GENETIC VARIABILITY AND CHARACTER ASSOCIATION FOR AGRONOMIC TRAITS IN HYBRID RICE (*Oryza Sativa* L.)

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ABSTRACT

Twenty four hybrid rice varieties of diverse origin were studied for genetic variability, correlation and path analysis under medium high land of Gazipur. The PCV values were greater than GCV, revealing little influence of environment in character expression. High values of heritability along with moderate genetic advance were observed for panicle/m^2, days to 50% flowering and plant height. Grain yield showed positive significant association with number of effective tillers/hill, panicle/m^2, spikelet fertility and thousand grain weight at both genotypic and phenotypic levels. Same traits had highest significant positive effect on yield.

Key words: Genetic variability, correlation, path analysis, hybrid rice

INTRODUCTION

Bangladesh has made notable technological progress in rice cultivation over the last two decades, which has contributed to achieving food security despite doubling of population and a reduction in arable land since its independence in 1971. Cereal production increased from 10.0 million MT (1971) to 35.0 million MT in 2010 reducing hunger and poverty but still we are facing food shortage. The population will increase to over 4.6 billion by 2050 (Honarnejad *et al.,* 2000) which demands more than 50% of rice needs to be produced (Ashikari *et al.,* 2005, Srividya *et al.,* 2010).

The hybrid rice is being the new answer to the growing hunger of world population; by the way of its elevated yield potential, agronomic performance and disease resistance. Genetic variability, correlation and path coefficients are pre-requisites for improvement of any crop including rice in any trait by selection of superior genotypes. Yield component directly or indirectly increasing grain yield if the components are highly heritable and genetically independent or positively correlated with grain yield. It is very difficult to judge whether observed variability is highly heritable or not. Moreover, knowledge of heritability is essential for selection based improvement as it indicates the extent of transmissibility of a character into future generations. Knowledge of correlation between yield and its contributing characters are basic and fore most endeavor to find out guidelines for plant selection. Partitioning of total correlation into direct and indirect effect by path analysis helps in making the selection more effective. Keeping in view the above facts, the present investigation was undertaken to know variability and correlation among yield and its contributing characters using 24 rice hybrids under direct seeded condition in a medium high land.

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MATERIALS AND METHODS

The experiment was conducted at Bangladesh Rice Research Institute, Gazipur, during Aus season, 2010. The trial was conducted with twenty four hybrid rice varieties collected from different parts of Bangladesh. The trial was set in a randomized complete block design with three replications. In this experiment, sprouted seeds were sown on well prepared puddle land. Direct seeding was done by using Drum Seeder. Unit plot size was 8 m^2. Thinning was done at proper time. Fertilizer was applied @ 150: 100: 70: 60: 10kg/ ha Urea, TSP, MP, Gypsum and $ZnSO_4$ respectively. Basal: ¼ Urea, Full dose of TSP, Gypsum, $ZnSO_4$, 2/3MP; Top dressing: ¼ Urea (15-20 DAT), ¼ Urea (35-40 DAT), ¼ Urea (booting stage) and 1/3 MP at 2nd top dress of urea. Water management; weeding and insects & pest control was done when it is required. Data was collected from ten randomly selected plants from each plot on plant height (cm), number of effective tillers/hill, number of panicles/m^2 flag leaf length, days to 50% flowering, spikelet fertility (%), panicle length (cm), thousand grain weight (TGW) and plot yield (t/ha).

The analysis of variance was done using MSTAT C software. Genotypic and phenotypic coefficients of variation were estimated as per Singh and Chaudhary (1979). The broad sense heritability and genetic advance in percent of mean were calculated as suggested by Jonson *et al.* (1955). Normal Pearson's correlation was calculated using SPSS 10.0 software. Genotypic and phenotypic correlation coefficients were calculated following Miller *et al.* (1958). Path coefficient analysis was estimated according to the method suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant variations among the varieties for all the characters studied (Table 1). The phenotypic variance was partitioned into genotypic and environmental variances for a clear understanding of the pattern of variations. The phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the characters studied indicating the presence of environmental influence to some degrees in the phenotypic expression of characters. GCV was the highest (21.58) for grain yield followed by flag leaf length (12.14) and days to 50% flowering (10.04) indicating higher degree of genetic variability among the tested hybrid for these traits. Similar results were obtained by Anseri *et al.* (2010) at different maintainer lines of hybrid rice.

Heritability estimates in broad sense (h^2b) were relatively higher for almost all the traits studied except for number of effective tillers per hill and spikelet fertility. Iftekharuddaula *et al.* (2001) also reported similar results in hybrid rice. High heritability estimates have been found to be helpful in making selection of superior genotypes on the basis of phenotypic performance. Heritability estimates along with genetic gain would be more useful for selecting the best individual. High heritability associated with high genetic advance were found in panicle per m^2 which indicated that the character was simply inherited in nature and controlled by few major genes or possessed additive gene effects.

These results were in agreement with Khaleda *et al.* (2004) in hybrid rice. The heritability estimates with low genetic advance indicated that non additive type of gene action and genotype x environment interaction played a significant role in the expression of the traits as observed in number of effective tillers/hill, grain yield, thousand grain weight, panicle length and days to maturity.

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Table 1. Genetic parameters of different yield and yield contributing characters of hybrid rice

	Plant height (cm)	No. of effective tillers/hill	Days to 50% flowering	Flag leaf length (cm)	Panicle length (cm)	No. of Panicles /m^2	Spikelet fertility (%)	Days to maturity	Thousand grain weight (g)	Grain Yield (t/ha)
MS	128.72**	0.99**	177.90**	40.67**	13.78**	938.41**	68.36**	256.63**	11.61**	1.16**
$\sigma^2 p$	44.17	0.78	58.45	14.08	5.17	348.17	84.23	5.17	3.61	0.43
$\sigma^2 g$	39.61	0.05	57.01	12.63	4.30	303.76	22.78	86.68	3.47	0.37
$\sigma^2 e$	4.56	0.73	1.44	1.45	0.87	44.41	61.45	0.87	0.15	0.06
$H^2 b$ (%)	89.68	6.84	97.54	89.68	83.18	87.25	27.04	96.77	95.97	85.95
GA (% of mean)	12.28	0.12	15.36	6.93	3.90	33.54	5.11	3.90	3.76	1.16
GCV	6.34	3.16	10.04	12.14	8.68	7.23	7.45	8.68	7.74	21.58
PCV	6.69	12.08	10.17	12.82	9.51	7.74	14.33	9.51	7.90	23.28
ECV	2.15	11.66	1.59	4.12	3.90	2.76	12.24	3.90	1.59	8.72

** Significant at 1% level of probability, * Significant at 5% level of probability.
MS = Mean sum of square, $\sigma^2 g$ = Genotypic variance, $\sigma^2 p$ = Phenotypic variance, GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation, $h^2 b$ = Heritability (Broad sense) and GA (%) = Genetic advance in percent of mean

Table 2. Pearson correlation coefficient among yield and yield contributing characters in hybrid rice

	Number of effective tillers/hill	Days to 50% flowering	Flag leaf length (cm)	Panicle length (cm)	Number of panicles/m^2	Spikelet fertility (%)	Days to maturity	Thousand grain weight (g)	Grain yield (t/ha)
Plant height (cm)	0.09	-0.04	0.52**	0.36**	0.27*	0.08	-0.13	0.53**	0.20
Number of effective tillers/hill		-0.27*	0.18	-0.01	0.64**	0.37**	-0.29*	0.29*	0.34**
Days to 50% flowering			0.05	-0.01	-0.38**	-0.34**	0.92**	-0.09	-0.42**
Flag leaf length (cm)				0.17	0.29*	-0.01	-0.12	0.18	-0.02
Panicle length (cm)					0.12	0.28*	-0.15	0.44**	0.17
Number of panicles/m^2						0.35**	-0.41**	0.34**	0.51**
Spikelet fertility (%)							-0.36**	0.33**	0.60**
Days to maturity								-0.18	-0.43**
Thousand grain weight									0.41**

** Significant at 1% level of probability, * Significant at 5% level of probability

Table 3. Genotypic (G) and phenotypic (P) correlations among yield and yield contributing characters in hybrid rice

Characters		Number of effective tillers/hill	Days to 50% flowering	Flag leaf length (cm)	Panicle length (cm)	Number of panicles /m^2	Spikelet fertility (%)	Days to maturity	Thousand grain weight (g)	Grain yield (t/ha)
Plant height (cm)	G	0.260	-0.036	0.589**	0.454**	0.339*	0.090	-0.151	0.579**	0.204
	P	0.105	-0.032	0.516**	0.363**	0.003	0.075	-0.545	0.532	0.206
Number of effective tillers/hill	G		-0.506*	0.336	0.015	0.655**	0.502**	-0.514*	0.564*	0.706**
	P		-0.270*	0.171	-0.003	0.645**	0.375**	-0.450*	0.297*	0.351**
Days to 50% flowering	G			0.037	-0.015	-0.427**	-0.408**	0.980**	-0.098	-0.462**
	P			0.050	-0.011	-0.385**	-0.342**	0.854**	-0.088	-0.429**
Flag leaf length (cm)	G				0.196	0.280*	0.048	-0.123	0.195	0.017
	P				0.180	0.295*	-0.007	-0.509	0.188	0.003
Panicle length (cm)	G					0.143	0.372*	-0.135	0.487**	0.232
	P					0.122	0.276*	-0.635	0.437**	0.173
Number of panicles/m^2	G						0.431**	-0.459**	0.388**	0.566**
	P						0.347**	-0.354**	0.346**	0.509**
Spikelet fertility (%)	G							-0.435**	0.381**	0.775**
	P							-0.354**	0.325**	0.614**
Days to maturity	G								-0.193	-0.503**
	P								-0.761	-0.420**
Thousand grain weight (g)	G									0.458**
	P									0.411**

** Significant at 1% level of probability, * Significant at 5% level of probability

Pearson correlation analysis among yield and its contributing characters are shown in Table 2. For clear understanding correlation coefficients are separated into genotypic and phenotypic level (Table 3). The genotypic correlation coefficients in most cases were higher than their phenotypic correlation coefficients indicating the genetic reason of association. In some cases phenotypic correlation coefficient were higher than genotypic correlation indicating suppressing effect of the environment which modified the expression of the characters at phenotypic level. Grain yield was positively correlated with number of effective tillers per hill, panicle length, spikelet fertility and thousand grain weight. Eradasappa *et al.* (2007) reported significant positive correlation for spikelet fertility percentage with yield in rice. Days to 50% flowering and days to maturity was negatively correlated with yield that means early maturing variety produced lower yield.

Plant height showed significant and positive correlation with flag leaf length and panicle length was significant both at genotypic and phenotypic level (Table 3). Mirza *et al.* (1992) reported positive correlation of number of panicles/m^2 and grain yield with number of tillers/plant. Thousand grain weights were positive and significantly correlated with plant height at genotypic level. Number of effective tillers per hill had negative significant association with days to 50% flowering and days to maturity but positive significant association with panicle/m^2, spikelet fertility, thousand grain weight and grain yield both at genotypic and phenotypic level.

Flag leaf length had positive significant association with panicle/m^2 both at genotypic and phenotypic level but no significant impact with yield. Panicle length had positive and significant association with spikelet fertility and thousand grain weight. Panicle/m^2 was positively and significantly correlated with spikelet fertility thousand grain weight and grain yield but negative significant association with days to maturity both at genotypic and phenotypic level. Kumar *et al.* (1998) observed high positive correlation of grain yield with spikelet fertility. Spikelet fertility exhibited negative significant association with days to maturity but positive significant association with thousand grain weight and grain yield both at genotypic and phenotypic level. Thousand grain weight exhibited positive significant association with yield both at genotypic and phenotypic level.

Path coefficient analysis (Table 4) revealed that spikelet fertility and panicle/m^2 possessed the highest positive effect on grain yield followed by thousand grain weight and number of effective tillers per hills. This indicates that more filled grain in panicle is the highly reliable component of grain yield. Another important character with high direct effect on seed yield is panicle/m^2 which showed positive direct effect on seed yield. Hence, spikelet fertility and panicle/m^2 should be given prior attention in rice improvement program because of their major influence on yield. This finding was in accordance with Hasan *et al.* (2010). Days to 50% flowering and days to maturity had negative significant effect with yield. Negative direct effect was observed for number of effective tillers/plant, flag leaf length, panicle length and days to maturity. The residual effect of the present study was 0.677, indicating that 32.5 % of the variability in grain yield was contributed by ten characters studied in the path analysis. This result gives an impression that some other major characters than those involved in the present study might also contribute to yield.

Table 4. Path analysis showing direct and indirect effects of yield components on hybrid rice

Traits	Direct effects	Indirect effect									Pearson correlation with yield
		Plant height (cm)	Number of effective tillers/hill	Days to 50% flowering	Flag leaf length (cm)	Panicle length (cm)	Number of panicles /m^2	Spikelet fertility (%)	Days to maturity	Thousand grain weight (g)	
Plant height (cm)	0.079	-	-0.011	-0.001	-0.087	-0.034	0.093	0.035	0.022	0.098	0.20
Number of effective tillers/hill	-0.121	0.007	-	-0.003	-0.030	0.002	0.222	0.156	0.041	0.053	0.34**
Days to 50% flowering	0.010	-0.003	0.033	-	-0.009	0.001	-0.133	-0.147	-0.156	-0.016	-0.42**
Flag leaf length (cm)	-0.168	0.041	-0.021	0.001	-	-0.016	0.099	-0.005	0.020	0.033	-0.02
Panicle length (cm)	-0.094	0.029	0.002	-0.001	-0.029	-	0.041	0.119	0.025	0.081	0.17
Number of panicles/m^2	0.347	0.021	-0.077	-0.004	-0.048	-0.011	-	0.148	0.070	0.064	0.51**
Spikelet fertility (%)	0.428	0.007	-0.044	-0.003	0.002	-0.026	0.120	-	0.062	0.060	0.60**
Days to maturity	-0.170	-0.010	0.035	0.009	0.020	0.014	-0.143	-0.155	-	-0.034	-0.43**
Thousand grain weight (g)	0.185	0.042	-0.035	-0.001	-0.030	-0.041	0.119	0.139	0.031	-	0.41**

Residual effect: 0.677

** Significant at 1% level of probability, * Significant at 5% level of probability

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