Study of Heterosis by Utilizing Male Sterility-Restoration System in Rice (*Oryza Sativa L.)*

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Abstract

Four lines and nineteen testers were crossed in a line x tester fashion to work out heterosis over better parent and standard check for seven yield and yield components in rice. Three crosses *viz.*, IR 68897A x RPHR 111-3, IR 68897A x RPHR-641-1 and IR 79156A x EPLT-104 exhibited the highest heterosis along with *per se* performance and *sca* effects for productive tillers per plant, number of filled grains per panicle and panicle length along with grain yield per plant over the standard check KRH-2.

Heterosis breeding is one of readily available alternatives to new plant type research to boost up the rice yield potential. Outstanding achievements have been made in the country during last one and half decade since the research on hybrid rice got started in 1989. At DRR, Hyderabad, a new set of restorers in new plant type (NPT) background were developed for use in the hybrid rice breeding programme. In this paper, we present the magnitude of heterosis in the form of heterobeltiosis and standard heterosis for grain yield and its components in 76 rice hybrids.

Materials and Methods

The experimental material was developed from four stable CMS lines *viz.*, APMS 6A, IR 58025A, IR 68897A and IR 79156A from wild abortive source and nineteen elite, diverse and identified restorer lines. The hybrids were evaluated along with parents and standard check KRH-2 in a randomized block design with two replications at three locations *viz.*, Warangal, Kampasagar and Hyderabad of Andhra Pradesh during *kharif* season 2008 under irrigated condition. Each entry raised in three rows of 1.8 m spaced 20 cm apart with 15 cm inner plant distance. The standard agronomic practices were followed while raising the crop at all the locations.

Observations were recorded on five randomly selected plants for panicle length, productive tillers per plant, spikelet fertility percentage, number of filled grains per panicle, 1000 grain weight and grain yield per plant whereas days to 50% flowering was recorded on plot basis. Based on pooled values, heterobeltiosis and standard heterosis were calculated.

Results and Discussion

Early maturing hybrids are desirable as they produce more yield per day and fit well in multiple cropping systems. In pooled analysis, out of 76 crosses, 26 cross combinations depicted significant negative heterobeltiosis for days to 50 per cent flowering. The spectrum of variation was from –9.35 per cent (APMS 6A x PNR-3158) to 8.28 per cent (IR-68897A x RPHR111-3). Forty one hybrids exhibited significant negative standard heterosis and matured earlier than the standard check KRH2. The highest negative standard heterosis of –12.71 per cent was recorded by IR-68897A x RWC-15. Presence of both negative and positive heterosis was reported earlier by Shanthala *et al*. (2006) and Chaudhary *et al*. (2007).

Hybrids are generally characterized by having longer panicles indicating their efficiency in partitioning of assimilates to reproductive parts. This is one of the attributes of higher yields in hybrids. For panicle length, Fifty nine hybrids exhibited significant positive heterobeltiosis ranged from 5.33 (IR-68897A x RPHR 1009) to 22.84 (IR-68897A x

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RPHR 641-1) and twenty eight hybrids recorded desirable, standard heterosis ranging from 5.30 per cent (IR-79156A x RPHR 1096) to 15.49 per cent (IR-68897A x RPHR 111-3). The estimates of heterosis varied from –33.90 per cent to 28.33 per cent over better parent for the character productive tillers per plant. Seventeen hybrids exhibited positive and significant heterobeltiosis ranging from 11.81 per cent (IR-79156A x RPHR 1009) to 28.33 per cent (IR-79156A x SG-22-289-3 and IR-79156A x IR 28142), while 53 hybrids were superior in positive direction over KRH2. The cross combination (IR-68897A x IR 655515) recorded the highest standard heterosis of 46.80 per cent over the check KRH-2. Positive heterosis for this character was also reported by Panwar *et al*. (2002) and Shanthala *et al*. (2006).

Number of filled grains per panicle is the main yield contributing character in the hybrids. Significant positive heterosis is desirable for this trait. The variation for heterobeltiosis in grains per panicle was from 9.25 per cent (IR-68897A x RPHR 1096) to 88.38 per cent (IR-68897A x RPHR 641-1). With respect to standard heterosis, the highest heterosis of 61.65 per cent (APMS6A x RPHR 1005) was observed. Earlier rice workers Vanaja and Babu (2004) and Bhandarkar *et al*. (2005) have reported similar results on standard heterosis for this character.

The extent of spikelet fertility is an important character which directly influences the ultimate product, grain yield. Over KRH2, the standard heterosis was varied from 18.80% (IR 68897A x RPHR 1190-2) to 8.23 % (APMS6A x RPHR 1009). Only four hybrids *viz.,* APMS6A x RPHR 1009, APMS6A x 3699R, IR 58025A x IR 655515, IR-58025A x RPHR 1009 manifested significant positive standard heterosis. Superiority of this trait was reported by Panwar *et al*. (2002). Thousand grain weight of a genotype gives as an indicator to the end product *i.e.,* grain yield. For this trait, heterobeltiosis ranged from 21.1% (IR 58025A x RPHR 641-1) to 14. 5 % (IR 58025A x RPHR 1096). Only one cross combination IR 68897A x RPHR 641-1 showed significant positive standard heterosis of 15.7 per cent. Similar results were reported by Verma *et al*. (2004) and Shanthala *et al*. (2006). In pooled analysis, heterobeltiosis and standard heterosis for grain yield per plant ranged from –16.6 to 150.6 % and from 44.3 per cent to 47.5%, respectively. High heterosis over KRH-2 manifested by the crosses IR 68897A x RPHR 111-3 (47.5%) followed by IR 68897A x RPHR 641-1 (44.7%), IR 79156A x EPLT-104 (37.1%). Heterosis and heterobeltiosis of both positive and negative nature was reported by Vanaja and Babu (2004), Verma *et al*. (2004) and Chaudhary *et al*. (2007).

The hybrid which exhibited maximum standard heterosis among the different crosses in the present study was IR 68897A x RPHR 111-3. The cross also expressed significant positive heterosis for panicle length, productive tillers per plant and filled grains per panicle. This indicated that morphological traits helped the hybrid to get high heterosis for grain yield. Similarly other hybrids which manifested significant standard heterosis for grain yield per plant were IR 68897A x RPHR 641-1, IR 79156A x EPLT 104, IR 68897A x RPHR 619-2 and APMS6A x RPHR 612-1 and also reported significant standard heterosis for different yield contributing traits.

A comparative study of top ten crosses with higher *sca*, and *gca* effects of parents, standard heterosis for grain yield and desirable heterosis for other traits is presented in Table 2. Majority of the crosses in this comparison with high *sca* effects for grain yield per plant had also desirable and significant *sca* effects for other traits like panicle length, grains per panicle, productive tillers per plant and 1000 grain weight. All the cross combinations with significant *sca* effects for grain yield did not possess significant and desirable *sca* effects for all the component traits which suggested that at least significant and desirable *sca* effects of two to three compound traits resulted in significant *sca* effect for grain yield. Similar results have been reported by Patil *et al*. (2003) and Parihar *et al*. (2008). It was further noticed that out of 10 cross combinations, 6 crosses had at least one parent as a good general combiner for grain yield per plant. Among the ten heterotic crosses which depicted high significant positive standard heterosis for grain yield per plant, nine crosses showed high per se performance over KRH-2 and significant and positive *sca* effects. Higher magnitude of heterosis in predominant number of crosses over standard variety was observed for productive tillers per plant, number of filled grains per panicle, panicle length and grain yield per plant. Association of these characters at both phenotypic and genotypic

Table 1: Estimates of heterobeltiosis (BP) and standard heterosis (over KRH-2) for indicated plant traits of rice hybrids

CROSSES	Days to 50% flowering		Panicle length		Productive tillers per plant		Spikelet fertility%		Filled grains per panicle		1000 Grain weight		Grain yield per plant	
	BP	KRH-2	BP	KRH-2	BP	KRH-2	BP	KRH-2	BP	KRH-2	BP	KRH-2	BP	KRH-2
APMS6A X RPHR-619-2	-0.55	0.18	18.49**	3.53	-18.24**	13.14	-9.24**	-9.61**	-4.33	1.86	8.64	-4.86	69.31**	8.70
APMS6A X EPLT-104	-2.00*	-0.55	17.47**	4.14	-29.05**	-1.82	-3.13	-9.10**	-0.77	5.65	3.89	-6.96	18.49	-23.93**
APMS6A X RPHR-1124	1.12	0.18	8.30**	-5.37*	-22.97**	6.59	-1.95	-7.99**	12.15**	19.41**	1.17	-14.02**	61.99**	4.00
APMS6A X SG-22-289-3	5.34**	-1.84*	7.36*	-4.82	-16.89**	15.01*	-0.12	1.80	15.96**	23.46**	-7.78	-21.63**	48.21**	-4.84
APMS6A X RPHR-1096	0.00	4.42**	8.24**	-0.41	-25.00**	3.79	3.63	-0.22	4.08	10.81*	3.61	-11.95**	29.29**	-16.99*
APMS6A X RPHR-1005	-0.35	4.05**	9.31**	-4.48	-20.27**	10.33	1.65	-4.62*	30.83**	61.65**	-15.45**	-28.15**	69.79**	9.01
APMS6A X RPHR-641-1	-1.26	0.74	13.90**	2.99	-21.62**	8.46	-2.20	-5.53**	-1.96	4.38	-1.47	2.08	44.82**	-7.03
APMS6A X RPHR-1190-2	-6.35**	-2.21*	8.32**	-4.55	-20.95**	9.40	-15.32**	-14.05**	-10.96**	-5.20	-12.57**	-10.32*	-16.61	-44.25**
APMS6A X IR-63879	-4.41**	-0.18	1.31	-4.09	-14.86**	17.81*	2.14	1.98	12.60**	19.88**	-6.38	-11.25**	46.31**	6.08
APMS6A X RPHR 111-3	-3.17**	1.10	8.64**	6.73**	-27.70**	0.05	3.95*	0.42	30.42**	38.86**	-2.04	-10.37*	72.13**	11.83
APMS6A X IR-65515	-5.47**	-1.29	5.67*	-2.04	-19.59**	11.27	-11.66**	-7.85**	-9.96*	-4.14	0.31	-8.32*	-3.19	-24.90**
APMS6A X RPHR-1009	-6.53**	-2.39**	4.91	3.06	-20.27**	10.33	15.34**	8.23**	31.56**	52.62**	6.66	-9.36*	36.38**	13.09*
APMS6A X BCW-56	-1.94*	2.39**	0.45	6.18*	-21.62**	8.46	-3.03	0.56	19.69**	27.44**	-7.09	-6.66	64.74**	5.77
APMS6A X RPSN 774	-5.84**	-4.97**	6.67*	3.91	-33.78**	-8.37	-14.40**	-14.04**	-23.92**	-19.00**	-2.48	-6.09	24.88*	-19.82**
APMS6A X RWC-15	-4.89**	-3.31**	8.93**	-4.82	-33.78**	-8.37	2.99	-3.36	19.37**	27.09**	-3.95	-18.38**	33.02**	-14.60*
APMS6A X PNR-3158	-9.35**	-5.34**	0.97	2.31	-6.08	29.97**	6.91**	1.87	13.38**	20.95**	-2.75	-12.18**	58.40**	1.69
APMS6A X IR 28142	-8.64**	-4.60**	16.62**	1.90	-26.35**	1.92	14.18**	7.80**	30.42**	38.86**	-1.87	-16.61**	63.23**	4.80
APMS6A X RPHR-612-1	-0.36	2.58**	7.10**	6.52*	-12.16*	21.55**	6.05**	-0.48	21.14**	28.98**	-0.87	-7.23	82.03**	28.69**
APMS6A X IR-63877	-2.94**	-2.76**	6.54*	7.91**	-22.30**	7.53	-4.89*	-7.79**	6.50	13.39**	-0.19	-13.20**	29.48**	-10.99
IR-58025A X RPHR-619-2	1.48	0.74	17.06**	3.78	18.11**	40.25**	-1.76	-2.16	6.75	12.41**	13.12**	-0.94	86.21**	9.22
IR-58025A X EPLT-104	0.56	-0.18	14.82**	1.79	11.81	32.77**	1.53	-5.44**	29.38**	28.05**	5.86	-5.19	69.89**	7.37
IR-58025A X RPHR-1124	-1.49	-2.39**	8.51**	-3.80	2.36	21.55**	7.51**	-5.13**	33.74**	16.10**	8.21	-11.59**	37.94**	-21.06**
IR-58025A X SG-22-289-3	3.16**	-3.87**	12.18**	-0.54	-4.72	13.14	0.06	1.98	38.36**	10.77*	0.40	-17.97**	90.53**	9.03
IR-58025A X RPHR-1096	4.45**	3.68**	13.02**	3.99	-6.30	11.27	-5.64**	-9.14**	25.30**	23.73**	14.45**	-6.50	88.41**	7.82
IR-58025A X RPHR-1005	-0.37	-1.10	14.56**	1.56	2.94	30.90**	-4.35*	-12.27**	10.53**	36.57**	0.35	-18.01**	79.09**	2.49
IR-58025A X RPHR-641-1	2.97**	2.21*	15.18**	4.14	13.39*	34.64**	4.25*	0.70	40.76**	1.82	-21.08**	-18.23**	45.82**	-15.79*
IR-58025A X RPHR-1190-2	0.37	-0.37	15.33**	2.24	17.32**	39.32**	-12.29**	-10.97**	13.78*	-17.69**	-5.57	-3.13	40.06**	-6.36
IR-58025A X IR-63879	2.04*	1.29	7.53**	1.81	18.90**	41.19**	1.81	1.65	17.75**	-14.82**	2.37	-2.95	36.05**	-1.36
IR-58025A X RPHR 111-3	3.34**	2.58**	9.27**	7.34**	-5.51	12.20	-0.31	-3.70	16.49**	19.62**	4.55	-4.34	101.52**	30.92**
IR-58025A X IR-65515	-0.93	-1.66	14.51**	6.15*	1.54	23.42**	2.25	6.65**	56.81**	13.43**	8.06	-1.24	33.98**	3.94
IR-58025A X RPHR-1009	-1.48	-2.21*	4.08	2.24	-3.94	14.07	18.54**	4.61*	19.68**	38.84**	10.64*	-9.60*	45.22**	20.42**
IR-58025A X BCW-56	3.34**	2.58**	1.62	7.42**	6.30	26.23**	-6.26**	-2.79	30.77**	3.64	0.74	1.19	63.48**	-4.50
IR-58025A X RPSN 774	-8.53**	-9.21**	6.60*	3.85	3.03	27.16**	3.12	3.54	33.69**	-2.33	5.17	1.27	27.74**	-20.48**
IR-58025A X RWC-15	-2.97**	-3.68**	3.95	-7.85**	0.00	21.55**	0.60	-6.54**	13.41**	6.09	8.55	-9.10*	92.68**	10.27
IR-58025A X PNR-3158	-2.60**	-3.31**	-3.46	-2.17	6.30	26.23**	0.24	-4.49*	-5.07	1.27	-8.23	-17.13**	63.95**	-6.18

Table 1 Contd….

CROSSES	Days to 50% flowering		Panicle length		Productive tillers per plant		Spikelet fertility%		Filled grains per panicle		1000 Grain weight		Grain yield per plant	
	BP	KRH-2	BP	KRH-2	BP	KRH-2	BP	KRH-2	BP	KRH-2	BP	KRH-2	BP	KRH-2
IR-58025A X IR 28142	-3.53**	-4.24**	14.28**	1.32	6.30	26.23**	6.59**	0.63	66.49**	20.43**	4.77	-14.23**	84.49**	8.94
IR-58025A X RPHR-612-1	1.86*	1.10	-3.71	-4.23	7.75	29.97**	-2.29	-13.14**	5.10	-11.45*	-7.86	-13.77**	29.33**	-8.57
IR-58025A X IR-63877	0.19	-0.55	1.41	2.72	-6.30	11.27	2.79	-0.35	44.40**	7.00	4.29	-9.30*	9.72	-24.58**
IR-68897A X RPHR-619-2	0.20	-6.45**	21.52**	7.81**	17.83**	42.12**	2.15	1.73	15.50**	21.62**	0.61	-4.22	131.03**	35.51**
IR-68897A X EPLT-104	-3.55**	-9.94**	17.38**	4.14	4.65	26.23**	2.65	-4.04*	12.12**	10.97*	3.34	-1.62	56.96**	-0.80
IR-68897A X RPHR-1124	-3.94**	-10.31**	7.96**	-4.21	6.20	28.10**	9.15**	2.04	14.74**	-0.39	-1.31	-6.05	111.14**	-3.89
IR-68897A X SG-22-289-3	-4.15**	-10.68**	11.41**	-1.15	-1.55	18.75**	-7.12**	-5.33**	-18.21**	-34.52**	9.51*	4.25	91.32**	-8.29
IR-68897A X RPHR-1096	1.78	-4.97**	16.36**	7.07**	2.33	23.42**	1.36	-2.40	9.25*	7.88	-4.25	-8.85*	122.42**	22.71**
IR-68897A X RPHR-1005	-2.17*	-8.66**	17.23**	4.01	0.74	28.10**	10.78**	3.56	-14.03**	6.22	-10.91*	-15.19**	58.81**	-15.94*
IR-68897A X RPHR-641-1	0.39	-6.26**	22.84**	11.07**	18.60**	43.06**	2.51	-0.98	88.38**	23.46**	11.64**	15.66**	150.56**	44.69**
IR-68897A X RPHR-1190-2	5.52**	-1.47	16.31**	3.19	6.20	28.10**	-20.00**	-18.80**	23.71**	-18.92**	-5.98	-3.56	65.20**	10.45
IR-68897A X IR-63879	1.97*	-4.79**	9.10**	3.29	5.43	27.16**	-2.42	-2.58	21.18**	-15.77**	2.03	-2.86	56.56**	13.51*
IR-68897A X RPHR 111-3	8.28**	1.10	17.57**	15.49**	20.93**	45.86**	0.95	-2.48	38.78**	42.51**	-2.03	-6.74	126.98**	47.46**
IR-68897A X IR-65515	-1.18	-7.73**	11.24**	3.13	20.77**	46.80**	-3.16	1.01	36.99**	-2.95	6.96	1.82	31.28**	1.84
IR-68897A X RPHR-1009	-2.37*	-8.84**	5.33*	3.46	12.40*	35.58**	4.57*	-2.24	-23.69**	-11.47*	12.51**	7.11	-2.69	-19.31**
IR-68897A X BCW-56	4.34**	-2.58**	1.80	7.61**	0.78	21.55**	-1.50	2.14	18.50**	-6.08	3.29	3.75	113.38**	24.65**
IR-68897A X RPSN 774	-2.56**	-9.02**	-2.72	-5.23*	-12.12*	8.46	-6.17**	-5.79**	2.30	-25.27**	2.67	-1.13	9.77	-31.66**
IR-68897A X RWC-15	-6.51**	-12.71**	14.85**	1.90	3.85	26.23**	4.78*	-2.05	-8.16	-14.09**	0.78	-4.06	62.84**	-13.44*
IR-68897A X PNR-3158	6.31**	-0.74	3.58	4.96	6.20	28.10**	-6.15**	-10.58**	-19.02**	-13.62**	-11.71**	-15.94**	55.25**	-14.01*
IR-68897A X IR 28142	0.79	-5.89**	20.00**	6.47*	1.55	22.49**	-3.04	-8.46**	30.90**	-14.21**	0.68	-4.16	60.73**	-5.10
IR-68897A X RPHR-612-1	6.31**	-0.74	12.23**	11.62**	10.85	33.71**	0.45	-6.09**	3.28	-12.98**	-2.35	-7.03	35.45**	-4.25
IR-68897A X IR-63877	0.00	-6.63**	5.63*	7.00**	14.73*	38.38**	-2.76	-5.72**	37.50**	1.88	9.12*	3.88	53.51**	5.53
IR-79156A X RPHR-619-2	-0.38	-2.39**	14.66**	10.22**	10.83	24.36**	-7.71**	-8.09**	-0.86	4.40	5.08	-7.99*	97.61**	15.91*
IR-79156A X EPLT-104	0.56	-1.47	13.36**	8.97**	12.50	26.23**	2.42	-4.61*	14.56**	13.39**	1.34	-9.24*	116.95**	37.12**
IR-79156A X RPHR-1124	-1.88*	-3.87**	3.96	-0.07	8.26	22.49**	-0.05	-8.56**	18.04**	2.48	6.05	-9.51*	98.16**	-8.34
IR-79156A X SG-22-289-3	0.99	-5.89**	9.89**	5.64*	28.33**	43.99**	-8.80**	-7.04**	19.41**	-4.40	3.42	-11.75**	75.29**	-15.97*
IR-79156A X RPHR-1096	2.07*	0.00	9.54**	5.30*	0.00	12.20	1.98	-1.80	16.79**	15.34**	2.63	-12.42**	98.51**	9.51
IR-79156A X RPHR-1005	1.32	-0.74	5.94*	1.83	1.47	29.03**	8.13**	-0.82	-9.64**	11.65**	13.51**	-3.14	129.98**	21.73**
IR-79156A X RPHR-641-1	1.13	-0.92	11.10**	6.79**	19.17**	33.71**	0.60	-2.83	64.52**	-8.01	-2.95	0.55	48.50**	-14.25*
IR-79156A X RPHR-1190-2	-0.56	-2.58**	8.69**	4.48	10.00	23.42**	-2.91	-1.45	50.55**	-5.75	-8.17*	-5.80	55.68**	4.08
IR-79156A X IR-63879	0.56	-1.47	11.94**	7.61**	0.83	13.14	1.47	1.31	40.44**	-2.38	1.27	-4.00	23.22*	-10.66
IR-79156A X RPHR 111-3	4.14**	2.03*	12.79**	10.80**	13.33*	27.16**	-2.46	-5.77**	3.21	5.98	2.93	-5.82	59.01**	3.31
IR-79156A X IR-65515	6.77**	4.60**	14.56**	10.12**	10.00	33.71**	-2.97	1.20	47.31**	4.36	10.39*	0.89	46.53**	13.68*
IR-79156A X RPHR-1009	-2.26*	-4.24**	7.26**	5.37*	11.81*	32.77**	8.74**	-0.51	6.51	23.57**	8.92	-7.05	17.27*	-2.76
IR-79156A X BCW-56	-0.75	-2.76**	3.86	9.78**	14.17*	28.10**	-4.40*	-0.86	32.99**	5.41	1.70	2.16	124.51**	31.15**

Table 1 Contd….

CROSSES	Days to 50% flowering		Panicle length		Productive tillers per plant		Spikelet fertility%		Filled grains per panicle		1000 Grain weight		Grain yield per plant	
	BP	KRH-2	BP	KRH-2	BP	KRH-2	BP	KRH-2	BP	KRH-2	BP	KRH-2	BP	KRH-2
IR-79156A X RPSN 774	-8.27**	-10.13**	7.04**	4.28	2.27	26.23**	-7.34**	-6.95**	19.65**	-12.59**	-0.10	-3.80	18.92	-25.97**
IR-79156A X RWC-15	-1.13	-3.13**	10.46**	6.18*	-1.54	19.68**	7.55**	-0.08	25.19**	17.12**	11.11*	-5.18	98.79**	5.67
IR-79156A X PNR-3158	-0.19	-2.21*	3.98	5.37*	10.00	23.42**	5.78**	0.79	-9.35*	-3.30	5.78	-4.48	68.38**	-6.73
IR-79156A X IR 28142	-1.32	-3.31**	8.83**	4.62	28.33**	43.99**	6.66**	0.70	84.09**	16.09**	3.11	-12.01**	69.23**	-0.08
IR-79156A X RPHR-612-1	2.07*	0.00	3.07	2.51	15.50*	39.32**	-5.87**	-13.88**	-7.17	-21.79**	7.70	0.78	20.47*	-14.83*
IR-79156A X IR-63877	-1.50	-3.50**	9.79**	11.21**	10.40	29.03**	1.08	-2.01	36.81**	1.37	-3.61	-16.17**	29.43**	-11.03
No.of hybrids with significant + ve value	17	10	59	28	17	53	18	04	52	33	10	01	69	14
No.of hybrids with significant - ve value	26	41	0	03	19	0	18	32	04	15	06	33	0	19
Range heterosis	-9.35 to 8.28	-12.71 to 4.60	-3.71 to 22.84	-7.85 to 15.49	-33.90 to 28.33	-8.37 to 46.80	-20.00 to 18.54	-18.80 to 8.23	-23.92 to 88.38	-34.52 to 61.65	-21.08 to 14.45	-28.15 to 15.66	-16.61 to 150.56	-44.25 to 47.46

Table 2: Promising top ten crosses with high *per se* performmance, Combining ability effects and Standard heterosis for yield and yield component traits.

S.no.	Cross combination	Mean	Heterosis over KRH-2	*sca* effect	*gca* female	*gca* male	Desirable heterosis for other traits
1	IR 68897A x RPHR 111-3	37.85	47.46**	5.14**	1.05*	5.84**	PL,PTL,NFG
2	IR 68897A x RPHR 641-1	37.14	44.69**	9.94**	1.05*	0.32	DF,PL,PTL,NFG,GW
3	IR 79156A x EPLT-104	35.19	37.12**	8.00**	0.26	1.10	PL,PTL,NFG
4	IR 68897A x RPHR 619-2	34.78	35.51**	3.62**	1.05*	4.28*	PL,PTL,NFG
5	IR 79156A x BCW-56	33.66	31.15**	4.07**	0.48	3.50*	PL,PTL
6	IR 58025A x RPHR 111-3	33.6	30.92**	2.08	-0.14	5.84**	PL,NFG
7	APMS 6A x RPHR 612-1	33.03	28.69**	8.46**	-1.16*	-0.10	PL,NFG
8	IR 68897A x RPHR 1096	31.5	22.71**	3.30**	1.05*	1.31	PL,PTL
9	IR 79156A x RPHR 1005	31.24	21.73**	4.21**	0.26	0.94	PTL,NFG
10	IR 58025A x RPHR 1009	30.91	20.42**	4.65**	-0.14	0.57	SPK FR%,NFG

*and**significant at P=0.05 and 0.01, respectively.

PL-panicle length, PTL-productive tillers per plant, NFG-number of filled grains per panicle, DF-days to flowering, GW-1000grain weight

levels was positive and significant (Dijee *et al*., 2000 and Eradasappa *et al*., 2007). Hence, for the above characters the cross combination showing higher hybrid vigour can be used in isolating high yielding pure lines and to break yield barrier in rice as the superior hybrids are expected to produce transgressive segregants.

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