45.18	98.70	34.32	91.87
Y/H(gm)	11.08-23.66	18.57	20.21	21.52	88.21	7.26	39.11

50% F=Days to Fifty Percent Plants to Flowering, DM=Days to Maturity, PH=Plant Height (cm), NET/H=Number of Effective Tillers per Hill, PL=Panicle Length(cm), NFG/P=Number of Filled Grain per Panicle, NCG/P=Number of Chaffy Grain per Panicle, L/B=Length Breadth ratio, 1000GW=Thousand Grain Weight(gm), Fe(B)=Iron at brown condition(ppm), Zn(B)=Zinc at brown condition(ppm), Y/H= Yield per Hill(gm), GCV= Genotypic coefficient of variation, PCV= Phenotypic coefficient of variation, h^2_b= Heritability in broad sense (%), and GA= Genetic Advance.

value. High heritability values indicate that the characters under study are less influenced by environment in their expression. The plant breeder, therefore, may make his selection safely on the basis of phenotypic expression of these characters in the individual plant by adopting simple selection methods. High heritability indicates the scope of genetic improvement of these characters through selection. Similar results have been reported by Panwar *et al.* (1997), Sarawgi *et al.* (2000), Gannamani (2001) and Sao (2002).

The genetic advance is a useful indicator of the progress that can be expected as result of exercising selection on the pertinent population. Heritability in conjunction with GA would give a more reliable index of selection value (Johnson *et al.*, 1955). Genetic advance in percent of mean was highest for zinc (brown) content followed by number of chaffy grains per panicle and lowest for plant height among characters (Table 2). The information on genetic variation, heritability and GA helps to predict the genetic gain that could be obtained in later generations, if selection is made for improving the particular trait under study. Similar findings were also reported by Regina *et al.* (1994), Vanniarajan *et al.* (1996), Shivani and Reddy (2000), Iftekharuddaula *et al.* (2001), Gannamani (2001) and Sao (2002). In general, the characters that show high heritability with high genetic advance are controlled by additive gene action (Panse and Sukhatme, 1957) and can be improved through simple or progeny selection methods. Selection for the traits having high heritability coupled with high genetic advance is likely to accumulate more additive genes leading to further improvement of their performance. In the present study, high heritability along with high genetic advance was noticed for the traits, number of zinc (brown) content and number of chaffy grains per panicle. Other characters showed high heritability along with moderate or low GA which can be improved by intermating superior genotypes of segregating population developed from combination breeding (Samadia, 2005).

Genotypic correlation coefficient (r_g) for all the traits are presented in Table 3. Days to 50% flowering showed significant positive genotypic correlation with days to maturity, plant height, panicle length, number of filled grains per panicle, yield per hill and significant negative genotypic correlation with number of effective tillers per hill. Days to maturity had significant negative association with number of effective tillers per hill. This trait also showed significant positive correlation with days to maturity, plant height, panicle length, number of filled grains per panicle, yield per hill. Plant height showed significant positive correlation with number of filled grains per panicle and number of chaffy grains per panicle and significant negative correlation with number of effective tillers per hill. Number of effective tillers per hill showed significant negative associations with panicle length, number of filled grains per panicle, number of chaffy grains per panicle, yield per hill (g). Significant positive associations were observed between panicle length and number of filled grains per panicle, panicle length and thousand grain weight, panicle length and yield per hill, and panicle length. Number of filled grains per panicle showed significant positive genotypic correlation with number of chaffy grains per panicle, yield per hill (g).

Significant positive genotypic association was observed between length breath ratio and zinc content at brown condition, on the other hand, length breadth ratio had significant negative association with thousand grain weight and yield per hill. Thousand grain weight showed significant positive genotypic correlation with yield per hill (g). Iron content at brown condition showed significant positive genotypic association with zinc content at brown condition.

Path coefficient analysis based on genotypic correlation is presented in Table 4. Days to 50% plants to flowering exhibited the highest positive significant direct effects to grain yield but negative indirect effect via days to maturity, number of chaffy grains per panicle, length breadth ratio and zinc content at brown condition. So direct selection through days to 50% plants to flowering would be significantly increase the grain yield. Although thousand grain weight showed high positive direct effects to grain yield but it had highest significant positive indirect effect on yield per hill. Number of filled grains per panicle showed higher positive direct effects to grain yield and insignificant positive indirect effect via all the traits except days to maturity, number of chaffy grains per panicle and Zinc content at brown condition. The

Table 3. Genotypic correlation coefficient (rg) among 12 characters of 12 rice varieties

	DF	DM	PH	ET	PL	FG	CG	L/B	1000GW	Fe(B)	Z(B)	Y/H
DF		0.998**	0.474	-0.591*	0.674*	0.411	0.263	-0.158	0.295	-0.090	0.006	0.696*
DM			0.478	-0.594*	0.686*	0.453	0.246	-0.153	0.298	-0.065	0.025	0.714**
PH				-0.636*	0.278	0.432	0.702*	0.055	-0.093	0.114	-0.011	0.268
ET					-0.557	-0.472	-0.677*	-0.064	-0.281	-0.267	-0.088	-0.567
PL						0.527	0.199	0.163	0.359	-0.049	0.244	0.675*
FG							0.336	0.138	0.123	0.236	0.280	0.612*
CG								0.352	-0.215	0.137	0.044	-0.048
L/B									-0.533	0.074	0.562	-0.382
1000GW										0.317	0.272	0.722**
I(B)											0.704*	0.340
Z(B)												0.269
Y/H												

*and** indicate significance at 5% and 1% levels, respectively.

50%F=Days to Fifty Percent Plants to Flowering, DM=Days to Maturity, PH=Plant Height(cm), NET/H=Number of Effective Tillers per Hill, PL=Panicle Length(cm), NFG/P=Number of Filled Grain per panicle, NCG/P=Number of Chaffy Grain per Panicle, GL=Grain Length(mm), GB=Grain Breath(mm), L/B=Length Breadth ratio, 1000GW=Thousand Grain Weight(gm), Fe(B)=Iron at Brown condition(ppm), Zn(B)=Zinc at Brown condition(ppm), Y/H= Yield per Hill(gm).

Table 4. Partitioning of genotypic correlation into direct (bold phase) and indirect component by path coefficient analysis

	50%F	DM	PH (cm)	NET/H	PL (cm)	NFG/P	NCG/P	L/B	1000GW (g)	Fe (B) (ppm)	Zn (B) (ppm)	Y/H (g)
50%F	0.712**	-0.371	0.056	0.099	0.065	0.166	-0.122	-0.019	0.132	-0.024	0.002	0.696*
DM	0.706	-0.374	0.057	0.099	0.067	0.179	-0.112	-0.016	0.129	-0.016	-0.004	0.714**
PH(cm)	0.336	-0.175	0.112	0.102	0.030	0.168	-0.334	0.011	-0.035	0.046	0.007	0.268
NET/H	-0.414	0.216	-0.070	-0.166	-0.053	-0.181	0.304	-0.004	-0.127	-0.090	0.019	-0.567
PL(cm)	0.459	-0.240	0.037	0.091	0.100	0.203	-0.081	0.031	0.151	-0.007	-0.068	0.675*
NFG/P	0.293	-0.164	0.048	0.076	0.050	0.395	-0.163	0.027	0.058	0.081	-0.089	0.612*
NCG/P	0.185	-0.090	0.076	0.103	0.018	0.135	-0.488	0.061	-0.079	0.048	-0.015	-0.048
L/B	-0.095	0.032	-0.006	-0.010	0.001	0.037	-0.157	0.190	-0.201	0.001	-0.174	-0.382
1000GW(gm)	0.218	-0.105	-0.004	0.052	0.037	0.057	0.099	-0.085	0.430	0.106	-0.083	0.722**
Fe(B)(ppm)	-0.053	0.026	0.017	0.042	0.000	0.090	-0.060	0.010	0.122	0.361	-0.215	0.340
Zn(B)(ppm)	0.010	-0.009	0.002	0.014	0.024	0.113	-0.022	0.103	0.117	0.242	-0.324	0.269

*and** indicate significance at 5% and 1% levels, respectively

Residual Effect= 0.118

50%F=Days to Fifty Percent Plants to Flowering, DM=Days to Maturity, PH=Plant Height (cm), NET/H=Number of Effective Tillers per Hill, PL=Panicle Length(cm), NFG/P=Number of Filled Grain per panicle, NCG/P=Number of Chaffy Grain per Panicle, L/B=Length Breadth ratio, 1000GW=Thousand Grain Weight (g), Fe (B)=Iron at Brown condition (ppm), Zn (B) =Zinc at Brown condition (ppm), Y/H= Yield per Hill (g).

highest positive indirect effect on yield was observed via thousand grain weight followed by days to maturity, days to 50% flowering, panicle length and number of filled grains per panicle.

The residual effect was 0.118 indicating that 88.2% of the variability observed for grain yield was represented by twelve yield related and quality traits studied. Therefore, 11.8% variability may be covered by other yield related and quality traits that was not included in this experiment that might also have major role in determining grain yield of rice.

Conclusion

It might be concluded from the results that yield per hill (g) is the most important trait due to low difference of GCV and PCV, high h^2_b with high GA in percent of mean, significant positive correlation and high positive indirect effects. Days to 50% plants to flowering and thousand grain weight might also be considered as important traits due to their minimum difference of GCV and PCV values, high h^2_b with high GA in percent of mean, significant positive correlation and higher positive direct effects. Direct selection on the basis of these traits (yield per hill, days to 50% plants to flowering and thousand grain weight) might be considered for the improvement of grain yield of rice.

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