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Heterosis for yield, its components and grain traits in rice (*Oryza sativa* L.)

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ABSTRACT

Heterosis, heterobeltiosis and standard heterosis were estimated for grain yield, its attributes and other physical characters in 32 cross combinations generated through Line x Tester mating design. In general, the estimates of heterosis values were low for physical characters when compared to yield and yield components. Nine hybrids manifested positive and significant heterosis over midparent, better parent and standard check for grain yield plant^{-1}, of which AD 95157 x IR 50, MDU 5 x IR 50, AD 95157 x ADT 43, MDU 5 x ADT 36, AD 95157 x ADT 36 and AD 95137 x ADT 36 were top rankers. On considering both yield and physical traits together the crosses MDU 5 x IR 50, MDU 5 x ADT 36, AD 95157 x ADT 36, AD 95157 x ADT 43, AD 95157 x IR 50 and AD 95137 x ADT 36 could be isolated for possessing desirable average heterosis, midparantal heterosis and standard heterosis for yield and grain traits.

Key words: *Heterosis, yield components, grain characters, rice*

Commercial exploitation of heterosis for enhancing rice yields is now an acceptable proposition. The present study was, therefore, performed to estimate the magnitude and direction of heterosis for important yield and quality characters.

The experimental materials comprised of eight extra early rice genotypes namely, AD 95128, AD 95134, AD 95137, AD 95157, AD 97230, ASD 8, ASD 17 and MDU 5 which were used as females and crossed with four popular high yielding short duration varieties *viz.*, ASD 16, ADT 36, ADT 43 and IR 50, that were taken as testers to generate 32 crosses in line × tester mating design. The F_1's along with their parents and a standard variety ADT 43 were evaluated in a randomized block design with three replications at Plant Breeding Farm, Annamalai University, Annamalai Nagar, Tamil Nadu. In each replication, every genotype was sown in three rows of 3m length with a spacing of 30 cm between and 15cm within the row. Normal agronomic practices and need based plant protection measures were adopted to raise the crop. Observations were recorded on ten randomly selected plants in each replication for days to first flower, plant height, number of panicles plant^{-1}, panicle length, number of grains panicle^{-1}, test weight and grain yield plant^{-1}. All these plants were harvested and threshed separately. After threshing, grain samples were analysed for grain length, grain breadth and grain L/B ratio on individual plant basis following standard methods (Murthy and Govindaswamy, 1967). The mean values were utilized for calculating heterosis in per cent over the mid parent (MP), the better parent (BP) and over standard parent (SP).

The mean performance of lines and testers for various yield components are given in Table 1. Among the lines studied, L_8 (MDU 5) recorded high mean values for number of panicles plant^{-1}, panicle length, number of grains panicle^{-1}, grain yield plant^{-1},grain length and grain L/B ratio and moderate mean values for days to first flower, plant height, test weight and grain breadth. The line L_4 (AD 95157) exhibited desirable mean values for all the traits except plant height followed by L3 (AD 95137). The line L_1 (AD 95128) and L_5 (AD 95230) possessed considerable mean values for five characters each. At the same time, these parents registered lower mean values for days to first flower, plant height, test weight and grain breadth. Among the testers, T_3 (ADT 43) was found to be the best based on mean performance followed by T_2 (ADT 36).

However, T_4 (IR 50) was also considered as superior as it showed lesser duration, short statured plant and slender grains. In general, the magnitude of

Table 1. Mean performance of grain yield and yield component of the parents used in the crossing programme

Parents		Days to first flower (days)	Plant height (cm)	No. of panicles plant^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	Test weight (gm)	Grain yield plant^{-1}	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio
Lines	L_1	59.00	62.12	13.68	12.49	61.35	21.20	10.45	8.13	2.55	3.03
	L_2	60.00	68.26	14.25	12.39	60.95	20.13	14.05	8.48	2.33	3.67
	L_3	59.00	65.97	15.82	15.27	89.52	20.10	16.30	8.61	2.23	3.83
	L_4	60.00	76.82	15.65	15.66	92.78	19.42	16.63	8.63	2.15	4.03
	L_5	65.10	73.36	14.73	13.24	73.85	21.32	13.55	8.14	2.66	3.64
	L_6	61.00	108.47	13.83	13.08	65.50	22.67	13.00	7.80	3.05	2.83
	L_7	70.00	79.91	15.36	13.07	77.43	22.11	13.98	7.76	2.92	2.61
	L_8	61.00	68.56	17.97	16.02	89.88	21.71	18.38	8.45	2.42	3.49
Testers	T_1	78.00	80.43	15.84	16.86	106.02	22.53	18.68	7.45	3.06	2.43
	T_2	69.00	72.28	16.82	16.69	117.54	20.10	18.79	7.81	2.57	3.03
	T_3	70.00	70.19	17.63	16.00	134.02	16.36	19.00	6.68	1.95	3.42
	T_4	69.00	70.56	16.84	15.56	93.54	20.40	18.31	8.94	2.35	3.80

L_1 = AD 95128, L_2 = AD 95134, L_3 = AD 95137, L_4 = AD 95157
L_5 = AD 97230, L_6 = ASD 8, L_7 = ASD 17, L_8 = MDU5
T_1 = ASD16, T_2 = ADT 36, T_3 = ADT 43, T_4 = IR50

heterosis was low for grain quality characters when compared to heterosis for yield and yield attributes. Among the traits test weight, grain breadth and days to flower manifested low heterosis. Similar reports were stated by Reddy *et al* (1991) and Reddy and Nerkar (1995).

In general, the range of the hybrids was as follows; -16.82 to 75.72 per cent for average heterosis, -35.17 to 67.66 for heterobeltiosis and -36.26 to 61.57 for standard heterosis for grain yield plant^{-1}. IR 50 is the best parent for all the yield characters while ADT 43 exhibited good grain quality characters. Among the hybrids L_4 x T_3 (AD 95157 x ADT 43) and L_8 x T_4 (MDU 5 x IR 50) manifested maximum heterosis and mean performance for grain yield plant^{-1}, number of panicles plant^{-1} and number of grains panicle^{-1} followed by L_4 x T_4 (AD 95157 x IR 50) and L_8 x T_2 (MDU 5 x ADT 36). For grain length, grain breadth and grain L/B ratio crosses viz., L_3 x T_2 (AD 95137 x ADT 36), L_4 x T_2 (AD 95157 x ADT 36), L_4 x T_3(AD 95157 x ADT 43), L_4 x T_4 (AD 95157 x IR 50), L_8 x T_2 (MDU 5 x ADT 36) and L_8 x T_4 (MDU 5 x IR 50) recorded maximum desirable mean performance. Out of 32 hybrids studied, nine cross combinations exhibited significant positive heterosis, heterobeltiosis and standard heterosis for grain yield plant^{-1}. Some of the crosses which recorded very high heterosis for grain yield plant^{-1} include L_4 x T_4 (AD 95157 x IR 50), L_8 x T_4 (MDU 5 x IR 50), L_8 x T_2 (MDU 5 x ADT 36), L_4 x T_3 (AD 95157 x ADT 43), L_3 x T_2 (AD 95137 x ADT 36) and L_4 x T_2 (AD 95157 x ADT 36) (Table 2). All these crosses manifested significant desirable heterobeltiosis and standard heterosis and non significant desirable relative heterosis for days to flower.

The crosses namely L_8 x T_4 (MDU 5 x IR 50), L_8 x T_2 (MDU 5 x ADT 36) and L_3 x T_2 (AD 95137 x ADT 36) recorded non-significant and desirable values for all the three types of heterosis and the crosses L_4 x T_2 (AD 95157 x ADT 36) and L_4 x T_4 (AD 95157 x IR 50) recorded non significant relative heterosis and standard heterosis and significant desirable heterobeltiosis for plant height. All these characters contributed for grain yield. Pandey *et al.*, (1995) reported very high estimates of heterosis for grain yield in rice upto 301.6% over standard check. Shorter plant type is an important character of hybrid to withstand lodging. In the present study, six crosses showed significantly negative values for all types of heterosis for characters days to first flower and plant height which are desirable. Rao *et al.*, (1996) also observed negative heterobeltiosis for plant height and significant heterotic effect for panicles plant^{-1} over better parent and standard check respectively (Singh *et al.*, 1980 and Virmani *et al.*, 1982).

Table 2. Estimates of heterosis (h), heterobeltiosis (h1) and standard heterosis (h2) for important yield components and quality characteristics in selected hybrids

Character		$L_3 \times T_2$	$L_4 \times T_2$	L_4 T_3	L_4 T_4	L_8 T_2	L_8 T_4
Days to First Flower	h	-2.76	-2.21	-4.18	-6.15	-6.44	-2.06
	h1	-9.81*	-8.59*	-11.03**	-12.27**	-11.87**	-7.74*
	h2	-11.10**	-9.90*	-11.02**	-13.52**	-13.12**	-9.05**
Plant height	h	0.52	-6.10	-10.29**	-5.11	-0.59	-0.33
	h1	-4.08	-8.88**	-14.18**	-9.75**	-3.15	-1.74
	h2	-12.25	-0.27	-6.06	-1.22	-0.27	-1.22
Panicles plant $^{-1}$	h	58.34**	9.56*	16.65*	41.99**	67.05**	85.36**
	h1	54.58**	7.61**	12.02**	39.78**	61.66**	78.96*
	h2	47.47**	36.13**	29.04**	32.72**	64.77**	82.41**
Panicle length	h	-5.51	3.09	12.63	16.91	8.13*	6.39
	h1	4.61	-0.12	11.43	16.53	5.93	4.87
	h2	9.12	4.18	11.43	14.06	10.50	5.00
Grains panicle^{-1}	h	17.84**	15.70**	15.65**	28.97**	14.89**	-18.39**
	h1	3.79	3.52	-2.14	28.44**	-0.66	13.67**
	h2	-8.96**	-9.20**	-2.14	-10.34**	-12.87**	-20.66**
Test weight	h	4.73	4.75	1.17	5.47	4.30	3.56
	h1	4.47	2.98	-6.79	2.94	0.41	0.41
	h2	28.36**	11.85**	10.63	16.13**	33.25**	33.25**
Grain yield plant $^{-1}$	h	72.92**	59.62**	68.44**	75.72**	61.19**	65.10**
	h1	54.33**	50.45**	57.89**	67.66**	58.96**	64.74**

* Significant at 5% level ; ** Significant at 1% level

Out of 32 hybrids most of the hybrids manifested positively significant heterosis for grain length and few crosses showed negatively significant average heterosis and heterobeltiosis for grain breadth.The crosses L_8 x T_4 (MDU 5 x IR 50), L_4 x T_4 (AD 95157 x IR 50), L_4 x T_3 (AD 95157 x ADT 43), L_4 x T_2 (AD 95157 x ADT 36) and L_3 x T_2 (AD 95137 x ADT 36) showed positive average heterosis, heterobeltiosis and standard heterosis for grain L/B ratio. Poor manifestation of heterosis for grain length and grain breadth was observed by Singh and Singh (1985), Vivekanandan and Giridharan (1995) also revealed poor heterosis for grain L/B ratio.

For practical value, a variety / hybrid with good yield potential combining quality features in the desirable range is useful. If we consider both yield and quality together the crosses *viz.*, L_8 x T_4 (MDU 5 x IR 50), L_4 x T_4 (AD 95157 x IR 50), L_4 x T_3 (AD 95157 x ADT 43), L_4 x T_2 (AD 95157 x ADT 36) and L_8 x T_2 (MDU 5 x ADT 36) manifested high heterosis for grain yield plant^{-1} as well as for important quality characteristics in the desirable range. Hence, these combinations could be exploited for their yield potential and quality traits to get desirable segregants in further breeding programme.

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