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HETEROSIS IN RICE (*Oryza sativa* L.)

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A study was made to assess the extent of exploitable heterosis in a 7 x 7 diallel. The results indicated that almost all combinations involving IR 8 as one of the parents possessed high mean and significant heterosis for yield but none of thec ombinations excelled it, indicating non-existence of exploitable heterosis with the parents under study. Similarly for other yield components like productive tillers per plant, number of grains per panicle and 100 grain weight, there was no standard heterosis at exploitable level. These results show that selection of parents is a critical step for successful hybrid rice programme.

In recent years after successful exploitation of hybrid vigour to produce commercial hybrids in China, a lot of research work is being carried out all over the world including India to exploit heterosis in rice. Since rice is not only a self pollinated crop but also forms single seed per pollination, substantial quantity of exploitable heterosis must be available for economic viability of hybrids. In the present study, investigations were undertaken to assess the extent of exploitable heterosis in 7 X 7 diallel of diverse parents.

MATERIALS AND METHODS

Seven rice varieties viz, Cult. 340, ADT 3, ADT 16, Co 33, Co 37, and IR 20 were crossed in all possible combinations and all the F_1s with the parents were raised in Randomised Blocks Design with three replications during *Kharif* 1983. Each variant consisted of a single row of 21 plants placed 10 cm apart and spacing between rows was 20 cm. Observations were recorded for six characters on ten randomly chosen plants from each replication and the mean values were used for estimation of heterosis, heterobeltiosis and standard heterosis using best check Cult. 340 for plant height and IR 8 for other characters. Significance for heterosis (di) was tested by using 't' test as per the following formula (Wynne *et al*, 1970).

$t = (F_1 - MP) / \sqrt{3/8 V_E}$ Where V_E is the error variance. Significance for hererobeltiosis (dii) and standard heterosis (diii) was tested using the CD values of analysis of variance for the two separately.

RESULTS AND DISCUSSION

Estimate of heterosis for different characters studied are furnished in Table 1. The results in general indicated that magnitude as well as direction of heterosis differed from character to character depending upon the cross combination. For mean number of days to flowering, the longest ,duration was recorded by the cross ADT. 16 X Co.37 (115 days) and the shortest by ADT 3 X Co. 33 (68 days). Heterosis was positive and significant in nine combinations while six recorded significant negative heterosis. Only two combination viz, ADT. 16 x Co. 37 showed positive and significant standard heterosis.

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Table 1. Estimates of heterosis (di) heterobeltiosis (dii) and standard heterosis (diii) for six characters in 7 x 7 diallel.

Cross	Days to flowering				Plant height			
	Mean	di	dii	diii	Mean (cm)	di	dii	diii
Cult. 340 X ADT. 3	69	2.28	−1.34	−34.49**	134.23	6.49**	4.18**	4.18**
Cult. 340 X ADT. 16	79	5.99*	−6.40*	−24.59**	124.21	2.87*	−3.59*	−3.59*
Cult. 340 X Co. 33	75	−4.98**	−19.72**	−28.16**	119.23	14.55**	−7.46**	−7.46**
Cult. 340 X Co. 37	85	17.29**	6.29	−19.24**	114.23	−1.43	−10.05**	−10.05**
Cult. 340 X IR. 8	94	11.61**	−9.75**	−9.75**	121.24	7.25**	−5.90**	−5.90**
Cult. 340 X IR. 20	93	10.88**	−9.57**	−11.56**	124.23	9.34**	−3.58*	−3.58**
ADT. 3 X ADT. 16	76	−1.68	−10.32**	−27.74**	120.44	2.11	2.29	−6.52**
ADT. 3 X Co. 33	68	−17.15**	−27.83**	−35.42**	102.15	0.84	−17.13	−20.72**
ADT. 3 X Co. 37	78	5.03	−1.58	25.22**	120.65	6.68**	−2.12	−6.36**
ADT. 3 X IR 8	92	6.10*	−11.72**	−11.72**	123.25	11.78**	−0.02	−4.35**
ADT. 3 X IR 20	85	−0.71	−16.65**	−18.48**	122.45	10.48**	−0.66	−4.96**
ADT. 16 X Co. 33	71	−19.74**	−23.74**	−31.76**	112.64	32.01**	−18.93**	−12.57**
ADT. 16 X Co. 37	115	40.85**	36.84**	10.25**	104.65	7.74**	−7.09**	−18.78**
ADT. 16 X IR 8	109	14.82**	3.66	3.66	107.65	14.18**	−4.43*	−16.45**
ADT. 16 X IR 20	83	−10.58**	−18.46**	−20.25**	108.64	14.52**	−3.55	−15.68**
Co. 33 X Co. 37	92	6.73**	−1.32	−11.69**	98.64	8.23**	−4.17	−23.44**
Co. 33 X IR 8	87	−11.80**	−16.43**	−16.43**	89.86	1.78	−7.59**	−30.26**
Co. 33 X IR 20	94	−3.62	−7.72**	−9.75**	93.46	5.17**	−5.02**	−27.46**
Co. 37 x IR 8	92	0.19	−11.85**	−11.85**	94.03	−6.05*	−8.64**	−27.01**
Co. 37 X IR 20	110	20.95**	7.45**	5.09	99.67	−0.99	−3.17	−22.64**
IR 8 X IR 20	91	−22.33**	−23.19**	−23.19**	99.25	1.46	0.86	−22.97**
S.E.	1.89	—	—	—	1.57	—	—	—
C.D. (0.05)	—	—	5.32	5.32	—	—	4.40	4.40
C.D. (0.01)	—	—	6.91	6.91	—	—	5.72	5.72

* Significant at 5% ** Significant at 1%

Table 1. Estimates of heterosis (di) heterobeltiosis (dii) and standard heterosis (diii) for six characters in 7 x 7 diallel.

Cross	Productivity tillers per plant				Number of grains per panicle			
	Mean	di	dii	diii	Mean	di	dii	diii
Cult. 340 X ADT. 3	10.13	16.71	9.75	—33.22*	86.30	— 3.09**	— 9.54**	—30.10**
Cult. 340 X ADT. 16	8.67	13.33	6.64	—42.85**	71.53	— 4.41*	—13.51**	—41.93**
Cult. 340 X Co. 33	13.33	37.42**	18.27	—12.13	99.20	9.37**	—19.95**	—19.55**
Cult. 340 X Co. 37	14.83	62.43**	46.39**	— 2.24	91.30	3.81	— 2.04	—25.95**
Cult. 340 X IR. 8	14.87	27.64*	—1.98	— 1.98	133.23	29.35**	8.03**	— 8.03**
Cult. 340 X IR. 20	10.10	—0.98	17.33	—28.61**	106.20	2.34**	— 4.51*	—26.12**
ADT. 3 X ADT. 16	10.10	23.17	9.43	—33.42**	72.10	—11.21**	—32.31**	—41.52**
ADT. 3 X Co. 33	8.07	—21.27	—28.39*	—46.80**	81.30	—16.23**	—14.78**	—34.06**
ADT. 3 X Co. 37	9.13	—5.68	—9.87	—39.82**	91.80	— 2.65	— 3.77	—25.55**
ADT. 3 X IR 8	16.57	35.82**	9.23	9.23	122.70	12.16**	— 0.49	— 0.49
ADT. 3 X IR 20	11.97	11.35	—2.45	—21.09*	99.60	0.54	— 3.05	—19.22**
ADT. 16 X Co. 33	10.17	10.30**	—9.76	—32.96**	84.07	1.49	—14.82**	—31.82**
ADT. 16 X Co. 37	11.83	36.76**	16.78	22.02*	77.60	— 3.10	—16.74**	—37.06**
ADT. 16 X IR 8	15.93	42.61**	5.01	5.01	128.10	34.72**	— 3.97*	— 3.89**
ADT. 16 X IR 20	10.77	10.80**	—17.93	—29.01**	84.07	— 0.94	—18.16**	—31.82**
Co. 33 X Co. 37	12.40	15.88**	10.02	—18.26	99.20	3.39**	— 0.51	—19.55**
Co. 33 X IR 8	16.97	28.36**	11.87	11.87	129.57	16.73**	— 5.09*	— 5.09**
Co. 33 X IR 20	13.70	16.40	11.65	—9.69	110.60	6.82**	— 7.69**	—10.22**
Co. 37 X IR 8	16.33	29.09	7.65	7.65	132.00	21.94**	— 7.06**	— 7.06**
Co. 37 X IR 20	13.90	24.11*	13.28	— 8.37	94.00	—4.05	— 8.47**	—23.76**
IR 8 X IR 20	17.63	28.50**	16.21	16.21	130.00	15.04	5.43**	— 5.43**
S.E.	1.13	—	—	—	1.56	—	—	—
C.D. (0.05)	—		3.18	3.18	—	—	4.37	4.37
C.D. (0.01)	—	—	4.13	4.13	—	—	5.67	5.67

* Significant at 5% ** Significant at 1%

Table 1. Estimates of heterosis (di) heterobeltiosis (dii) and standard heterosis (diii) for six characters in 7 x 7 diallel.

Cross	100 grain weight				Grain yield per plant			
	Mean	di	dii	diii	Mean	di	dii	diii
Cult. 340 X ADT. 3	2.23	—2.87	—4.89	—11.07*	22.24	15.35**	4.71	—36.87**
Cult. 340 X ADT. 16	2.03	10.27**	—9.78*	—19.16**	15.29	0.06*	—11.72	—56.60**
Cult. 340 X Co. 33	2.14	6.78	—4.84	—14.74	22.57	22.13**	—14.92*	—35.94**
Cult. 340 X Co. 37	2.22	0.68	—1.29	—11.55	28.63	43.51**	26.85**	—18.73**
Cult. 340 X IR. 8	2.42	1.26	—3.98	—3.98	36.23	37.86**	2.84**	—2.84
Cult. 340 X IR. 20	2.12	0.52	—5.69	—15.49**	19.63	—0.76	—11.74	—44.28**
ADT. 3 X ADT. 16	1.99	5.39	29.43**	—34.01**	18.24	5.80	—14.12*	—48.23**
ADT. 3 X Co. 33	2.12	3.21	—9.71*	—15.57**	22.03	7.78	3.72	—37.47**
ADT. 3 X Co. 37	2.17	—3.73	—7.54	—13.54**	27.46	24.74**	21.09**	—22.42**
ADT. 3 X IR 8	2.49	1.19	—2.07	—2.07	28.24	0.00**	—19.84**	—19.84**
ADT. 3 X IR 20	2.17	2.78	—5.45	—11.59**	24.14	11.04*	8.54	—31.48**
ADT. 16 X Co. 33	1.72	7.58	—2.44	—31.62**	19.14	16.42*	—2.55	—45.67**
ADT. 16 X Co. 37	1.96	9.19*	—9.26	—21.90**	24.11	34.69**	—6.82	—31.56**
ADT. 16 X IR 8	2.16	9.44*	—14.10**	—14.10**	31.24	28.93**	—11.33*	—11.33**
ADT. 16 X IR 20	1.78	4.76	—9.59	—22.03**	21.64	21.98**	—2.70	—38.56**
Co. 33 X Co. 37	2.09	6.68	—3.19	—16.69**	26.45	24.35**	—16.31*	—24.92**
Co. 33 X IR 8	1.99	—6.79**	20.71	—20.71**	27.94	1.82	—20.69*	—20.69**
Co. 33 X IR 20	1.67	—11.40	15.22	—33.45	25.34	21.01**	13.94*	—28.07**
Co. 37 X IR 8	2.35	0.69	6.33	6.33	31.84	10.17**	—9.62**	—9.62**
Co. 37 X IR 20	1.92	—7.07	11.15*	—23.54**	26.40	17.81**	—16.97**	—25.06**
IR 8 X IR 20	2.61	16.51	3.98	3.98	33.33	16.32**	5.11	—5.11**
S.E.	0.08	—	—	—	1.03	—	—	—
C.D. (0.05)	—	—	0.22	0.22	—	—	2.88	2.88
C.D. (0.01)	—	—	0.28	0.28	—	—	3.74	3.74

* Significant at 5% ** Significant at 1%

For plant height, the highest mean value was recorded by the combination Cult 340 X ADT.3 (134.23 cm) and the lowest by the combination Co 33 X IR 8 (89.86 cm). A total of 14 combinations showed significant positive heterosis while only one hybrid (Cult. 340 X ADT.3) exceeded the better parent and best check in the positive direction.

The mean values of hybirds for productive tillers per plant ranged from 8.07 (ADT.3 X Co.33) to 17.63 (IR 8 x IR 20). A total of nine hybirds recorded significant positive heterosis whereas a positive and significant heterobeltiosis was recorded in only one combination (Cult 340 x Co. 37). Positive and significant standard heterosis was not noted in any of the combinations studied for this trait.

For number of grains per panicle, the mean values ranged from 71.53 (Cult. 340 X ADT. 16) to 133.23 (Cult.340 X IR 8). Eight combinations recorded positive and siginificant heterosis. Of them, seven were found to possess heterobeltiosis and five had significant standard heterosis.

The mean for 100 grain weight varied 1.67 g (Co.33 X IR 20) to 2.61 (IR 8 X IR 20). Four combinations recorded significant and positive heterosis and none expressed significant positive heterobeltiosis or standard heterosis.

The mean for grain yield per plant varied from 15.29 g (Cult. 340 X ADT. 16) to 36.23 g (Cult. 340 x IR 8). Positive and significant heterosis was observed in 15 hybrids of which six had heterobeltiosis and none showed standard heterosis.

Correlation coefficients between heterosis based on midparent values are presented in Table 2. The heterosis for days to flowering alone had positive and significant correlations with heterosis for grain yield while there was no significant correlation between other traits.

Almost all combinations involving IR 8 as one of the parents possessed high mean and significant heterosis for yield but non of them exceeded itr Similarly, for other yield components like tiller number, number of grains per panicle and 100 grain weight, in the combinations involving IR 8, there was non-existence of exploitable heterosis with the parents under study. However heterosis for grain yield and component characters were reported by Purohit (1972), Mohanty and Mahapatra (1873), Singh and Singh (1978) and Singh *et al.* (1979). Therefore selection of parents is a critical step for successful hybrid rice programme.

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