Study of Genetic Variability and Heterosis of Selected F_1 Rice

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Abstract: Genetic variability and heterosis was studied for the characters of no. of effective tiller, no. of ineffective tiller, initial flowering, no. of filled grain/panicle and no. of unfilled grain/panicle for six newly developed hybrids. In this study high heritability with high genetic advance (GA) was found for the character of initial flowering, no. of effective tiller/hill and no. of filled grain/panicle. Therefore considerable scope for improvement of rice exists by selecting of those characters. In case of hybrids the cross RGBU010 A X LP70 R, RGBU012 A X LP70 R, and RGBU013 A X Gold R were found promising for developing improved rice variety as they shown vigor for yield contributing character including initial flowering, no. of effective tiller/hill and no. of filled grain/panicle.

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Introduction

Rice is the most important food crop and the staple food for 40% of the world population. More than 90% of rice is produced and consumed in Asia (Virmani, 1996). With the increasing population pressure the demand of cereal is increased day by day. The world population is expected to reach 8 billion in 2025 and it is estimated that 50 % more food is required to feed the increased population (Khush, 2004). In Bangladesh about 80 % of the total cultivable land is used for rice cultivation. Total rice production is 29.74 million metric tons (Anonymous, 2010) which supplies more than 70% calories and 50 % protein (Islam, 2001). At present, in Bangladesh the area under rice cultivation is gradually decreasing due to industrialization and expansion of urban area. The population continues to grow but arable land area is shrinking. A lot of rice land is being converted to non-rice areas. The only way to meet this challenge is by increasing the yield per unit area through the use of hybrid rice varieties.

For this reasons, hybrid rice development may be one of the ways to satisfy the future demand. Hybrid rice breeding aims to improve the desirable characters of parental lines and ultimately the yield performance of their F1 hybrids. Selection of parent and their hybrid of higher magnitude for yield traits and utilization in varietals development are the possible approaches to increase the yield. Therefore, the study was conducted to study the mid parent, batter parent and standard heterosis of the selected $F_{1,}$ and the performance of selected yield contributing traits.

Materials and Methods

Plant materials

The experimental materials was developed from nine stable CMS lines viz. RGBU002 A, RGBU003 A, RGBU005 A, RGBU014 A, RGBU012 A, RGBU013 A, RGBU006 A, RGBU009 A, RGBU010 A, and four identified restorer lines viz. SL 8 R, LP70 R, Gold R, Mitali R. The newly developed thirteen crosses are RGBU006 A X SL8 R, RGBU013 A X SL8R, RGBU012 A X LP70 R, RGBU010 A X LP70 R, RGBU013 A X Gold R, RGBU009 A X Mitali R, RGBU002 A X SL8 R, RGBU002 A X Mitali R, RGBU003 A X SL8 R, RGBU005 A X LP70 R, RGBU010 A X SL8 R, RGBU014 A X SL8 R and RGBU014 A X Gold R. and they were evaluated along with parent and standard check BRRI dhan 29. The experiment was carried out during December 2011 to July 2012 (respective cross was conducted) and December 2012 to July 2013 (cross material was planted).

Design and Layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The whole experimental area was divided into three blocks, representing three replications. Five rows of 4m each constituted the experimental unit. Healthy seedlings of 45 days old were transplanted in separate strips of the experimental field. Observations were recorded for different characters on five randomly selected plants per replication in both hybrids and parents for days to initial flowering, number of effective tillers per plant (no), number of ineffective tillers per plant (no), initial flowering (Days) number of filled grains per panicle (no), number of unfilled grains per panicle (no).

Analysis of variance

The genotype (G), phenotype (p), and environmental (E) coefficients of variations (CV) were calculated. The expected genetic advances for different characters under selection were estimated by the formula as suggested by Johnson *et al.* (1955).

Measurement of Heterosis

Measurement of heterosis is quite simple. It was worked out by utilizing the overall mean of each hybrid for each trait. Heterobeltiosis was estimated as percent increase or decrease of F1 over better parent (BP). Standard heterosis for each character was expressed as per cent increase or decrease of F1 value over the standard variety (SV) and standard hybrid (SH) Virmani *et al*., (1997).

$$\text{Better parent heterosis (\%)} = \frac{F_1 - \text{better parent}}{\text{Better parent}} \times 100$$

$$\text{Standard heterosis (\%)} = \frac{F_1 - \text{Check variety}}{\text{Check variety}} \times 100$$

The t' test was applied to determine significant difference of F_1 hybrid means from respective better parent and standard parent values using formulae as reported by Wynne *et al.* (1970).

Result And Discussion

The analysis of variance showed significant differences in hybrids vs. parents for all the character. The component of variation along with coefficient of variability and genetic parameters of the studied characters are presented (Table 2). The narrow difference between genotypic and phenotypic component of variance revealed that the major portion of this phenotypic variance are genetic in nature. No. of filled grain showed the height genotypic and phenotypic variability followed by no. of unfilled grain. The days to initial flowering showed minimum difference between the genotypic, and phenotypic component of variance, followed by the no. of ineffective tiller. In this study days to initial flowering showed height broad sense heritability (HB) followed by no. of filled grain/panicle and no. of unfilled grain/panicle. The lowest broad sense heritability was found in case of no. of ineffective tiller/hill followed by no. of effective tiller/hill. Higher GA was found in case of no. of effective tiller/hill hollowed by days to maturity, no. of uneffective tiller/hill and no. of unfilled grain/panicle. The lowest genetic advance (GA) was found in case of no. of filled grain/panicle. Height broad sense heritability (HB) along with high genetic advance (GA) is usually more helpful in predicting the resultant effect for selection of the best individual than heritability. In this study high heritability with high genetic advance (GA) was found for the character of initial flowering, no. of effective tiller/hill and no. of filled grain/panicle, indicating the presence of additive gene effect in controlling those characters. Therefore considerable scope of improvement of rice exists by selecting of those characters. Similar results were also reported by Rahman *et al.* (1988), Alam *et al.* (1988) and Alam *et al*. (1989).

Table 1. Analysis of variance for yield and yield related character in rice

source of variation	No of Effective Tiller	No of Uneffe ctive Tiller	Days to initial flowering	No of Filled grain	No of unfilled grain
Replication	0.347	0.792	42.58	41.44	12.483
Parent vs Hybrid	62.929**	20.914**	95.35**	1191.432**	237.295**
Error	1.620	1.889	0.13	20.421	6.546

** indicate 5% level of significant

Table 2. Estimation of genetic component of variation of yield and yield contributing characters in rice

	VG	VE	VP	GCV	GPV	GEV	h^2b	GA	%GA
Effective tiller	10.14	1.62	11.76	21.75	23.45	1.7	86.22	19.9	15.55
No.of uneffective tiller	6.34	1.89	8.23	17.08	19.46	2.83	77.03	17.3	13.91
Days to flowering	31.73	0.13	31.87	5.43	0.35	5.42	99.56	18.5	14.50
No of filled grain/panicle	398.07	17.87	415.9	14.91	3.09	14.59	95.70	3.38	2.64
No of unfilled grain	76.91	6.54	83.46	43.84	12.28	42.09	92.15	15.1	11.81

VG = Genotypic component of variance GCV = Genotypic coefficient of variance
VP = Phenotypic component of variance PCV = Phenotypic coefficient of variance
VE=Environmental component of variance ECV = Environmental coefficient of variance
h^2b = Broad sense heritability GA = Genetic advance

Table 3. Better parent and standard heterosis of yield and yield contributing characters in rice

Character	Heterosis	1	2	3	4	5	6	7	8	9	10	11	12	13
NET	BPH	-28.64**	-17.32**	4.29**	-27.32**	3.88**	-15.52**	-26.24**	1.20	-12.00**	-15.78**	43.48**	-23.54**	12.97**
	STH	-6.01**	8.80**	-21.27**	-28.39**	-45.25**	-25.64**	-2.93**	33.14**	15.85**	10.81**	7.85**	0.22	-3.86**
NUT	BPH	-27.49**	-15.12**	-3.16**	-39.31**	-0.08	-11.54**	-26.19**	4.05**	4.05**	0.55	11.50**	5.89**	27.02**
	STH	-17.61**	-3.58**	-19.68**	-5.03**	-49.68**	-31.25**	-16.16**	18.23**	8.99**	14.33**	-7.54**	-1.25	-11.7**
IF	BPH	3.59**	14.05**	-6.36**	0.31	5.92**	-0.0098	2.94	3.92*	1.30	11.43**	-3.82**	-1.64	-8.54**
	STH	-7.31**	2.04*	-14.03**	-12.57**	-7.89**	-7.60**	-7.89**	-7.01**	-9.35**	-0.29	-11.70**	-15.8**	-5.85**
NFG	BPH	-31.72**	-21.29**	-6.21**	-26.86**	-15.03**	-16.47**	-20.77**	-21.57**	-27.37**	-20.81**	-18.29**	-19.49**	-16.75**
	STH	-36.84**	-21.17**	-22.39**	-0.22	-39.51**	-28.34**	-26.70**	-24.43**	-32.82**	-23.35**	-32.42**	-21.71**	-30.49**
NUG	BPH	-43.87**	-82.52**	-66.72**	-41.27**	-53.61**	-42.93**	-36.61**	57.08**	-7.67**	-51.96**	54.05**	34.48**	-63.19**
	STH	69.96**	-3.31**	128.02**	59.00**	106.08**	60.60**	-34.05**	63.49**	-3.93**	-49.23**	82.72**	-42.86**	118.20**

* indicate 1% level of significant
** indicate 5% level of significant

Here,
1= RGBU006 A x SL8 R
2= RGBU013 A x SL8 R
3= RGBU010 A x LP70 R
4= RGBU012 A x LP70 R
5= RGBU013 A x Gold R
6= RGBU009 A x Mitali R
7= RGBU014 A x SL8 R
8= RGBU002 A x SL8 R
9= RGBU003 A x SL8 R
10= RGBU010 A x SL8 R
11= RGBU005 A x LP70 R
12= RGBU014 A x Gold R
13= RGBU002 A x Mitali R
NET= No. of effective tiller
IF = Initial flowering
NUT= No. of uneffective tiller
NFG = No. of filled grain
NUG = No. of unfilled grain

Heterosis

Heterosis refers to the increase or decrease in F_1 over the mean parental value. From the view point of plant breeding, increased yield of F_1 over the better or best commercial variety is more relevant. A higher yield over high yielding check varietirs and wider adaptability has been instrumental in rapid spread of hybrid rice in Bangladesh. The hybrids which are likely to be released for commercial scale should surpass the yield level of locally cultivated superior variety/hybrid. Hence, in practical breeding program standard heterosis would along be taken into consideration for selection of hybrid. In this study, considerable heterosis over standard check was observed both in positive and negative direction and degree of heterosis varied from cross to cross and from character to character. Heterosis of F_1 hybrid over their respective better parent and standard variety are present in (Table 3) for each character, the percentage value of the thirteen hybrid have been compared with better parent and standard variety and the relative superiorities being termed as better parent heterosis and standard heterosis.

Effective Tiller

The tillering ability is one of the most important traits of rice because it influences on future panicle production as well as grain yield. Rice varieties having higher tiller number gave shorter and thicker leaves which lead to less competition for dry matter and N among tiller. Positive heterosis is desirable for effective tillers per hill. Better parent heterosis of all the crosses was significant. Better parent heterosis for effective tillers per hill ranged from 4.29 to –28.64 percent. Standard heterosis for most of the crosses was also significant for tillers per hill. The highest standard heterosis in positive direction (33.18 %) was found for this trait in hybrid RGBU002 A x SL8 R. The lowest standard heterosis in negative direction (-45.25 %) was found for this trait in hybrid RGBU014 x SL8R (Table 3). Considering desirable and significant positive heterosis over standard checkcross combination RGBU013A x SL8 R, RGBU002 A x SL8 R, RGBU010 A x SL8 R, RGBU005 A x LP70 R, RGBU003 A x SL8 R might be identified as good hybrids for this trait. Shanthala *et al.* (2006) and Akram *et al.* (2007) reported similar results in rice.

Ineffective Tiller

In case of ineffective tillers per hill negative heterosis is desirable. Standard heterosis for most of the crosses was significant for tillers per hill. Standard heterosis for uneffective tillers per hill ranged from 18.25 to -49.68 percent. Considering desirable and significant negative heterosis over standard check, cross combination RGBU013A x Gold R might be identified as good hybrids for this trait. Bhandarkar *et al*. (2005) and Akram *et al.* (2007) reported similar results in rice.

Days to Initial Flowering

Early maturing hybrid is desirable as they produce more yield per day and fit well in multiple cropping. For this negative heterosis is desirable for days to initial flowering. Significant batter parent heterosis was observed in three crosses. Better parent heterosis for days to flowering ranged from 14.05 to -8.54 percent and standard heterosis rabged from -14.03% to -2.04%. Significant negative and desirable standard heterosis was observed in four cross combinations, i e, RGBU006A X SL8R, RGBU010A X LP70 R, RGBU012A X LP70 R, RGBU013A X Gold R which might be considered for early flowering hybrids. These results were in agreement with the findings of Bhandarkar *et al*. (2005) in rice.

No. of Filled Grains per Panicle

For filled grains per panicle positive heterosis is desirable. Standard heterosis of most of the crosses was non significant for number grains per panicle. Standard heterosis for number of grains per panicle range from -0.22% to -39.51%. The highest standard heterosis in negative direction (-0.22 %) was found for this trait in hybrid RGBU012 A x LP70 R. The negative standard heterosis -31.72% was found for the trait in the hybrid RGBU006 A x SL8 R .No cross combination was identified as good heterotic hybrids for standard heterosis percentage. Shanthala *et al*. (2006) and Chaudhary *et al*. (2007) reported similar results in rice.

No. of Unfilled Grains per Panicle

For unfilled grains per panicle negative heterosis is desirable. Standard heterosis of all the crosses was significant for unfilled grains per panicle. Standard parent heterosis ranged from 128.02 to -3.31 percent. The highest standard heterosis in positive direction (128.02%) was found for this trait in hybrid RGBU010A X LP70 R. The lowest standard heterosis in negative direction (-49.23 %) was found for this trait in hybrid RGBU013A x SL8 R. Cross combinations RGBU013 Ax SL8 R was found to be good for heterosis due to significant negative value. Janardhanam *et al.* (2001), Vanaja and Babu (2004), Bhandarkar *et al*. (2005) and Liakat (2011) reported similar results in rice.

Conclusion

The emphasis should be given on the character of initial flowering, no. of effective tiller/hill and no. of filled grain/panicle for future improvement and in case of hybrid the cross RGBU010 A X LP70 R, RGBU012 A X LP70 R, and RGBU013 A X Gold R were found promising for developing improved rice variety because they shown vigor for yield contributing character including initial flowering, no. of effective tiller/hill and no. of filled grain/panicle.

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