STUDIES ON HETEROSIS FOR DEVELOPING NEW HYBRIDS USING CMS LINES IN RICE (*Oryza sativa* L.)

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ABSTRACT

Three complete sets of 101 entries comprising of 76 F_1s developed from 4 females and 19 males following line x tester (L x T) mating design along with two checks were evaluated during kharif 2011. The trials were conducted at three locations viz., Vyara (L-I), Navsari (L-II), and Bardoli (L-III) following Randomized Block Design, replicated thrice. The results of analysis of variance for mean squares of experimental design pooled over environments revealed that mean squares due to parents and hybrids for all the characters were found significant, indicated that enormous amount of variability was present in the experimental material. The parents vs. hybrids comparison was found significant for all the characters except straw yield per plant, indicating substantial amount of heterosis in hybrids. The highest and positive significant extent of heterosis for grain yield per plant on pooled basis was recorded by the hybrid IR-58025A x GR-7 [BP = 52.83%, Jaya (SC-I) = 50.28%, and Sahyadri (SC-II) = 36.44%] with first rank in respect of per se performance followed by hybrids, RTN-3A x GR-7 [BP = 36.16%, Jaya (SC-I) = 34.15%, and Sahyadri (SC-II) = 21.55%], IR-58025A x GR-3 [BP = 37.26%, Jaya (SC-I) = 28.80%, and Sahyadri (SC-II) = 16.05%] and RTN 13A x GR-7 [BP = 23.46%, Jaya (SC-I) = 21.04%, and Sahyadri (SC-II) = 10.21%]. These hybrids could be exploited for commercial cultivation.

KEY WORDS: Heterosis, L x T, Oryza sativa, rice.

INTRODUCTION

Rice is the seed of the monocot plants *Oryza sativa* or *Oryza glaberrima*. As a cereal grain, it is the most important staple food for a large part of the world's human population, especially in East and South Asia, Middle East, Latin America, and West Indies. It is the grain crop with the second-highest worldwide production, after maize (corn).

The hybrid rice research programme was accelerated in 1989 and intensified within a period of 5 years with half a dozen hybrid rice varieties were developed from public and private sectors in India. Presently, 59 hybrid rice varieties released till now, 31 came from the public sector, while 28 came from the private sector in the country (Anonymous, 2012a).

Area under rice cultivation in India was 43 million hectares with a production of 99 million tonnes and productivity of 3450 kg per hectare (Anonymous, 2012b). Area under rice cultivation in Gujarat was 8.08 lakh hectares with a production of 14.97 lakh tonnes and productivity of 1852 kg per hectare (Anonymous, 2012c)

MATERIAL AND METHODS

Three complete sets of 101 entries comprising of 76 F_1s developed from 4 females and 19 males following line x tester (L x T) mating design along with two checks were evaluated during *kharif* 2011. The trials were conducted at three locations *viz.*, Vyara (L-I), Navsari (L-II), and Bardoli (L-III) following Randomized Block Design, replicated thrice. The experimental materials were represented by a single row plot of 10 plants, placed at 20 x 15 cm. The observations were recorded on five randomly selected plants in each replication for 76 hybrids, their respective parents and two checks for fourteen different characters.

RESULTS AND DISCUSSION

The results of analysis of variance for mean squares of experimental design pooled over environments are presented in Table 1 revealed that mean squares due to parents and hybrids for all the characters were found significant, indicated that enormous amount of variability was present in the experimental material. The parents vs. hybrids comparison was found significant for all the characters except straw yield per plant, indicating substantial amount of heterosis in hybrids.

Out of 76 hybrids evaluated, nine promising hybrids for grain yield per plant *per se* with significant and positive heterobeltiosis are presented in Table 2. An examination of performance of hybrids over environments in respect of standard heterosis revealed that out of nine hybrids showing significant and positive heterobeltiosis, 7 and 4 hybrids manifested significant positive heterosis over standard checks, Jaya and Sahyadri, respectively for grain yield per plant. The highest and positive significant extent of heterosis for grain yield per plant on pooled basis was recorded by the hybrid IR-58025A x GR-7 [BP = 52.83%, Jaya (SC-I) = 50.28%, and Sahyadri (SC-II) = 36.44%] with first rank in respect of *per se* performance followed by hybrids, RTN-3A x GR-7 [BP = 36.16%, Jaya (SC-I) = 34.15%, and Sahyadri (SC-II) = 21.55%], IR-58025A x GR-3 [BP = 37.26%, Jaya (SC-I) = 28.80%, and Sahyadri (SC-II) = 16.05%] and RTN 13A x GR-7 [BP = 23.46%, Jaya (SC-I) = 21.04%, and Sahyadri (SC-II) = 10.21%]. On pooled basis, These 9 hybrids showed significant and positive heterobeltiosis for grain yield per plant also manifested significant and desirable heterosis for different component traits. Significant positive heterosis for grain yield per plant, straw yield per plant, number of fertile spikelets per panicle has been reported by in the past in rice by Yadav *et al*. (2004), Singh (2005) and Singh *et al*. (2007). Similarly, significant desirable heterosis was also reported by Vishwakarma *et al.* (1999), Yadav *et al*. (2004) and Singh (2005) for productive tillers per plant; Ramalingam *et al.* (2000), Yadav *et al*. (2004) and Singh *et al.* (2007) for panicle length; Singh (2005) and Singh *et al*. (2007) for 1000-grain weight; Yolanda and Vijendra (1995) and Vishwakarma *et al*. (1999) for pollen and spikelet fertility; and Peng and Virmani (1991) and Yadav *et al.* (2004) for harvest index; Sahai and Chaudhary (1991), Vishwakarma *et al*. (1999), Singh and Maurya (1999), Yadav *et al*. (2004) and Singh (2005) for days to 50 per cent flowering; and Pandey *et al*. (1995), Vishwakarma *et al*. (1999), Janardhanam *et al*. (2001), Yadav *et al*. (2004) and Singh (2005) for plant height. The significant and desirable heterosis was also reported by research for quality traits in rice *viz*., for length to breadth ratio by Singh and Singh (1985), Singh *et al*. (1993), Geetha *et al.* (1994) and Singh (2005); for protein content by Chao (1972), Quah and Rao (1975) and Kshirsagar (2002); and for amylose content, Sarthe *et al*. (1986), Yolanda and Vijendradas (1995) and Singh (2005).

CONCLUSION

Crosses, IR-58025A x GR-7, RTN-3A x GR-7, IR-58025A x GR-3 and RTN 13A x GR-7 manifested high and significantly positive heterobeltiosis and also the standard heterosis over both the check varieties could be exploited for commercial cultivation.

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Table 1: Analysis of variance (mean squares) of experimental design for different characters

Source of Variance	d.f.	Days to 50 Per Cent Flowering	Productive Tillers per Plant	Plant Height (cm)	Panicle Length (cm)	Grains per Panicle^{-1}	Grain Yield per Plant (g)	Straw Yield per Plant (g)
Replication within location	2	0.54	0.78	38.28	19.91	48.24	16.52	64.32
Locations	2	2392.23**	450.29**	32952.49**	47.20**	920.32**	139.04**	1079.48**
Parents	22	1187.70**	8.70**	647.54**	16.50**	656.41**	210.94**	357.26**
Females	3	577.33**	2.56	638.10**	37.23**	153.99	50.47**	164.11**
Males	18	1332.09**	9.34**	679.89**	12.75**	767.21**	239.36**	386.40**
Females vs. Males	1	419.83**	15.43**	93.58	21.75*	169.36	180.70**	412.06**
Hybrids	75	493.98**	9.72**	293.40**	30.14**	1569.90**	273.31**	460.99**
Parents vs. Hybrids	1	146.33*	21.09**	2850.87**	173.34**	72062.57**	1838.58**	75.37
Parents x Locations	44	20.60**	1.17	31.89	4.23	213.65**	74.57**	69.93**
Females x Locations	6	40.77**	0.42	16.97	9.55*	131.21	62.02**	60.08*
Males x Locations	36	16.22**	1.35	26.86	1.19	235.95**	79.04**	71.30**
Females vs. Males x Locations	2	39.03**	0.27	167.35**	42.90**	59.49	31.63	74.82
Hybrids x Locations	150	49.56	2.98**	133.06**	8.74**	202.09**	74.82**	57.94**
Parents vs. Hybrids x Locations	2	6.25	0.39	35.15	18.07**	494.95**	128.61**	0.10
Pooled error	588	27.61	1.68	29.97	3.44	87.74	12.44	25.89

Table 1: Contd….

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Source of Variance	d.f.	Harvest Index (%)	Pollen Fertility (%)	Spikelet Fertility (%)	Length to Breadth Ratio	1000-Grain Weight (g)	Protein Content (%)	Amlyose Content (%)
Replication within location	2	41.97	10.20	14.29	0.00	0.70	0.08	0.17
Locations	2	61.25*	5196.28**	4903.91**	3.33**	78.82**	30.06	24.42**
Parents	22	97.19**	100.08**	95.90**	1.09**	128.77**	6.40**	32.30**
Females	3	79.42**	33.30**	41.36**	2.31**	12.34**	26.63**	6.91**
Males	18	105.22**	91.02**	84.36**	0.80**	152.45**	3.25**	37.29**
Females vs. Males	1	6.09	463.57**	467.18**	2.66**	51.70**	2.43**	18.71**
Hybrids	75	32.49**	68.08**	88.93**	0.81**	64.48**	4.60**	23.69**
Parents vs. Hybrids	1	675.74**	601.20**	453.46**	5.11**	275.11**	22.20**	31.92**
Parents x Locations	44	84.01**	35.31**	26.43**	0.003	2.42**	0.01	2.30**
Females x Locations	6	63.67**	8.04	2.61	0.001	5.45**	0.01	5.43**
Males x Locations	36	91.55**	39.93**	30.59**	0.003	1.99	0.01	1.90**
Females vs. Males x Locations	2	9.20	33.83*	22.90*	0.00	1.06	0.01	0.09
Hybrids x Locations	150	73.91**	30.16**	35.30**	0.01*	2.30**	0.04	1.32**
Parents vs. Hybrids x Locations	2	98.13**	77.83**	11.30	0.006	3.97	0.02	1.63
Pooled error	588	19.12	7.54	7.29	0.009	1.41	0.06	0.67

Table 2: Promising hybrids for grain yield per plant per se with heterobeltiosis and standard heterosis and component traits showing significant and desired heterosis based on pooled over environments in rice

Sr. No.	Hybrid	Grain Yield per Plant (g)	Heterobeltiosis (%)	Standard Heterosis (%)		Useful and Significant Heterosis for Component Traits		
				Jaya (SC I)	Sahyadri (SC II)	Heterobeltiosis	Jaya (SC I)	Sahyadri (SC II)
1	IR-58025A x GR-7	50.25	52.82**	50.57**	36.43**	DF,PT,PL,GP, GY, SY, HI, PF, SF, TW, AC	DF,PT,PH,PL,GP,SY,PF,SF,L:B, TW,PC,	DF,PT,PH,PL,GP,SY,PF,SF,TW,PC ,
2	RTN-3A x GR-7	44.77	36.16**	34.15**	21.55**	DF,PT,PL,GP,SY,PF,S F,TW,AC	DF,PT,PH,PL,GP,SY,PF,SF,L:B,P C	DF,PT,PH,PL,GP,SY,PF,SF,PC
3	IR-58025A x GR-3	42.74	37.26**	28.80**	16.05**	PL,GP,PF,SF,TW,AC	PT,PH,GP,SY,PF,SF,L:B,TW,PC,	DF,PT,PH,GP,SY,PF,SF,TW,PC
4	RTN-13A x GR-7	40.59	23.46**	21.64**	10.21*	PL,GP,SY,PF,TW,PC, AC	PH,PL,GP,SY,PF,SF,L:B,PC,	DF,PL,GP,SY,PF,SF,PC,
5	RTN-13A x GR-3	38.01	20.87**	13.91**	3.21	PL,GP,PF,SF,LB,TW	PT,PH,GP,SY,PF,SF,L:B,TW,PC,	DF,PT,PH,PL,GP,SY,PF,TW,PC,
6	IR-58025A x Jaya	37.91	23.97**	13.60**	2.93	PT,PL,GP,PF,SF	PT,PH,PL,GP,SY,PF,SF,TW,PC, AC	PT,PH,PL,GP,PF,SF,TW,PC,AC
7	IR-58025A x NVSR-178	36.52	9.41*	9.43*	-0.85	PT,PL,GP	PT,GP,SY,PF,TW,PC,	DF,PT,GP,SY,TW,PC,
8	RTN-3A x GR-3	35.81	14.98**	7.30	-2.78	PL,GP,TW,AC	PT,PH,PL,GP,SY,PF,SF,L:B,TW, PC,	DF,PT,PH,PL,GP,SY,PF,SF,TW,PC ,
9	RTN-13A x Jaya	35.45	13.02**	6.51	-3.50	PL,GP	PH,PL,GP,SY,TW,PC,	DF,PL,GP,SY,TW,PC,

**, ** Significant at 5 and 1 per cent levels of significance, respectively*

DF = Days to 50 per cent flowering
PT = Productive Tillers per Plant
PHT = Plant Height (cm)
PL = Panicle Length (cm)
GP = Grains per Panicle
GY = Grain Yield per Plant (g)
TW = 1000-Grain Weight (g)
SY = Straw Yield per Plant (g)
HI = Harvest Index (%)
PF = Pollen Fertility (%)
SF = Spikelet Fertility (%)
L:B = Length to Breadth Ratio
PC = Protein Content (%)
AC = Amylose Content (%)

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