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Heterosis for yield components in intermutant hybrids of rice

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ABSTRACT

Four rice mutant strains were crossed in all possible combinations excluding their reciprocals. F_1s of these crosses, their parents (i.e. mutants) and one check variety Srilanka were grown in RBD with three replications. Observations were recorded on plant height, number of panicles plant^{-1}, panicle length, number of grains panicle^{-1}, grain density, grain yield and days to 50% flowering. All the characters showed significant variations amongst the genotypes. Hybrids showed higher mean performance than their parents for almost all the characters. Both positive and negative heterosis were observed amongst the hybrids. The expression of heterosis varied with the crosses and characters. Two crosses MS_1'MS_2 and MS_2MS_4 were identified for exploitation of heterosis and to isolate desirable segregants in later generations. Grains panicle^{-1} played important role in the expression of heterosis.

Key words: *rice, inter mutant hybridization, heterosis, heterobeltiosis*

Hybrid rice technology aims to increase the yield potential of rice beyond the level of inbred high yielding varieties (HYV) by exploiting the phenomenon of hybrid vigour or heterosis. Since most of the tropical rice growing countries have a high population growth ratio and limited land for rice cultivation, there must be an increase in the production per unit area in order to obtain food security. Hybrid rice is one of the most time-tested tools for meeting this objective. Heterosis is manifested as improved performance for F_1 hybrid generated by crossing two inbreed parents. Although heterosis is expressed in three ways (heterosis over mid parents, heterobeltiosis and standard heterosis), standard heterosis is most important because it is desired to develop hybrids which are better than the existing high yielding varieties grown commercially by farmers. The present study was carried out for the of exploitation of hybrid vigour resulting from inter mutant hybridization in rice.

MATERIALS AND METHODS

The experiment was conducted during the wet season. Six hybrids were obtained by crossing four rice mutants (M_1, M_2, M_3 and M_4) in all possible combinations excluding their reciprocals. These six F_1 hybrids along with their parents and a high yielding variety *Srilanka* as check were explored for their heterosis by raising them in a randomized block design with three replications at the experimental garden of Botany Department, Gauhati University, Assam. Original parent of M_1 and M_2 was "Ronga Solpona" while that of M_3 and M_4 was "Boga Solpuna". These mutants were developed earlier in the Botany Department, Gauhati University (Dutta, 2000).

Twenty five days old seedlings at the rate of one seedling hill^{-1} were transplanted in the field. The field was made into three plots. Each plot represented one replication, and divided into 11 smaller plots. Each smaller plot allotted to individual F_1s, their parents and the check variety. In each smaller plot, plants in one row having five hills with 20cm x 20cm spacing between and within rows were planted. Thus, 165 seedlings were grown in an area of 6.6m^2. Three rows each of 'Boga solpuna' and 'Ronga solpuna' were planted in all sides of the plot to minimize the boarder affects. Recommended crop management practices were followed during the entire growing period. At maturity, data were recorded from all the plants in each replication for plant height, number of panicles plant^{-1}, panicle length, grain density, number of grains panicle^{-1} grain yield and days to 50% flowering. The mean values for each of these parameters were used for computation of heterosis over mid parents (MP), heterobeltiosis (HB) and standard heterosis (SH) as per the method outlined by Turner (1953). The significance was tested by using the formula given by Wyne *et al*. (1970). The analysis of variance for different characters was done as suggested by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

The performances of F_1 hybrids and their respective parents are presented in the Table 1. The analysis of variance for the different characters are presented in the Table 2. Analysis of variance that indicated significant variations were present amongst the genotypes for all the characters under study. Hybrids exhibited higher mean values as compared to those of parents. This indicates the presence of heterosis for these characters. None of the crosses showed higher mean values for all the characters simultaneously Table 1. In the present study, the cross M_2xM_4 showed the best heterosis as it showed significant positive heterosis over mid parents, better parents and check variety *Srilanka* for grain yield and all other yield attributing characters. Similarly, the cross also M_1xM_2 showed significant positive heterosis for yield and all yield attributing characters except for number of panicles plant^{-1}. Other workers (Rao, 1965; Maurya and Singh, 1978; Geeta *et al*., 1994; Ramalingam *et al*., 1994) also reported highly significant positive heterosis over better parent and over check variety for grain yield in rice. The cross M_1xM_3 showed significantly positive mid parent heterosis for grain yield and yield attributing characters; heterobeltiosis for panicle length, number of grains panicle^{-1}, grain density, grain yield and days to 50% flowering and standard heterosis for plant height and panicle length. The other characters such as number of panicles plant^{-1} and number of grains panicle^{-1} showed significant negative

Table 1. Mean performance of F_1 hybrids and their respective parents

Parents/ cross	Plant height (cm)	Number of panicles	Panicle length (cm)	No. of grains panicle^{-1}	Grain density	Grain yield (gm)	Days to 50% flowering
M_1	125.30±0.66	3.38±0.09	21.53±0.17	66.30±2.61	10.68±0.18	6.60±0.19	117
M_2	101.32±2.21	5.40±0.78	18.20±0.33	55.60±3.06	16.36±0.44	8.80±0.08	122
M_3	132.011.39	4.36±0.10	20.06±0.23	60.70±1.87	12.77±0.41	7.20±0.15	119
M_4	142.40±1.23	3.01±0.12	19.26±0.23	40.31±2.65	6.36±0.40	6.50±0.17	130
Srilanka	110.75±1.22	5.60±0.06	25.40±0.02	106.00±3.31	23.37±0.41	10.20±0.13	120
M_1xM_2	182.00±0.80	6.20±0.51	29.80±0.34	140.406.44	29.21±1.56	17.45±0.35	125
M_1xM_3	137.01±1.24	4.50±0.18	34.30±0.36	83.60±2.00	17.75±0.87	9.75±0.76	123
M_1xM_4	145.00±0.94	3.00±0.29	20.30±0.32	59.60±1.80	8.81±0.69	4.20±0.12	118
M_2xM_3	119.00±0.75	5.00±0.74	21.20±0.35	112.202.80	26.46±1.39	12.90±0.19	125
M_2xM_4	182.30±1.69	5.80±0.24	29.23±1.34	181.40±3.08	35.99±0.60	18.40±0.30	135
M_3xM_4	118.11±1.59	5.62±0.01	22.10±0.40	66.60±2.04	10.85±0.40	9.35±0.20	121

MS = Mutant strain

Table 2. Analysis of variance for various characters

Source of variation	d.f.	Mean sum of square						
		Plant height	Panicle no. plant^{-1}	Panicle length	Grain density	Grains panicle^{-1}	Grain yield	Days to 50% flowering
Genotypes	10	2417.97**	3.99**	47.55**	50.78**	5876.01**	9021.66**	95.76**
Replication	2	17.43^{NS}	0.66^{NS}	2.92^{NS}	2.41^{NS}	312.05^{NS}	16.79^{NS}	9.23^{NS}
Error	20	9.58^{NS}	0.07^{NS}	1.30^{NS}	1.44^{NS}	53.99^{NS}	12.37^{NS}	8.94^{NS}

** Significance level P=0.01

NS = Not significant

Table 3. Heterosis, heterobeltiosis and standard heterosis for different characters in F_1 generation.

Cross	Heterosis type	Plant height (cm)	No. of panicles plant^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	Grain density	Grain yield (gm)	Days to 50% flowering
M_1xM_2	H%	71.59**	40.90**	48.77**	130.35**	116.05**	125.16**	4.60*
	HB%	80.49**	14.80**	38.41**	111.76**	78.65*	98.29**	6.83**
	SH%	64.30**	10.71*	4.73**	32.45**	24.98*	71.07*	4.23*
M_1xM_3	H%	6.44**	16.88**	64.89**	31.65**	51.32**	40.28*	4.23*
	HB%	9.34^{NS}	4.65^{NS}	59.31**	26.10**	38.99*	35.41**	5.12*
	SH%	23.7**	-19.64**	35.05**	-21.13**	-24.04^{NS}	-4.41^{NS}	2.51^{NS}
M_1xM_4	H%	8.30**	-7.69^{NS}	-0.44^{NS}	11.81**	3.40^{NS}	35.87*	-4.45*
	HB%	15.72^{NS}	-11.76^{NS}	-5.71**	-10.10^{NS}	-17.51^{NS}	-36.36^{NS}	0.85^{NS}
	SH%	30.92**	-46.43**	-5.48**	43.77**	-62.30**	-58.82**	1.66^{NS}
M_2xM_3	H%	7.24**	3.09^{NS}	10.82*	92.94**	81.73**	61.25**	2.07^{NS}
	HB%	17.45**	-7.40^{NS}	6.18**	84.84**	61.83*	46.59**	3.36^{NS}
	SH%	7.45*	-10.71*	-16.53**	58.50**	13.22*	26.51*	4.16^{NS}
M_2xM_4	H%	56.99**	36.47**	56.60**	278.30**	216.81**	180.92**	7.14**
	HB%	79.92**	7.41**	49.70**	226.6**	120.12**	178.80**	10.65**
	SH%	64.60**	3.57^{NS}	15.07**	11.13**	54.00**	80.40**	12.50**
M_3xM_4	H%	-14.02**	51.89**	12.99**	31.88**	13.49^{NS}	39.12**	-3.12^{NS}
	HB%	-10.53**	30.69**	10.90**	9.71^{NS}	-15.03^{NS}	29.86^{NS}	1.68^{NS}
	SH%	6.55**	0.35^{NS}	-12.99**	-37.21**	-53.57^{NS}	-8.33^{NS}	0.83^{NS}

H=Heterosis; HB=Heterobeltiosis; SH=Standard Heterosis
* and ** Significant at P=0.05 and 0.01 respectively

heterosis. The cross M_1xM_4 showed significantly positive heterosis for plant height, number of grains panicle^{-1} and grain yield; standard heterosis for plant height and number of grains panicle^{-1}. The other characters *viz.*, days to 50% flowering for heterosis over mid parent, panicle length for heterobeltiosis and number of panicles plant^{-1}, panicle length, grain density and grain yield for standard heterosis showed negative heterosis. The cross M_2xM_3 showed significant positive heterosis for plant height, panicle length, number of grains panicle^{-1}, grain density and grain yield; positive heterobeltiosis for plant height, panicle length, number of grains panicle^{-1}, grain density and grain yield; standard heterosis for plant height, number of grains panicle^{-1}, grain density and grain yield. Negative standard heterosis was observed for panicle numbers plant^{-1} and panicle length. The cross M_3xM_4 showed significant positive heterosis for number of panicles plant^{-1}, panicle length, number of grains panicle^{-1} and grain yield; positive heterobeltiosis for number of panicles plant^{-1} and panicle length and positive standard heterosis for plant height. This cross also showed negative heterosis and heterobeltiosis for plant height and also standard heterosis for panicle length and number of grains panicle^{-1}. Many workers (Singh *et al*., 1980; Kalaimani and Sundaram, 1987; Lokprakash *et al*., 1992; Sarma and Roy, 1996; Ganesan *et al*., 1997; Souframanien *et al*., 1998; Paramasivan and Sree Rangasamy, 1988) also observed both positive and negative heterosis. Thus the expression of heterosis varied with crosses as well as with characters.

Among the crosses, M_1xM_2 and M_2xM_4 may be selected as they exhibited desirable heterosis for most of the characters and showed superiority of mean performance over the check variety. Hence these hybrids may be exploited for heterosis and desirable segregants may be isolated from these crosses. Shivani and Reddy (1999) also reported that superiority of hybrid over check variety could be utilized for the development of hybrids in rice breeding program.

In the present study, it was observed that the cross, which showed significant positive heterosis for yield, also showed significant positive heterosis for at least two yield attributing characters. The hybrid showed heterosis for grain yield also showed significant heterosis for number of grains panicle^{-1}. This indicates the importance of this trait for the expression of heterosis. Thus different rice mutants may be improved further by exploiting the heterosis after an intermutant hybridization programme.

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