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HETEROSIS AND INBREEDING DEPRESSION IN UPLAND RICE CROSSES

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ABSTRACT

F_1 heterosis over midparent (MP) and better parent (BP) and F_2 inbreeding depression (ID) were studied in 8 crosses of rice for grain yield/plant and its four other component traits, i.e., plant height, effective tillers/plant, No. of filled grains/panicle and 1000-grain weight. Highly significant and positive MP and BP heterosis for grain yield was expressed by four hybrids and ID in each case invariably accompanied in F_2. Such high heterosis for yield was due to additive heterotic effect of one or more component traits. In all the cases, heterosis for effective tillering was found to be the major contributor and number of filled grains/panicle contributed less to grain yield heterosis. High heterosis accompanied by high ID for effective tillers/plant and number of filled grains/panicle indicated the presence of nonadditive gene effects governing the inheritance of these traits. Since growth vigour was not of retentive nature as indicated by high ID in F_2 for grain yield, it should be exploited in F_1 itself.

Key words: Heterosis, inbreeding depression, rice, *Oryza sativa*.

Commercial exploitation of heterosis in rice today is a profitable proposition. The knowledge on the extent of heterosis for a trait, accompanied by the extent of decline in vigour in the subsequent generations manifested by inbreeding depression would be desirable for its exploitation by adopting appropriate breeding methodology. We report the results on heterosis and inbreeding depression in 8 rice crosses.

MATERIALS AND METHODS

Eight F_1 hybrids were obtained by crossing 9 diverse rice cultivars as parents utilising cv. Prabhavati as the female parent and 8 others as male parents. Prabhavati is a semidwarf variety while the rest belonged to different plant height and maturity groups. During summer 1986, a part of F_1 seed along with parents were sown to obtain seed for F_2. The final

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experiment was laid out in split plot design with 3 replications during the next rainy season (1987) by direct seeding. The 8 crosses constituted the main treatments, and 6 populations in each cross constituted subtreatments. In each subtreatment, all the populations were raised in single rows, while F_2 was raised in 7 rows continuously, with a single row of cv. Prabhavati around each subplot. Each row was 2.2 m long with the spacing 30 cm between and 10 cm within rows. Fertilization with 100 N + 50 P_2O_5 kg/ha was done and necessary agronomic practices and plant protection measures were followed. Ten random plants in all other populations, and 50 in the F_2 populations per cross in each replication were used to record observations on grain yield and its four important contributing characters. Heterosis over mid- and better parental (MP, BP) values was calculated for F_1 hybrids [1, 2]. Inbreeding depression in F_2 over F_1 calculated was according to [3].

RESULTS AND DISCUSSION

Heterosis of F_1s in percentage over MP and BP and ID of F_2s over F_1s for five quantitative traits in respect of 8 rice crosses are presented in Table 1. The magnitude and direction of MP and BP heterosis varied substantially from cross to cross and from character to character. The overall average heterosis was of higher magnitude for effective tillers/ plant, closely followed only by grain yield/plant. Moderate BP heterosis and either least or negative BP heterosis was observed for the remaining characters. However, negative BP heterosis observed for plant height is desirable for breeding short statured hybrids and variety. The average ID overall the crosses was most favourable for plant height, least for 1000-grain weight, moderate for filled grains/panicle, and was high for number of effective tillers and grain yield/plant.

For plant height, MP heterosis was significant and positive in all the crosses except in Prabhavati x RPA 5929 (nonsignificant) and ranged from 0.01 to 18.71%. However, BP heterosis was negative and significant in most of the F_1s which is desirable with a range of – 18.74% (Prabhavati x CRM mutant) to 6.71% (Prabhavati x Basmati 370). Almost all the crosses which expressed significant negative heterosis over BP in F_1 also showed favourable ID in their F_2s, indicating their short stature. Therefore, selection for short plant types in all these crosses would be effective in F_2 and advance generations. Negative BP heterosis for this trait was also reported from other studies.

The magnitude of heterosis was highest for number of effective tillers/plant. Significantly positive MP and BP heterosis was expressed in four hybrids with equally high ID, the highest being in F_1 Prabhavati x Punjab 1 (100.9 and 61.2% over MP and BP, respectively). The observations on heterosis for this trait by [4, 5] were also similar. Virmani et al. [6], however, reported negative heterosis for tiller number in hybrid rice although yield was not affected adversely due to increased number of spikelets per unit area. Average ID was also highest for this attribute. High heterosis in each case was followed by equally higher magnitude of ID, as was also observed by [7].

In respect of number of filled grains/panicle, the MP heterosis was positive in all F_1s and was highly significant in six F_1 hybrids. The BP heterosis was either nonsignificant positive or negative except in the F_1s of Prabhavati x Dee-geo-woo-gen (12.40%) and Prabhavati x Basmati 370 (23.1%) with high ID of 16.5 and 20.0%, respectively. Virmani et al. [6] also reported similar results for this attribute.

Average negative BP heterosis of lower magnitude was observed for 1000-grain weight. Such low heterosis for this attribute was also reported [8]. However, the ID observed was the lowest. The cross Prabhavati x Dee-geo-woo-gen could be used to improve this trait as ID observed in F_2 was desirable (negative).

The MP and BP heteroses for grain yield were highly significant in four F_1 hybrids only, the highest being in the F_1 Prabhavati x Punjab 1 (126.2 and 68.9%, respectively) with high ID (52.7%) in F_2. High and significant heterosis in all the four crosses was invariably accompanied by high ID. The average ID was also high, i.e., 26.6% (the least ID which is desirable was observed in the cross Prabhavati x Ambemohor Local, although this cross also expressed least heterosis). In the present investigation, none of the crosses showed heterosis for seed yield alone. In the cross Prabhavati x Basmati 370, highly significant and positive heterotic effect of grain yield

Table 1. MP and BP heteroses and inbreeding depression for different characters of crosses of rice

Cross	Plant ht.			Tillers/plant			Grains/panicle			1000-grain wt.			Yield/plant		
	heterosis (%)		ID	heterosis (%)		ID	heterosis (%)		ID	heterosis (%)		ID	heterosis (%)		ID
	MP	BP	(%)	MP	BP		MP	BP		MP	BP		MP	BP	
Prabhavati x Ambemohor Local	6.2**	−5.1**	2.3	−6.6	−15.6**	−8.3	6.5	−0.2	1.6	0.7	−2.0	2.1	8.2	0.2	1.6
Prabhavati x Punjab 1	18.7**	6.1**	10.3	100.9**	61.2**	47.2	12.7**	−8.2	10.9	6.9**	−6.3**	4.5	126.2**	68.9**	52.7
Prabhavati x IET 8573	7.7*	−5.4**	2.1	67.8**	13.2**	36.4	13.4**	2.2	6.6	10.0**	3.7	3.0	99.3**	28.4**	37.6
Prabhavati x RPA 5929	0.0	−13.4**	3.8	39.1**	−1.6	33.5	15.0**	−3.2	8.7	5.8*	−1.0	0.7	0.1	−33.5**	4.2
Prabhavati x Dee-geo-woo-gen	14.3**	−9.8**	7.9	54.0**	6.1	31.9	37.7**	12.4**	16.5	8.7**	−1.8	−5.9	6.1	−40.6**	9.4
Prabhavati x CRM mutant	7.6**	−18.7**	3.0	36.6**	4.5	12.3	10.3	−17.6**	−0.9	4.9	−17.0**	−0.04	2.7	−39.6**	14.1
Prabhavati x Pusa 33	10.0**	−9.5**	0.5	76.4**	28.5**	34.0	14.1**	−1.8	13.5	10.6**	−0.8	4.9	93.3**	18.0**	38.4
Prabhavati x Basmati 370	16.2**	6.7**	17.6	74.6**	42.0**	39.2	22.2**	23.1**	20.0	5.1*	−7.6**	2.8	127.8**	55.8**	54.6
Mean	10.1	−6.1	5.9	55.3	17.3	28.3	16.5	0.9	9.6	6.6	−4.1	1.5	58.0	7.2	26.6

*,**Significant at 5% and 1% levels, respectively.

was due to the cumulative effect of highly significant and positive heterosis of all the quantitative traits studied except for 1000-grain weight. Similarly, high heterosis in the crosses Prabhavati x Punjab 1 and Prabhavati x Pusa 33, it was due to the additive heterotic effect of two traits, and in the cross Prabhavati x IET 8573 due to only one trait. In the F_1s of these four crosses, high grain yield heterosis was, to a larger extent, due to additive effect of heterosis for number of effective tillers/plant, and to a lesser extent due to heterosis for number of filled grains/panicle. Grafius [9] stated that heterosis for grain yield is the result of interaction of simultaneous increase in the expression of heterosis for individual yield components. High MP and BP heterosis for grain yield in some rice crosses were also reported from earlier studies [4, 5, 7]. In almost all the cases, the high heterosis for grain yield and its components were accompanied by high and positive ID in their F_2s, which may be due to greater role of the dominant gene action in controlling the heterosis for the various traits [2, 7, 8].

Since plant vigour was not of retentive nature, as indicated by high ID in F_2 for grain yield and its component traits, it is suggested that heterosis should be exploited in F_1 itself.

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