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Magnitude of heterosis for yield and yield components in rice (*Oryza sativa* L.)

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Abstract

Performance of eighteen F_1 hybrids along with their nine parents was evaluated in a randomized block design with four replications. Positive and significant heterosis for most of the characters except plant height was recorded. The present study revealed that the hybrid ADT 42 × IR 50 and ADT 45 × IR 50 were the best hybrid and can be exploited for hybrid vigour to increase yield potential in rice.

Keywords: Rice, Standard heterosis

Introduction

Rice is a staple food for more than half of the world population (Vanniarajan *et al.*, 2012) [11]. Globally, rice is the most important food grain from a nutritional, food security or economic perspective (Smith and Dilday, 2003) [10]. The current levels of rice production do not meet the future demand. Rice yields increased by about 30% due to the development of semi dwarf varieties (Fang *et al.*, 2004) [2] and an additional 15-20% was achieved through the use of heterosis (Yuan, 2003) [13]. Heterosis in rice was first reported by Jones (1926) [4] who observed a marked increase in culm number and grain yield in some F_1 hybrids in comparison of their parents. Both positive and negative heterosis is useful in crop improvement, depending on the breeding objectives. In general, positive heterosis is desired for yield and negative heterosis for early maturity (Nurzzaman *et al.*, 2002) [8]. Heterosis is expressed in three ways, depending on the criteria used to compare the performance of hybrid (Gupta, 2000) [3]. From a practical point of view, standard heterosis is the most important of the two levels of heterosis because it is aimed at developing desirable hybrids superior to the existing high yielding commercial varieties (Chaudhary, 1984) [1]. The information on standard heterosis for yield and yield components in rice is presented.

Materials and Methods

Six varieties as lines namely, ADT 37, ADT 41, ADT 42, ADT 45, ADT 47 and ADT 48 were crossed with three testers, which are IR 50, CO 51 and ADT 36 (treated as standard variety) in an L × T matting design. Eighteen cross combinations along with their nine parents were grown in a randomized block design with four replications. Both parents and F_1s were raised and transplanted in rows with spacing 30 cm between rows and 20 cm between plants. The row length of 3 m was maintained for each genotype. Recommended cultural practices and need based plant protection measures were also adopted to raise the crop. The biometrical observations on days to 50 per cent flowering, plant height, number of productive tillers per plant, panicle length, number of grains per panicle, 100 grain weight and grain yield per plant were recorded. Standard heterosis was estimated and tested for significance as suggested by Wyne *et al.* (1970).

Results and Discussion

The estimates of mean squares were highly significant for all the characters indicating considerable diversity of parents. *Per se* performance revealed the superiority of ADT 41 (L_2) which recorded highest mean value for the traits *viz.*, days to 50% flowering, plant height at maturity, panicle length, number of grains per panicle, grain yield per plant. The line ADT 43 (L_5) also had significant high mean all the traits. Hence, ADT 41 and ADT 45 could be rated as desirable parents for hybridization to increase rice yield. Among the testers, ADT 36 recorded high mean values for all the traits except hundred grain weight. Hence, based on *per se* performance ADT 41 (L_2), ADT 45 (L_5) and ADT 36 (T_3) can be adjudged as superior parents. The mean performance is the primary criterion to evaluate the merit of hybrid. Kadambavanasundaram (1980) [5] and Natarajan (1986) [7] reported that *per se* performance of hybrids appeared to be useful index for judging the hybrids.

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Based on *per se,* the hybrid ADT 41 × ADT 36 ($L_2 \times T_3$) performed better in all the traits followed by ADT 46 × AT 36 ($L_6 \times T_3$).

Information on the magnitude of heterosis is the prerequisite in the development of hybrids. A good hybrid should manifest high amount of heterosis for commercial exploitation. High and low positive heterosis observed was mainly due to varying genetic composition between parents at different crosses for the components characters (Rjesh and Gulsan, 2001) [9]. Positive and significant heterosis for grain yield per plant, number of grains per panicle, number of productive tillers and days to 50per cent flowering was recorded by the hybrids ADT 42 × IR 50 ($L_2 \times T_1$) and ADT 45 × IR 50 ($L_4 \times T_1$).

Also hybrid ADT 42 × IR 50 ($L_2 \times T_1$) recorded negative and significant heterosis for plant height. Thus, this hybrid can be used to produce dwarf varieties with high yield in later breeding programs. Alam *et al.* (2004) and Nuruzzaman *et al.* (2002) [8] also reported negative heterosis for plant height in several crosses. A high percentage of heterosis for grain and it's related traits were reported by Zhang *et al.* (1994) [14], Li *et al.* (2002) [6]. Therefore, from the foregoing discussion, it may be concluded that the above hybrid

ADT 42 × IR 50 ($L_2 \times T_1$) can be adjudged as best followed by ADT 45 × IR 50 and these hybrids can be exploited for hybrid vigour to increase yield potential in rice.

Table 1: Mean performance of parents and hybrids

Parents / Hybrids	Days to 50% flowering	Plant height at maturity (cm)	Number of productive tillers per plant	Panicle length (cm)	No. of grains per panicle	100 grain weight (g)	Grain yield per plant (g)
L_1	68.80	98.10	23.22	19.09	130.83**	1.42	26.58
L_2	63.32**	75.65**	28.73	34.84**	151.62**	2.69	33.29**
L_3	85.81	99.34	22.42	17.10	112.84	1.42	28.04
L_4	67.72*	82.27**	25.92	20.15	86.50	1.57	26.89
L_5	65.74**	81.40**	26.39*	26.08**	143.77**	2.66*	30.94**
L_6	66.63**	81.81**	23.98	21.54	139.08**	2.36**	29.87**
T_1	73.64	69.67	19.38	20.42	91.12	1.07	22.71
T_2	69.36	79.95**	21.20	22.87	111.27	1.61	25.88
T_3	60.35**	75.37**	33.53**	24.71**	140.94**	2.01	36.29**
$L_1 \times T_1$	71.73**	89.74**	39.95**	22.21	212.85**	2.01**	48.22
$L_1 \times T_2$	88.33**	98.84	30.94	19.29	173.08	1.70	49.33
$L_1 \times T_3$	74.16**	86.34**	27.38	23.49	181.51	1.69	41.80
$L_2 \times T_1$	98.98	88.45**	34.29**	19.27	133.93	1.58	55.89**
$L_2 \times T_2$	66.45**	81.14**	41.31**	30.65**	215.83**	2.22**	58.74**
$L_2 \times T_3$	61.27**	70.73	41.36**	33.13**	219.30**	2.33**	65.55**
$L_3 \times T_1$	78.46**	98.44	26.23	21.39	209.99**	1.14	45.59
$L_3 \times T_2$	70.00**	98.76	39.14**	18.95	165.79	1.40	49.28
$L_3 \times T_3$	108.01	89.22**	39.37**	20.70	178.54	1.31	40.38
$L_4 \times T_1$	98.98	90.57**	38.17**	18.17	192.87**	2.00**	56.07**
$L_4 \times T_2$	96.22	122.15	21.66	27.58**	189.30	1.47	52.54**
$L_4 \times T_3$	93.66	130.06	38.09**	21.27**	212.45**	1.74	47.11
$L_5 \times T_1$	86.54	103.84	36.94**	17.88	181.97	1.80	45.63
$L_5 \times T_2$	88.50	101.22	29.70	19.46	127.62	2.12**	41.16
$L_5 \times T_3$	66.48**	97.19	40.97**	29.01**	215.06**	1.68	56.78**
$L_6 \times T_1$	76.01**	87.83**	28.44	18.29	156.47	1.65	48.04
$L_6 \times T_2$	70.88**	87.46**	39.91**	28.82**	201.27**	2.10**	44.14
$L_6 \times T_3$	64.81**	80.29**	41.32**	21.31	216.00**	2.29**	60.74**

Table 2: Heterosis in percentage for seven traits in rice

Parents / Hybrids	Days to 50% flowering	Plant height at maturity (cm)	Number of productive tillers per plant	Panicle length (cm)	No. of grains per panicle	100 grain weight (g)	Grain yield per plant (g)
$L_1 \times T_1$	3.42**	-16.83**	106.16**	17.43**	136.03**	-0.33	32.89**
$L_1 \times T_2$	-4.14**	-34.78**	59.63**	24.95**	89.95**	-15.40**	35.95**
$L_1 \times T_3$	6.92**	-19.98**	41.28**	-4.94	99.20**	-16.06**	15.19**
$L_2 \times T_1$	7.31**	-24.04**	76.93**	-22.00**	137.06**	-21.52**	54.03**
$L_2 \times T_2$	6.55**	-20.33**	1.98	-26.46**	109.83**	-17.88**	43.22**
$L_2 \times T_3$	-4.20**	-8.40**	8.67*	-12.83**	130.46**	-14.72**	19.24**
$L_3 \times T_1$	13.13**	-8.76**	35.35**	-13.42**	140.68**	-43.21**	36.67**
$L_3 \times T_2$	-11.66**	-8.47**	101.96**	-23.31**	81.95**	-30.46**	35.80**
$L_3 \times T_3$	53.73**	-17.31**	103.15**	-16.22**	96.28**	-35.10**	11.27**
$L_4 \times T_1$	42.71**	-16.06**	96.96**	24.07**	111.67**	-0.66	54.53**
$L_4 \times T_2$	38.73**	13.21**	11.78**	11.63**	107.75**	-26.99**	44.80**
$L_4 \times T_3$	35.04**	20.54**	96.56**	10.36**	133.16**	-13.41**	29.82**
$L_5 \times T_1$	24.78**	-3.76**	90.63**	-27.64**	99.71**	-10.60**	25.75**
$L_5 \times T_2$	27.60**	-6.19	53.27**	-21.24**	40.06**	-16.56**	13.43**
$L_5 \times T_3$	27.35**	-18.03**	105.93**	-10.09**	133.66**	-9.44**	6.23**
$L_6 \times T_1$	-9.60**	-18.60**	46.73**	-25.97**	71.73**	10.10**	32.39**
$L_6 \times T_2$	2.19*	-25.59**	111.40**	16.64**	120.89**	13.91**	21.65**
$L_6 \times T_3$	0.93	-18.94**	52.70**	-21.94**	46.99**	4.14	7.16**

*Significant at 5% level

**Significant at 1% level

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