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GENETIC VARIABILITY AND PATH ANALYSIS IN EXOTIC HYBRID RICE GENOTYPES

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ABSTRACT

Variability, correlation and path coefficients for seven morphological characters were studied on 17 exotic rice hybrids with three check varieties which were imported from different countries. Genotypic and phenotypic coefficients of variation were high for grain yield and number of spikelets per panicle; moderate for 1000 grain weight and low for growth duration, panicle length and panicles per m^2. High heritability accompanied by high to moderate genetic advance for number of spikelets per panicle, 1000 grain weight and grain yield indicated the predominance of additive gene action for the expression of these characters. Grain yield was found to be positively and significantly correlated with plant height, number of panicles per m^2, number of spikelets per panicle, 1000 grain weight and growth duration at both genotypic and phenotypic levels indicating the importance of these characters for yield improvement in this population. The results of genotypic path analysis revealed that spikelet number per panicle had the highest positive direct effect followed by 1000 grain weight and growth duration. The overall results indicated that selection favoring larger number of spikelets per panicle and 1000 grain weight with a reasonable balance for moderate growth duration would help to achieve higher grain yield in this population of rice hybrids.

Key words: Correlation coefficient, genotype, genetic advance and heritability

Introduction

Hybrid rice varieties are expected to shift the yield potential of the rice by 15-20% or more with same amount of agricultural inputs. The technology has attracted the attention of researchers and policy makers in all over the world as a viable option to overcome the yield

ceilings of presently available modern rice varieties. By the year of 2030, Bangladesh has to produce 40 million tons rice from around 8.5 million hectare of land for 190 million peoples. In that case, an average yield of rice needs to be increased from 2.80 t/ha to 4.0 t/ha (Krishi diary 2011). Rice breeder will be the key person to mitigate this huge task. 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 17 rice hybrids for selecting best contributor towards yield.

Materials and Method

Seventeen exotic rice hybrids along with three check varieties were grown in a randomized complete block design with three replications at the experimental farm of Bangladesh Rice research Institute, Gazipur during boro season 2008-2009. Thirty days old seedlings were transplanted in each plot of $30m^2$ size with spacing of 15x20 cm plant to plant and 20x20 cm row to row. Necessary intercultural operation was made during cropping period for proper growth and development of the plants. Data were collected from five randomly selected plants of each hybrids per replication for yield ton per hectare and six yield components viz. plant height (cm), panicle length (cm), number of panicle per m^2, number of spikelet per panicle, 1000 grain weight (g) and growth duration. The data were subjected to analysis of phenotypic and genotypic coefficients of variability (Burton, 1952), heritability and genetic advance (Johnson *et al.* 1955a),

genotypic and phenotypic correlation (Johnson *et al.* 1955b) and path coefficients (Dewey and Lu 1959).

Results and Discussion

The analysis of variance of 17 exotic hybrid rice and three check varieties with respect to 7 quantitative characters revealed that the mean sum of squares due to rice genotypes were highly significant for all the characters studied indicating genetic variability among the experimental materials.

Genetic variability

The extent of variability for any character is very important for the improvement of a crop through breeding. The highest δ^2g were found for number of spikelets per panicle (143.070) and the lowest magnitude of δ^2g was observed in panicle length (0.704). The highest δ^2p were found for number of spikelets per panicle (149.385) and the lowest magnitude of δ^2p was observed in yield (0.907). Similar results with respect to the highest δ^2p were found for filled grains

Table1. Name of the rice hybrids genotypes included in the experiment

Sl. no.	Genotype	Source	Country of origin	Sl. no.	Genotype	Source	Country of origin
1	Heera	Supreme seed company Ltd.	China	11	BRRI dhan36	BRRI	Bangladesh
2	Heera-2	Supreme seed company Ltd.	China	12	ACI93024	ACI seeds Ltd.	India
3	Gold	Lal Teer seed Ltd.	China	13	BRRI hybrid dhan1	IRRI, Philippines	Philippines
4	Tia	Lal Teer seed Ltd.	China	14	ACI1	ACI seeds Ltd.	China
5	Mayna	Lal Teer seed Ltd.	China	15	ACI2	ACI seeds Ltd.	China
6	Richer	Lal Teer seed Ltd.	China	16	Aloron	BRAC	China
7	HP-01	Petrocam Bd. Ltd	China	17	Sonar Bangla	Mollika seed company	China
8	HP-02	Petrocam Bd. Ltd	China	18	Jagoron-2	BRAC	China
9	BRRI dhan28	BRRI	Bangladesh	19	Jagoron-3	BRAC	China
10	BRRI dhan29	BRRI	Bangladesh	20	LP 05	Abtab Bohumukhi Farm Ltd	China

per panicle in exotic rice germplasm (Tania Akter, 2010). The results (Table 2) revealed that genotypic coefficient of variability (GCV) and phenotypic coefficient of variability (PCV) were high for grain yield (14.244 and 14.886) followed by number of spikelets per panicle (11.729 and 11.985) and 1000 grain weight (9.989 and 10.178). The findings were almost supported by Saravanan and Senthil (1997) who observed high GCV and PCV for grains per panicle and moderate for 1000 grain weight in rice. The GCV and PCV were the lowest for growth duration (2.139 and 2.159) followed by panicle length (3.602 and 5.004), panicles per m^2 (5.709 and 5.841). PCV were slightly higher than GCV in case of all the traits, indicating presence of environmental influence to some degrees in the phenotypic expression of the characters. Akanda *et al.* (1997) also reported similar result.

Difference between PCV and GCV for the studied characters was very less indicating low sensitivity to environment and consequently greater role of genetic factors influencing the expression of these characters, which led to high estimates of broad sense heritability for all the characters, except panicle length (51.806%). Almost

Table 2. Estimation of genetic parameters for rice yields and yield contributing traits of hybrid rice

Characters	MSG	MSE	Grand mean	δ^2g	δ^2p	GCV	PCV	h^2b	GA
PHT	113.51	0.83	97.03	37.557	38.391	6.316	6.386	97.827	12.868
PL	2.77	0.66	23.30	0.704	1.360	3.602	5.004	51.806	5.341
P/m2	369.75	5.71	192.97	121.346	127.058	5.709	5.841	95.505	11.492
Sp/P	435.53	6.31	101.98	143.070	149.385	11.729	11.985	95.773	23.645
1000GW	15.59	0.20	22.68	5.132	5.329	9.989	10.178	96.309	20.194
GD	29.10	0.182	145.12	9.639	9.820	2.139	2.159	98.151	4.366
Yield	2.57	0.08	6.40	0.830	0.907	14.244	14.886	91.567	28.079

*** Significant at 0.001 probability levels,

MS_G= Mean sum of squares due to genotypes, MS_E= Mean sum of square due to error, δ^2g= Genotypic variance, δ^2p= Phenotypic variance, GCV= Genotypic coefficient of variation, PCV= Phenotypic coefficient of variation, h^2_b= Heritability, GA= Genetic advance, PHT= Plant height (cm), PL= Panicle length (cm), P/m^2 = Panicle/m^2, Sp/P = No. of spikelet/panicle, 1000GW = 1000 grain weight(g), GD = Growth duration, Yield = Yield (t/ha).

Table 3. Genotypic (rg) and Phenotypic (rp) correlation coefficient among yield and yield contributing traits of hybrid rice

Parameters		PL	P/m^2	Sp/P	1000GW	GD	Yield
PHT	r_g	0.287	0.580**	0.748**	0.185	0.619**	0.541*
	r_p	0.201	0.568**	0.720**	0.179	0.600**	0.512*
PL	r_g		0.325	0.000	-0.466*	-0.141	0.007
	r_p		0.236	0.008	-0.339	-0.108	-0.019
P/m^2	r_g			0.734**	0.563**	0.684**	0.677**
	r_p			0.703**	0.537*	0.660**	0.642**
Sp/P	r_g				0.538*	0.846**	0.904**
	r_p				0.530*	0.823**	0.830**
1000GW	r_g					0.651**	0.655**
	r_p					0.639**	0.626*
GD	r_g						0.841**
	r_p						0.817**

*, ** Significant at 0.05 and 0.01 probability levels,

legend:

r_g = Indicates genotypic correlation coefficient and r_p = Indicates phenotypic correlation coefficient PHT= Plant height (cm), PL= Panicle length (cm), P/m^2 = Panicle/m^2, Sp/P = No. Of Spikelet/panicle, 1000GW= Thousand grain weight (g), Yield= Yield ton per hectare.

(environmental) variance to minor proportions as reported by Dewey and Lu (1959). Wide difference between two characters is due to dual nature of phenotypic correlation, which is determined by genotypic and environmental correlations and heritability of the characters (Falconer, 1981).

Grain yield was found to be positively and significantly correlated with plant height, number of panicles per m^2, number of spikelets per panicle, 1000 grain weight and growth duration at both genotypic and phenotypic levels indicating the importance of these characters for yield improvement in this population. The results are in agreement with Nayak *et al.* (2001) and Shanthi and Singh (2001) for plant height; Nayak *et al.* (2001) and Chaudhary and Motiramani (2003) for panicle number.

When characters having direct bearing on yield are selected, their associations with other characters are to be considered simultaneously as this will indirectly affect yield. Significant positive correlations at both the levels were recorded for plant height with number of panicle per m^2, number of spikelets per panicle and growth duration; number of panicles per m^2 with number of spikelets per panicle, 1000 grain weight and growth duration; number of spikelets per panicle with 1000 grain weight and growth duration; 1000 grain weight with growth duration. Similar associations in rice were also reported by Manuel and Palanisamy (1989) and Kennedy and Rangasamy (1998).

Genotypically significant negative correlations were noted for panicle length with 1000 grain weight. The results are in agreement with Shanthi and Singh (2001) for test weight. Negative genotypic correlation of yield per plant was reported with panicle length by Saini and Gagneja (1975). Pleiotropy and/or linkage may also be the genetic reasons for this type of negative association. According to NeWall and Eberhart (1961) when two characters show negative phenotypic and genotypic correlation, it would be difficult to exercise simultaneous selection for these characters in the development of a variety. Hence under such situations judicious selection programme might be formulated for simultaneous improvement of such important developmental and component characters.

The results of correlation coefficients implied that plant height, number of panicles per m^2, number of spikelets per panicle, 1000 grain weight and growth duration may be considered for selection of yield improvement.

Path analysis

Considering grain yield as effect and six characters as causes, genotypic correlation coefficients were partitioned by using method of path analysis to find out the direct and indirect effects of yield contributing characters towards yield. Shrivastava and Sharma (1976) suggested that only direct yield components should be used for path analysis. The results of genotypic path analysis revealed (Table 4) that number of spikelets per panicle (1.107) had the highest positive direct effect followed by panicle length (0.724), 1000 grain weight (0.692) and growth duration (0.300). Tania Akter (2010) noted greatest contribution of number of spikelets per panicle to grain yield.

Spikelet number had highest positive direct effect and no indirect effect through panicle length. Panicle length exhibited very high direct positive effect and no indirect effect through

Table 4. Path coefficient showing direct (bold value) and indirect effects of yield related characters on yield of hybrid rice

Characters	PHT	PL	P/m^2	Sp/P	1000GW	GD	Yield
PHT	-0.373	0.208	-0.435	0.828	0.128	0.186	0.541*
PL	-0.107	0.724	-0.244	0.000	-0.323	-0.042	0.007
P/m^2	-0.216	0.236	-0.750	0.812	0.390	0.205	0.677**
Sp/P	-0.279	0.000	-0.551	1.107	0.373	0.254	0.904**
1000GW	-0.069	-0.337	-0.423	0.596	0.692	0.196	0.655**
GD	-0.231	-0.102	-0.513	0.937	0.451	0.300	0.841**
					Residual	effect =	0.043

legend:

PHT= Plant height (cm), PL= Panicle length (cm), P/m^2 = Panicle/m^2, Sp/P = No. of Spikelets/panicle, 1000GW= Thousand grain weight (g), GD= Growth duration, Yield= Yield ton per hectare.

spikelet number which was counterbalanced by its indirect negative effect through rest of the characters and this resulted in non-significant association between panicle length and grain yield.

Thousand grain weight had also high positive direct effect. Its indirect effect through growth duration was positive and that of panicle length was negative. This resulted in significant positive correlation with grain yield.

Growth duration showed moderate positive direct effect and its indirect effect through number of spikelets per panicle was relatively large and positive through that of number of panicles per m^2, Panicle length and plant height were negative. Growth duration showed significant positive correlation with grain yield.

Number of panicles per m^2 and plant height had negative direct effect on grain yield. Moreover, the contributions of these two characters in the path-way of other characters were negligible and negative in majority of the cases.

The overall results indicated that selection for larger number of spikelets per panicle, 1000 grain weight with a reasonable balance for moderate growth duration would particularly encourage the breeders to achieve higher grain yield. The results are in conformity with Mehetre *et al.* (1996) for grain number; Nayak *et al.* (2001)

for grain number and Khedikar *et al.* (2004) for 1000 grain weight.

Very low residual effects (0.043) indicated that six characters included in this study explained high percentage of variation in grain yield. Similar findings (r=0.0111) was found by Kole *et al.* (2008) in basmati rice. Moreover, majority of values were less than unity, which indicated that inflation due to multicolinearity was minimal (Gravois and Helms, 1992).

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