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STUDIES ON HETEROSIS AND INBREEDING DEPRESSION FOR GRAIN YIELD AND GRAIN QUALITY TRAITS IN RICE (*Oryza Sativa* L.)

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Abstract: The present study was carried out with a view to know the extent of heterosis, heterobeltiosis and inbreeding depression for grain yield and grain quality characters in rice. Significant heterosis over mid and better parent in desired direction was observed in many crosses for various traits under study. The crosses IR 64 X NLR 34449 and MTU 1010 X BPT 5204 exhibited highly significant heterosis and heterobeltiosis for yield. The crosses JGL 3844 X JGL 11690, Erramallelu X LGL 11690, BPT 5204 X JGL 11690 and MTU 1001 X JGL 1798 exhibited significant positive heterosis for yield along with one or more grain quality traits. In most of crosses significant inbreeding depression existed for grain yield while five crosses reported inbreeding depression towards negative side. Those crosses with significant positive heterosis and heterobeltiosis were also reported with high percentage of inbreeding depression.

Keywords: Rice, Heterosis, Heterobeltiosis, Inbreeding depression.

INTRODUCTION

Rice is the most important staple food crop for more than two third of the population in India. In India, this crop plays a livelihood for millions of rural households. Rapid increase in production and productivity of rice is the need of hour as per the growing population. Exploitation of hybrid vigour in rice has been recognized as important tool in improving the yield and grain traits for breeders. For hybrid exploitation of hybrid vigour, heterosis, heterobeltiosis and inbreeding depression are important aspects. Therefore, the present study was carried out with a objective to estimate extent of heterosis and inbreeding depression for yield and grain characters.

MATERIALS AND METHODS

The experimental material for heterosis, Inbreeding depression studies comprised of nine (*Oryza sativa* L.) genotypes viz., MTU 1010, MTU 1001, BPT 5204, NLR 34449, JGL 1798, Erramallelu, JGL 3844, and JGL 11690, their 36 F_1s (crosses were effected in a 9x9 diallel

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design to produce 36 crosses) and F_2s. All the parents, F_1s and F_2s were evaluated during *Rabi* 2007-08 to 2008-09 at Rice Research Scheme, Regional Agricultural Research Station, Jagtial to estimate mid parental heterosis, heterobeltiosis and inbreeding depression. The recommended package of practices and necessary prophylactic measures were adopted to raise a healthy crop. Observation on grain yield was recorded on 5 randomly selected plants from each plot per replication in parents, F_1s and F_2s. The means were computed for yield and grain characters such as Hulling percentage, Kernel length, Kernel width and L/B ratio. Heterosis over mid parent was estimated as percent increase or decrease in F_1s over the mid mid parent as F_1-MPX100/MP and Heterobeltiosis as F_1-BPX100/BP(Liang *et al.,*1971), where F_1 is mean of F_1s, MP is mean of parents and BP is mean of better parent. Inbreeding depression was expressed as per cent decrease observed in F_2 over F_1 as F_1-F_2X100/F_1, where F_2 is mean of F_2s.

RESULTS AND DISCUSSIONS

Estimation of heterosis, heterobeltiosis and inbreeding depression are presented in table 1.

Out of 36 crosses tested, thirty were recorded positive significant heterosis over mid parent ranging from 24.98 (JGL 1798 X JGL 11690) to 257.87 per cent (Erramallelu X JGL 3844). Two hybrids MTU 1010 X JGL 1798 and MTU 1010 X JGL 3844 recorded significant negative heterosis. Out of all the crosses tested, 27 hybrids recorded positive and two negative significant values of heterosis over their better parents.

Among all the hybrids studied, none of the hybrid recorded positive heterosis and heterobeltiosis for the trait Hulling percentage. Six crosses expressed heterobeltiosis in significant negative direction with a range of –4.97 to –2.68 per cent. Raju *et al.,* (2006) reported both negative and positive heterosis and Heterobeltiosis, while Pandya and Tripathi (2006) reported positive Heterobeltiosis and both negative and positive Heterobeltiosis for Hulling Percentage.

For Kernel Length the hybrid MTU 1001 X BPT 5204 recorded significant positive heterosis with highest value of 10.48 per cent. Heterobeltiosis was observed in both posotive and negative direction. 7 crosses had higher kernel length than their respective better parent with a range of 2.83 to 6.92 per cent. Heterosis and Heterobeltiosis was recorded in undesirable direction in most of the crosses. The results of low or negative heterosis was reported by Chauhan and Chauhan (1995) and significant positive heterosis was reported by Saravanan *et al.,* (2006).

For the trait Kernel breadth, heterosis in negative direction is desirable for quality rice. Seven crosses recorded significant negative heterosis over mid parent ranging from –3.30 to (IR 64 X JGL 1798) to – 11.41 per cent (IR 64 X NLR 34449).Significant negative heterobeltiosis observed in three hybrids viz., Erramallelu X JGL 11690, BPT 5204 X JGL 11690 and IR 64 X NLR 34449 with –8.27, -7.10 and –5.29 per cent respectively. heterosis was positive and significant for grain breadth for twenty five and negative in seven crosses out of thirty six crosses studied. Similar results were obtained by Pandya and Tripathi (2006) and Saravanan et al. (2006).

Four crosses had shown heterosis to kernel L/B ratio in desirable direction and maximum percentage of 10.20 was associated with the Erramallelu X JGL 11690 and minimum was seen in MTU 1001 X JGL 1798 (4.15 percent). The hybrid JGL 3844 X JGL 11690 recorded significant positive heterobeltiosis with a percentage of 8.27. Pandya and Tripathi (2006) have also reported heterobeltiosis in positive direction.

The crosses Erramallelu X JGL 3844, IR 64 X JGL 1798, MTU 1010 X Erramallelu, NLR 34449 X JGL 1798 and BPT 5204 X NLR 34449 which were significantly superior in performance over their respective mid as well as better parent had shown highly significant depression from F1 to F2 indicating the major involvement of non-additive gene action in the inheritance of grain yield (Ram, 1992 and Reddy and Nerkar, 1995).

The cross with high heterosis followed by depression in F2 involve dominance and epistatic components of gene interactions, hence the crosses viz., MTU 1001 X BPT 5204, JGL 1798 X JGL 3844 and MTU 1001 X NLR 34449 could effectively be utilized through heterosis breeding. In the present study there was nither any appreciable heterosis nor any significant inbreeding depression for grain length, suggesting that additive gene action might be controlling the inheritance of this character. Thus this character could be fixed early generations and single plant selection in F2 could be quite effective in improving grain length. Similar findings were reported by Chauhan and Chauhan (1995).

For grain breadth negative heterosis is desirable to evolve quality rice. Accordingly in three crosses viz., Erramallelu X JGL 11690, BPT 5204 X JGL 11690 and IR 64 X NLR 34449, heterobeltiosis as well as inbreeding depression was highly significant and negativ indicating the presence of certain amount of non-additive gene action (dominance and epistasis) for grain breadth.

Only one cross JGL1798 X JGL 11690 showed highest significant Heterobeltiosis with least Inbreeding depression suggesting that additive gene action play key role for L/B ratio in this cross. Same findings were reported by Reddy *et al.,* (1991).

Most of the crosses exhibited significant heterosis, heterobeltiosis coupled with Inbreeding depression, this might be due to close relationship between Heterosis and Inbreeding depression and also due to non-additive gene action. The segregating material generated during this study may be utilized in identification and selection of desirable recombinants in advanced generations in order to develop high yielding varieties with specific attributes.

Table 1: Estimation of heterosis over mid parent (H_1), better parent (H_2) and inbreeding depression (ID) for grain yield per plant, hulling per cent, Kernel length, Kernel breadth and Kernel L/B ratio.

Crosses	Grain yield per plant			Hulling per cent		Kernel length			Kernel breadth			Kernel L/B ratio		
	H_1	H_2	ID	H_1	H_2	H_1	H_2	ID	H_1	H_2	ID	H_1	H_2	ID
MTU 1010 X IR 64	51.60**	43.46**	22.96 **	1.16	1.06	-14.43**	-16.57**	-1.57	-0.66	-0.66	7.37 *	-14.00**	-16.18**	-9.84 **
MTU 1010 X MTU 1001	13.58	10.86	-8.73	-0.49	-0.55	-1.71*	-9.10**	-3.31 *	-1.87	4.49*	-0.22	-0.59	-12.94**	-3.07
MTU 1010 X BPT 5204	58.98**	51.17**	28.52 *	0.25	-0.54	5.16**	-5.63**	1.14	9.41**	16.26**	1.45	-3.52*	-8.62**	-0.22
MTU 1010 X NLR 34449	38.01**	18.79*	11.26	-3.58**	-4.97**	-3.94**	-13.40**	1.42	6.81**	14.18**	-0.83	-9.71**	-13.55**	2.49
MTU 1010 X JGL 1798	-24.09**	-25.32**	-36.22	-1.22	-2.08	-2.79**	-13.55**	-2.60	2.43	7.48**	1.53	-4.59**	-11.50**	-4.06
MTU 1010 X Erramallelu	150.00**	104.70**	50.14 **	-0.29	-1.20	-4.63**	-8.29**	3.35 *	20.63**	28.57**	15.20 **	-21.12**	-22.87**	-14.10 **
MTU 1010 X JGL 3844	-29.56**	-38.42**	-80.19 **	-0.25	-0.96	-9.34**	-20.10**	-13.87 **	-5.60**	-0.19	-13.51 **	-3.72*	-10.88**	-0.54
MTU 1010 X JGL 11690	92.94**	87.92**	44.58 **	-2.55*	-3.83**	4.35**	-7.42**	3.54	5.84**	11.38**	3.13 *	-1.00	-8.11**	0.56
IR 64 X MTU 1001	80.31**	66.77**	40.16 **	2.24	2.07	-8.36**	-17.20**	-2.42	-7.49**	-1.50	4.15 *	-1.82	-15.89**	-6.76 **
IR 64 X BPT 5204	35.20**	34.51**	25.21 *	0.99	0.29	-11.41**	-22.25**	-7.72 **	3.25	9.72**	6.34 *	-13.76**	-20.27**	-15.04 **
IR 64 X NLR 34449	136.59**	113.91**	44.02 **	-1.81	-3.12*	-10.09**	-20.75**	4.09 **	-11.41**	-5.29*	-13.81 **	1.83	-4.87**	15.65 **
IR 64 X JGL 1798	187.98**	168.34**	66.45 **	0.82	0.04	-11.56**	-23.08**	-4.14	-3.30*	1.46	2.10 **	-8.02**	-16.67**	-6.28
IR 64 X Erramallelu	73.68**	48.87**	25.25 *	1.32	0.50	-2.20**	-8.21**	11.68 **	-2.82	3.57	6.86 *	0.54	0.19	5.13
IR 64 X JGL 3844	-4.50	-12.22	-26.34	0.02	-0.58	-11.92**	-24.05**	-7.99 **	-1.93	3.70	2.84	-9.65**	-18.32**	-11.06 **
IR 64 X JGL 11690	8.84	5.66	2.29	-1.48	-2.68*	-1.90*	-14.87**	0.60	7.24**	12.84**	5.85 **	-7.96**	-16.57**	-5.42 **
MTU 1001 X BPT 5204	-2.02	-8.95	-9.23	0.19	-0.67	10.48**	6.92**	7.91 **	6.67**	21.12**	16.16**	2.81	-5.40**	-9.60 *
MTU 1001 X NLR 34449	40.15**	18.21*	16.49	-0.86	-2.34	5.73**	2.83**	2.99 *	4.05*	18.90**	3.97	0.55	-8.42**	-1.10
MTU 1001 X JGL 1798	46.38**	45.21**	34.94 **	-0.02	-0.96	10.02**	5.42**	3.62	5.05**	17.70**	0.06	4.15*	-2.16	3.58

(Contd…1)

Table 1 Contd…

Crosses	Grain yield per plant			Hulling per cent		Kernel length			Kernel breadth			Kernel L/B ratio		
	H_1	H_2	ID	H_1	H_2	H_1	H_2	ID	H_1	H_2	ID	H_1	H_2	ID
MTU 1001 X Erramallelu	31.61**	5.75	2.98	0.31	-0.66	-9.12**	-12.74**	-7.11 **	-4.79**	8.46**	-7.28 **	-6.57**	-19.73**	0.24
MTU 1001 X JGL 3844	52.24**	30.35**	24.50 *	-0.23	-1.00	4.44**	-0.90	-2.61	1.80	15.00**	-2.74	2.11	-3.86	0.13
MTU 1001 X JGL 11690	99.83**	90.10**	49.92 **	-0.86	-2.22	8.28**	3.49**	2.16	12.65**	26.61**	14.17 **	-4.60*	-10.43**	-14.06 **
BPT 5204 X NLR 34449	138.55**	114.70**	43.15 **	-1.53	-2.18	-5.95**	-6.43**	-14.15 **	4.32*	4.91*	-14.99 **	-9.65**	-10.66**	0.93
BPT 5204 X JGL 1798	36.28**	27.60**	17.56	-1.08	-1.16	-5.98**	-6.95**	-6.79 **	3.23	4.49*	4.78	-8.80**	-10.79**	-12.21 *
BPT 5204 X Erramallelu	83.11**	56.28**	36.51 *	-0.96	-1.08	-0.21	-7.15**	9.61 **	7.22**	7.52**	4.90 **	-7.09**	-13.84**	4.90 **
BPT 5204 X JGL 3844	105.80**	88.28**	43.38 **	-4.33**	-4.41**	-5.48**	-7.40**	-21.82 **	3.81*	4.30*	0.54	-8.94**	-11.14**	-22.74 **
BPT 5204 X JGL 11690	80.32**	75.93**	48.09 **	-0.91	-1.44	-2.48**	-3.73**	-1.00	-7.96**	-7.10**	-9.86 **	5.81**	3.56	7.87 *
NLR 34449 X JGL 1798	143.21**	106.49**	50.90**	-1.90	-2.47	-0.52	-2.04*	1.48	6.78**	8.70**	-0.92	-6.61**	-9.65**	2.65
NLR 34449 X Erramallelu	97.04**	85.58**	21.05 *	-1.98	-2.51	-2.64**	-8.98**	6.49 **	15.55**	15.88**	10.95 **	-15.92**	-21.20**	-5.16 **
NLR 34449 X JGL 3844	68.72**	65.70**	12.76	-3.60**	-4.31**	6.76**	4.08**	-6.92 **	4.96**	6.05**	3.03	1.63	-1.91	-10.18 **
NLR 34449 X JGL 11690	125.93**	98.94**	50.00 **	-2.26	-2.38	-0.97	-2.74**	-4.08 *	4.66**	6.24**	4.06 **	-5.51**	-8.53**	-8.50 **
JGL 1798 X Erramallelu	30.52**	5.52	1.54	-0.08	-0.12	-6.82**	-14.13**	-1.46	6.11**	7.71**	2.84	-12.31**	-20.31**	-4.37 *
JGL 1798 X JGL 3844	56.69**	35.06**	17.94 *	-0.46	-0.62	6.54**	5.45**	4.62 **	8.64**	9.44**	6.46 **	-1.93	-2.16	-1.95
JGL 1798 X JGL 11690	24.98**	19.81*	13.92	-1.61	-2.06	0.99	0.72	0.98 *	-1.37	-1.10	-4.27	2.70	2.64	5.37
Erramallelu X JGL 3844	257.87**	231.39**	63.19 **	1.75	1.54	1.09	-7.70**	8.06 **	4.48**	5.26*	4.91 *	-3.46*	-12.46**	3.20
Erramallelu X JGL 11690	29.52**	8.32	17.76	-1.24	-1.65	-0.09	-8.14**	-2.25	-9.38**	-8.27**	-14.14 **	10.20**	0.20	10.56 **
JGL 3844 X JGL 11690	132.64**	108.14**	55.78 **	-1.28	-1.89	6.76**	5.94**	-0.61	-1.75	-1.30	-2.57	8.60**	8.27**	1.92

* Significant at 5 % level, ** Significant at 1 % level

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