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Heterosis for Yield, Components and Quality Traits in Rice (*Oryza sativa* L.)

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ABSTRACT

Ninety six hybrids derived from crossing four CMS lines with 24 testers were evaluated for the extent of heterosis over mid-parent, better parent and standard hybrid check for yield, components and quality traits in rice. Twenty crosses out of 96 exhibited highly significant standard heterosis for grain yield plant $^{-1}$. Heterosis for seed yield was due to the significant and positive heterosis for components like panicle length, number of fertile spikelets, number of panicles and harvest index.The top heterotic combinations identified for grain yield plant $^{-1}$ were, PMS10A X MTU II 161-28-1-1, PMS3A X MTU II 178-20-2-2-1, PMS10A X MTU II 178-20-2-2-1, PMS10A X MTU II 193-23-1, APMS6A X MTU 1064 and IR58025A X MTU 1064, exhibiting more than 50% standard heterosis.

Key words : CMS lines, Harvest Index, Heterosis, Rice

Rice is a staple food crop in India, providing 43% of calorie requirement for more than 70% of Indian population, which is grown in 44 million hectares with a production of about 90 million tonnes. To meet the demands of increasing population and to maintain self sufficiency, the present production level needs to be increased upto 120 million tonnes by 2020. Hybrid rice is a practically feasible and readily adoptable genetic option to increase the rice production, as has been amply demonstrated in People's Republic of China. Hence, the present investigation was undertaken to estimate the magnitude and direction of heterosis for yield, components and quality traits.

MATERIAL AND METHODS

Four cytoplasmic male sterile (CMS) lines *viz.,* IR58025A, PMS3A, PMS10A and APMS6A were crossed with 24 restorers *viz.,* DA313-1, MTU II 1719-5-1-1, MTU II 1686-8-1-1-11, MTU ITJ 226-18-1-1-2 , MTU II 112-62-1-4, MTU ITJ 226-18-1-1-2, MTU II 112-62-1-4, MTU ITJ 218-5-1, MTU II 139-1-1-1-1-1, MTU II 178-20-2-2-1, MTU II 187-6-1-1, MTU II 193-23-1, MTU II 161-28-1-1, MTU II 143-26-2, MTU II 161-22-1, MTU II 156-13-1-2, MTU II 127-95-1-1, MTU PS 194-1-1, MTU ITJ 201-12-1, MTU II 124-41-1-1, MTU II 124-41-1-1, MTU II 134-6-1-1, MTU II 110-11-1-1-1-15, MTU 1064.Crosses were made in line x tester fashion (Kempthorne,1957) to synthesize 96 F1 hybrids. The hybrids along with parents and one popular hybrid check APHR-2 were grown in a randomized block design with two replications at Andhra Pradesh Rice Research Institute and Regional Agricultural Research Station, Maruteru during Rabi 2006-07. Twenty eight days old seedlings were transplanted at a spacing of 20x15 cm. Observations were recorded on five randomly selected plants for plant height, number of panicles, panicle length, number of fertile spikelets, spikelet fertility per cent, harvest index, grain length, grain length/breadth ratio. Whereas days to 50% flowering and 100-grain weight were recorded on plot basis. Heterosis over mid parent, better parent and standard hybrid check for yield, components and quality traits were studied.

RESULTS AND DISCUSSION

The analysis of variance revealed that variances due to genotypes were highly significant for all the traits studied indicating considerable variation in the material taken for the study. In the present investigation, considerable heterosis existed both in positive and negative direction for all the traits. The estimates of heterosis for grain yield plant $^{-1}$ ranged from -84.28 % to 101.91 % over the mid-parent, -84.43 % to 89.83 % over the better parent and -85.78 % to 69.43 % over the hybrid check .Out of 96 crosses, twenty three crosses were found to be highly significant over better parent and twenty crosses exhibited highly

Table 1. Heterosis(%) over standard check (APHR-2) in ten best crosses selected for seed yield per plant in rice (*Oryza sativa* L.)

	Days to 50 % flowering	Plant height	No of panicles/ plant	Panicle length	No of fertile spikelets	Spikelet fertility percent	100-grain weight	Grain yield plant^{-1}	Harvest index	Grain length	Grain breadth	Grain length/ breadth ratio
PMS10A X MTU II 161-28-1-1	7.69**	18.05**	29.44**	18.70**	39.41**	7.02**	-7.14	69.43**	6.51	-5.81**	-9.05**	3.30
PMS3A X MTU II 178-20-2-2-1	10.99**	1.18	-3.33	16.03**	47.62**	0.59	-11.67*	65.74**	7.19*	-11.85**	-4.53	-7.92*
PMS10A X MTU II 178-20-2-2-1	11.54**	8.47**	20.00*	12.76**	45.07**	1.34	-13.33*	60.81**	7.76*	-11.45**	-0.86	-10.82**
PMS10A X MTU II 193-23-1	4.95**	24.82**	-11.11	19.10**	51.87**	2.18	-6.67	57.39**	6.96*	-12.07**	-6.68*	-5.94
APMS6A X MTU 1064	2.75	3.80*	-12.78	19.53**	56.64**	6.53**	8.10	56.72**	6.85*	-7.00**	-4.53	-2.64
IR58025A X MTU 1064	0.00	2.73	8.89	21.62**	44.86**	2.68	-3.57	56.11**	6.85*	-2.79	-1.08	-1.98
IR58025A X DA 313-1	1.10	22.32**	21.11**	17.10**	19.81**	-1.25	-15.00**	44.13**	6.74*	-4.27*	1.72	-6.20*
IR58025A X MTU II 143-26-2	1.65	18.92**	-6.11	16.19**	25.32**	3.92*	-22.38**	41.32**	6.51	-3.59	-4.53	0.79
PMS 3A X MTU II 156-13-1-2	10.44**	23.28**	-9.44	16.25**	55.21**	4.54*	-26.67**	40.51**	5.37	-7.57**	0.43	-8.18**
PMS3A X DA313-1	3.30*	23.13**	-17.22*	15.43**	51.47**	2.37	-16.19**	29.65**	6.62*	-9.17**	13.36**	-16.89**
SEd ±	1.49	1.77	0.69	1.13	2.59	1.64	0.12	1.42	0.02	0.18	0.08	0.11
Hb range	-19.82 to 8.25	-18.56 to 10.52	-33.16 to 82.11	-12.19 to 16.42	-93.48 to 56.05	-96.24 to -2.5	-35.77 to 19.16	-84.43 to 89.83	76.07 to 8.68	-24.33 to 5.76	-9.25 to 12.63	-76.14 to 8.15
C_1	15	18	10	25	27	-	2	23	5	1	11	1
Sh range	0.0 to 20.33	-7.06 to 25.84	-28.33 to 92.22	-4.04 to 21.62	-93.53 to 26.64	-95.87 to 7.02	-26.67 to 8.33	-85.78 to 69.43	-76.48 to 7.76	-15.43 to 10.88	-10.78 to 13.36	-16.89 to 8.71
C_2	-	70	18	45	28	5	-	20	8	2	6	6

Hb range = Heterobeltiosis range   Sh range = Standard heterosis range

C_1 & C_2 = Number of hybrids showing significant desirable heterosis over better parent and standard check, respectively.

significant standard heterosis for grain yield plant^{-1}. The hybrid PMS10A X MTU II 161-28-1-1 exhibited maximum heterosis over standard hybrid check APHR-2 (69.43 %) followed by PMS3A X MTU II 178-20-2-2-1 (65.74 %) while heterobeltiosis exhibited maximum for PMS3A X MTU II 178-20-2-2-1(89.83 %) followed by PMS10A X MTU II 161-28-1-1 (87.24%). Heterosis for seed yield was due to the significant and positive heterosis for components like panicle length, number of fertile spikelets, number of panicles and harvest index. Similar results were reported by Dalvi *et al.,* 2005 and Pandya and Tripathi 2006.

The range of mid-parent heterosis, heterobeltiosis and standard heterosis and number of hybrids showing desirable significant heterosis are presented in Table.1

The hybrids IR58025A X MTU1064, PMS3A X MTU1064, PMS10 X MTU1064 and APMS6A X MTU1064 exhibited maximum significant negative mid-parent heterosis and heterobeltiosis desirable for days to 50% flowering as also reported by Yalanda and Vajendradas (1996) and Raj *et al.,* (2007). Shorter plant stature is an important character of hybrid to withstand lodging. Hybrid PMS10A x MTU II 1719-5-1-1 recorded maximum heterotic effect over the mid parent where as APMS6A X MTU II 112-62-1-4 over the better parent and APMS6A X MTU II 1719-5-1-1 over the standard check had exhibited maximum desirable heterosis for plant height.

Number of panicles is closely associated with higher production. The crosses PMS10A X MTU II 134-6-1-1, IR58025A X MTU II 1719-5-1-1 and PMS10A X MTU II 112-62-1-4 exhibited maximum values for all the three types of heterosis.For panicle length, the maximum heterosis was reported in the cross PMS3A X MTU ITJ 201-12-1 over mid-parent while the cross IR58025A X MTU 1064 showed maximum heterosis over the better parent and check.The cross PMS3A X MTUII 156-13-1-2 exhibited maximum mid-parent heterosis and heterobeltiosis for the character number of fertile spikelets while APMS6A X MTU 1064 had exhibited maximum standard heterosis for the same character. Five hybrids recorded significant and positive standard heterosis for spikelet fertility per cent, the highest being recorded by PMS10A X MTU II 161-28-1-1 followed by IR58025A X MTU 1064 .Estimates of the negative heterosis recorded by majority of the hybrids for spikelet fertility per cent in this study. Similar results were also reported by Manuel and Palaniswamy (1989) and Ushakumari *et al .,* (2006).The hybrids APMS6A X MTU ITJ 226-18-1-1-2 and IR58025A X MTU 1064 exhibited maximum heterosis for 100-grain weight over mid-parent and better parent.For the character harvest index the hybrid PMS10A X MTU II 178-20-2-2-1 exhibited maximum mid-parent heterosis and standard heterosis followed by PMS3A X MTU II 178-20-2-2-1. Further PMS3A X MTU II 178-20-2-2-1 exhibited maximum heterosis over better parent for the same character.

The hybrid APMS6A X MTU II 112-62-1-4 exhibited maximum heterosis over mid-parent and better parent for the characters grain length and grain length/ breadth ratio, while IR58025A X MTU II 161-28-1-1 for grain length and IR58025A X MTU ITJ 226-18-1-1-2 for grain length/ breadth ratio recorded maximum standard heterosis.For the character grain breadth IR58025A X MTU ITJ 226-18-1-1-2 over mid-parent , PMS10A X MTU II 161-28-1-1 over better parent and IR58025A X MTU ITJ 201-12-1 over standard check exhibited maximum heterosis. Poor manifestation of heterosis for grain length and grain breadth was also reported by earlier workers Singh and Singh(1985) and Venkatesan *et al.,* (2008).The perusal (Table 1) of the data indicated that heterosis for grain yield of hybrids were due to increased heterosis in panicle length, number of fertile spikelets, number of panicles and harvest index. The crosses PMS10A X MTU II 161-28-1-1, PMS3A X MTU II 178-20-2-2-1, PMS10A X MTU II 178-20-2-2-1, PMS10A X MTU II 193-23-1, APMS6A X MTU 1064 and IR58025A X MTU 1064 exhibited more than 50 % standard heterosis for grain yield over standard hybrid check APHR-2, offers greater scope for exploitation of the hybrid vigour. If we consider both yield and quality together the crosses *viz.,* PMS10A X MTU II 161-28-1-1 and PMS10A X MTU II 193-23-1 manifested high heterosis for grain yield plant^{-1} as well as desirable standard heterosis for grain breadth. Hence, these hybrids were identified as high yielding hybrids coupled with desirable grain quality characters.

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