ISSN: 0974 - 0376

The Ecoscan : Special issue, Vol. VII: 477-481: 2015
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.in

HETEROSIS STUDIES FOR GRAIN YIELD AND COMPONENT CHARACTERS IN RICE (*ORYZA SATIVA* L.)

Ishu Kumar Khute *et al.,*

KEYWORDS

Rice
Heterosis
Average heterosis
Heterobeltiosis
Standard heterosis

Proceedings of National Conference on Harmony with Nature in Context of Bioresources and Environmental Health
(HORMONY - 2015)
November 23 - 25, 2015, Aurangabad,
organized by
Department of Zoology,
Dr. Babasaheb Ambedkar Marathwada University
Aurangabad (Maharashtra) 431 004
in association with
National Environmentalists Association, India
www.neaindia.org

The Ecoscan
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES

ISHU KUMAR KHUTE*, DEEPAK SHARMA, NAVEEN MARKAM, DEENDAYAL SINHA AND AKASH THAKUR
Department of Genetics and Plant Breeding,
College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur - 492 012, Chhattisgarh, INDIA
e-mail: ishukhuteAg53@gmail.com

ABSTRACT

Experiment for estimating the average heterosis, heterobeltiosis and standard-heterosis in rice during 2013 was conducted at research farm Department of Genetics and Plant Breeding, College of Agriculture, I.G.K.V. Raipur (C.G.) to identify combinations expressing high hybrid vigour. Heterosis in rice was studied for yield and component traits in 18 hybrids involving 9 parents comprises of 3 lines and 6 testers. The analysis of variance revealed that mean squares due to progenies and parents were highly significant for all the traits. Maximum heterotic effect was obtained by two cross combinations viz. IR 58025A/HR 703, IR 79156A/IIRON-1-114 over the mid parent better parent and check variety for grain yield per plant and almost all the characters. Eight crosses had positive average heterosis for grain yield/plant and ranged from -54.82% (CRMS 31A x IIRON N-1-114) to 217.24% (IR58025A x HR 703) and 7 hybrids having heterobeltiosis and six hybrids showing positive standard heterosis for grain yield were also significant for days to 50% flowering, plant height, number of spikelet per panicle, panicle and almost all the characters.

***Corresponding author**

INTRODUCTION

Rice is the most important staple food grain in the global food grain production. India has the largest acreage under rice, about 44.6 m ha of land with a production of about 90 MT (Roy *et al.*, 2013). Chhattisgarh is popularly known as "Rice bowl of India" occupies an area around 3.61 millions hectare with the production of 5.48 millions tones and productivity of 1517 kg/hectare (*Anonymous 2013*). The expression of heterosis varied with the crosses and also with character (Lokaprakash *et al.*, 1992). To know the potentiality of hybrids the magnitude and directions of heterosis are important. The magnitude of heterosis depends on the degree of genetic distinctiveness of the parental lines used (Akhter *et al.*, 2003). While both positive and negative heterosis is useful for crop improvement depending upon the breeding objectives. The hybrid vigor is the manifestation of heterosis which is positive and negative performance in hybrids or cross over the mid-parent, better-parent and check variety. Positive heterosis is desirable for grain yield and negative heterosis is desirable for early maturity and lower plant height for lodging resistance (Nuruzzaman *et al.*, 2002).The successful use of hybrid cultivars depends upon the existence of an economically significant level of heterosis, sufficient crosspollination to make hybrid seed production cost competitive and an efficient and reliable system of producing the female parent of the hybrid. (Madakemohekar*et al.*, 2015)

MATERIALS AND METHODS

The material for the present study comprised 18 F_1s of rice generated from using 3 CMS lines (IR 58025A, IR 79156A and CRMS 31A) and 6 testers (PAU 1196, Jirashankar (NPT-sel), R1138-396-821-3-1, HR 703, IIRON N-1-114 and TCN 490) through line × tester design during *rabi* season 2012. The resultant 18 F_1 s and 9 parents are grown in Randomized Completely Block Design with two replication during *kharif* 2013 in instructional and research farm, Department of Genetics and Plant Breeding, College of Agriculture, I.G.K.V. Raipur (C.G.) for line × tester analysis. Twenty one days old nursery of parents and hybrids were transplanted in crossing block in five rows of one meter length keeping 20 × 15 cm. spacing and three CMS lines were transplanted in separate blocks to avoid out crossing with other parents. Single seedlings per hill was transplanted, package of practices were followed. Extent of heterosis was measured as percentage deviation of F_1 mean values from better parent (Heterobeltiosis). Midparent heterosis (Ht) and high-parent heterosis (Htb) or heterobeltiosis were determined as outlined by (Falconar and Mackay, 2004).

RESULTS AND DISCUSSION

Analysis of variance (Table 1) reveals that mean sum of squares were highly significant for all the traits depending that sufficient variability was present in the studied material. The range of average heterosis, heterobeltiosis and standard heterosis is presented in Tables II, III and IV the trait wise discussion is presented as

Table I: ANOVA for different quantitative and quality characters

Source of variation	df	Mean sum of square 1	2	3	4	5	6	7	8	9	10	11
Replication	1	11.65**	2.91**	0.11	3.76**	3.49	10.67**	6.20**	1.03	0.75	14.99**	13.95**
Treatment	28	38.76**	263.76**	13.92**	9.52**	5189.75**	175.43**	1444.28**	28.86**	78.92**	466.64**	103.99**
Error	28	0.98	0.12	0.27	0.15	1.31	1.01	0.71	0.73	0.58	0.34	0.3

* = Significant p >0.05, ** = Significant p >0.01; 1. Days to 50% flowering; 2. Plant height (cm); 3. Productive tillers per plant; 4. Panicle length (cm); 5. No. of spikelet/panicle; 6. Spikelet fertility (%); 7. Pollen fertility percentage; 8. 1000 grain weight (gm); 9. Grain yield per plant (g); 10 Biological yield per plant (g);11. Harvest index (%)

Table II: Mid parentheterosis, heterobeltiosis and standard heterosisfor different characters

Parents	Days to 50% flowering			Plant height (cm)		Productive tiller per plant				Panicle length (cm)		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
IR58025A												
PAU 1196	2.90**	8.33**	-3.47**	-0.40	16.58**	-14.04**	-24.22**	-26.52**	-20.66**	8.90**	-3.28	13.25**
Jirashankar (NPT sel-)	4.00**	8.33**	-3.47**	35.39**	63.05**	20.22**	1.77	-2.54	7.98	3.56*	-1.39	15.45**
R1138-396-821-3-1	6.70**	10.56**	-1.49**	16.94**	34.96**	-0.49	-7.74	-28.24**	-27.23**	-3.75*	-5.76**	10.34**
HR 703	-6.91**	-2.78*	-13.37*	16.74**	43.24**	5.61**	45.57**	10.19*	11.74*	14.50**	5.84**	23.91**
IIRON N-1-114	-2.21*	-1.67	-12.38	28.78**	58.14**	16.60**	26.95**	16.67**	18.31**	2.95*	1.84	19.24**
TCN 490	8.94**	9.55**	-3.47**	8.35**	34.61**	-0.75	14.75**	-2.78	-1.41	-5.67**	-8.79**	14.35**
IR 79156A												
PAU 1196	-3.65**	0.00	-8.42**	13.02**	30.43**	-1.42**	-33.48**	-33.91**	-27.70**	10.92**	1.24	11.48**
Jirashankar (NPT sel-)	-8.42**	-5.95**	-13.86**	20.68**	43.26**	8.28**	-31.77**	-32.20**	-24.88**	18.57**	16.29**	28.06**
R1138-396-821-3-1	-3.70**	-1.62	-9.90**	12.56**	28.11**	-3.17**	-26.35**	-44.21**	-38.97**	11.01**	9.98**	23.39**
HR 703	-4.46**	-1.62	-9.90**	16.31**	40.64**	6.30**	-12.79*	-35.62**	-29.58**	15.99**	10.33**	21.49**
IIRON N-1-114	-0.27	0.55	-9.41**	22.83**	48.65**	12.35**	-24.64**	-33.05**	-26.76**	8.22**	6.12**	21.58**
TCN 490	1.93	3.93**	-8.42**	10.10**	34.78**	1.87**	-51.96**	-60.52**	-56.81**	5.65**	-0.77	24.40**
CRMS 31A												
PAU 1196	2.58**	5.29**	-1.49	17.76**	28.70**	7.31**	35.78**	20.43**	30.05**	19.73**	13.40**	15.27**
Jirashankar (NPT sel-)	1.56	3.17**	-3.47**	21.34**	36.24**	13.60**	-14.01**	-24.58**	-16.43**	15.42**	13.11**	19.77**
R1138-396-821-3-1	-4.71**	-3.70**	-9.90**	23.20**	32.86**	10.78**	-46.31**	-55.06**	-62.44**	-7.85**	-12.18**	-1.48
HR 703	-3.90**	-2.12	-8.42**	6.46**	21.67**	1.45**	-16.96*	-32.58**	-43.66**	16.45**	15.13**	17.04**
IIRON N-1-114	-1.89	0.00	-9.90**	8.03**	23.57**	3.03**	-23.68**	-24.31**	-35.68**	8.46**	2.35	17.26**
TCN 490	-1.36	1.69	-10.40**	1.28**	17.13**	-2.34**	-40.24**	-44.94**	-53.99**	-14.87**	-22.93**	-3.37

* = Significant p >0.05,** = Significant p>0.01, MP = Mid parent h eterosis, BP = Better parent heterosis, SH = Standard heterosis

Table III: Mid parentheterosis, heterobeltiosis and standard heterosisfor different characters

parents	No. of spikelet/panicle			Spikelet fertility percentage			Pollen fertility percentage			1000 grain weight (gm)		
	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
IR58025A												
PAU 1196	31.27**	19.82**	81.30**	7.39**	-8.46**	-12.15**	14.33**	12.14**	-10.33**	35.71**	3.47	-32.69**
Jirashankar (NPT sel-)	60.93**	36.38**	70.36**	2.95	-5.33**	-23.68**	-3.85**	-6.19**	-21.15**	18.96**	-17.92**	-26.25**
R1138-396-821-3-1	38.11**	18.29**	107.25**	43.59**	40.05**	-0.34	-11.39**	-19.75**	-20.90**	16.85**	-16.80**	-33.01**
HR 703	3.62**	-3.61**	39.94**	20.90**	20.73**	-18.10**	1.48	-7.82**	-9.73**	36.73**	-4.49	-17.87**
IIRON N-1-114	-41.40**	-55.22**	5.88**	-9.82**	-18.32**	-31.91**	18.80**	13.82**	-0.60	76.67**	38.81**	-17.07**
TCN 490	1.21*	-6.34**	37.51**	21.81**	13.67**	-23.11**	-43.76**	-60.33**	-68.28**	66.09**	25.06**	-15.62**
IR 79156A												
PAU 1196	32.20**	14.47**	73.20**	8.10**	-1.44	-5.41**	2.28*	1.97	-21.27**	12.56**	7.95*	-23.51**
Jirashankar (NPT sel-)	134.88**	109.50**	131.98**	-10.25**	-11.14**	-28.37**	-1.62	-5.63**	-20.68**	-18.44**	-27.06**	-34.46**
R1138-396-821-3-1	64.53**	34.25**	135.22**	4.61**	-0.59	-21.44**	-21.18**	-29.73**	-30.73**	-4.04	-9.80**	-27.38
HR 703	12.54**	-0.81	44.01**	13.08**	5.08**	-16.96**	-22.88**	-31.03**	-32.46**	-11.70**	-19.48**	-30.76**
IIRON N-1-114	33.87**	-1.72**	132.38**	-16.00**	-18.19**	-31.80**	22.29*	-26.78**	-36.09**	10.48**	1.82	-27.86**
TCN 490	45.20**	27.36**	86.97**	-2.81	-15.37**	-33.12**	18.61**	-15.47**	-34.73**	10.83**	8.18*	-23.35**
CRMS 31A												
PAU 1196	27.65**	14.16**	119.01**	-26.69**	-29.34**	-32.19**	-72.94**	-73.79**	-78.54**	3.55	-2.48	-36.55**
Jirashankar (NPT sel-)	37.69**	-0.01	91.83**	-24.13**	-27.72**	-35.65**	-19.74**	-20.78**	-33.42**	-14.32**	-29.75**	-36.88**
R1138-396-821-3-1	-6.52**	-10.58**	71.56**	-17.72**	-25.97**	-34.10**	-28.24**	-34.32**	-35.26**	-15.05**	-27.20**	-41.38**
HR 703	2.76**	-9.74**	73.16**	-8.24**	-19.16**	-28.03**	-14.03**	-21.08**	-22.71**	-1.23	-17.60**	-29.15**
IIRON N-1-114	-29.17**	-35.85**	51.69**	-43.17**	-44.97**	-51.01**	-14.87**	-17.51**	-27.99**	15.11**	12.94**	-32.53**
TCN 490	-12.82**	-23.05**	47.62**	9.15**	-9.50**	-19.43**	9.17**	-23.52**	-37.38**	0.77	-6.68	-37.04**

* = Significant p >0.05,** = Significant p>0.01, MP = Mid parent heterosis, BP = Better parent heterosis, SH = Standard heterosis

under.

Negative heterosis is desirable for days to flowering because this will make the hybrids to mature earlier. Highest negative heterosis exhibited by cross combination IR 79156A / Jirashankar(NPT-Sel) with value -8.42.16 hybrids flowered earliar than their check variety.For the plant height negative heterosis is also desirable because this will prevents lodging of plantbut no any hybrids shown significant negative for relative heterosis and heterobeltiosis while 4 hybrids shown significant negative heterosis for their check variety. Similar results have also been reported by Gawas *et al.* (2007), Saidaiah *et al.* (2010) and Kumar *et al.* (2012).

Table IV: Mid parentheterosis, heterobeltiosis and standard heterosisfor different characters

parents	Grain yield/plant (gm)			Biological yield/plant (gm)			Harvesting index (%)		
	MP	BP	SH	MP	BP	SH	MP	BP	SH
IR58025A									
PAU 1196	-4.43	-28.10**	-8.21	-39.58**	-34.21**	-20.23**	37.43**	11.01**	-3.80**
Jirashankar (NPT sel-)	73.95**	46.45**	37.99**	39.04**	44.81**	75.61**	31.02**	16.42**	-20.09**
R1138-396-821-3-1	115.35**	98.58**	27.96**	12.61**	43.32**	12.45**	81.30**	67.02**	5.74**
HR 703	217.24**	209.42**	109.73**	115.85**	137.26**	140.08**	44.68**	28.65**	-11.85**
IIRON N-1-114	5.61	-18.78**	-2.74	13.23**	15.04**	35.18**	-1.74	-24.01**	-25.85**
TCN 490	58.06**	54.50**	4.26	28.82**	52.61**	35.15**	32.95**	18.29**	-19.05**
IR 79156A									
PAU 1196	-35.50**	-48.10**	-33.74**	-12.34**	-1.13	12.42**	-27.37**	-34.18**	-42.96**
Jirashankar (NPT sel-)	47.35**	34.52**	26.75**	-8.26**	-1.15	12.40**	60.43**	58.43**	11.53**
R1138-396-821-3-1	46.67**	24.61**	-3.04	-15.69**	3.25	-18.99**	61.33**	53.21**	7.86**
HR 703	15.24*	7.81	-16.11**	-36.52**	-32.59**	-31.79**	71.12**	68.84**	18.86**
IIRON N-1-114	74.46**	43.91**	72.34**	36.63**	38.91**	57.95**	23.93**	6.67**	4.08**
TCN 490	3.35	-3.52	-24.92**	-15.03**	-2.97	-14.07**	17.79**	16.14**	-18.24**
CRMS 31A									
PAU 1196	5.02	0.88	39.82**	-2.98**	0.88	44.04**	8.64**	7.78**	-5.09**
Jirashankar (NPT sel-)	-21.15**	-33.77**	-8.21	-24.78**	-18.25**	7.37**	5.92**	-5.76**	-17.01**
R1138-396-821-3-1	-32.60**	-53.07**	-34.95**	-20.70**	17.54**	-7.78**	-16.22**	-27.99**	-36.59**
HR 703	-26.07**	-44.96**	-23.71**	-42.56**	-27.53**	-26.67**	27.11**	13.02**	-0.48
IIRON N-1-114	-54.82**	-57.89**	-41.64**	-48.78**	-40.79**	-30.43**	-14.70**	-18.86**	-20.83**
TCN 490	-42.48**	-57.24**	-40.73**	-42.71**	-21.50**	-30.48**	-0.78	-11.84**	-22.37**

* = SignificantP > 0.05,** = Significant P > 0.01 ,MP = MidParent Heterosis, BP = BetterParentHeterosis,SH = StandardHeterosis

Tillers per plant is considered as most important one and the strains with profuse tillering habit are selected to enhance grain yield. Highest tiller per plant found in cross 58025A/HR 703 (45.57). Three hybrids shown significant positive heterosis for their respective better parent and highest tiller per plant found by cross CRMS 31A /PAU 1196 (20.43 %). Similar results have been reported by Soni *et al.* (2005) and Kumar *et al.*(2012). Heterosis in positive direction was considered to be desirable for panicle length because its direct affect the yield. Maximum panicle length found in cross, IR 79156A / Jirashankar(NPT-Sel) (28.06%).No. of spikelet per panicle is direct affect grain yield. Positive heterosis is desirable for this trait. Maximum number of spikelet found by IR 79156A / Jirashankar(NPT-Sel). heterobeltiosis shown by cross, IR 79156A /Jirashankar(NPT-Sel) (109.50%).Yield is the ultimate result, which isinfluenced by fertility percent of spikelet, highest fertility percent found in IR 58025A /R1138-396-821-3-1 (43.59%)Similar results have been reported by Singh (2005) and Soni *et al.* (2005).Heterosis in positive direction was considered to be desirable for 1000 grain weight, maximum 1000 grain weight found in IR 58025A /IIRON N-1-114 (76.67%) Similar results have been reported byWang *et al.* (2010).Positive heterosis was considered to be desirable for grain yield, maximum grain yield found by IR 58025A /HR 703 (217.24%) Similar results have been reported byVaithiyaligan and Nandarajan (2010). Positive heterosis was desirable for harvest index.13 hybrids has shown significant positive heterosis over mid parent and highest harvest index was found in cross IR 58025A /R1138-396-821-3-1 (81.30%).12 hybrids has shown significant positive over better parent and highest harvest index found by cross IR 79156A / HR 703 (68.84%).5 hybrids has shown significant positive heterosis over check variety and highest harvest index found in cross IR 79156A /HR 703 (18.86%) Similar results have been reported by Garg *et al.* (2015) and Tiwari *et al.* (2011).

REFERENCES

Akhter, Z., Shamsuddin, A. K. M., Rohman, M. M., shalim Uddin, M., Mohi Uddin, M. and Alam, A. K. M. N. 2003. Studies on heterosis for yield and yield components in wheat. *J. Bio. Sci.* **3:** 892-897.

Anonymous 2013. Annual report 2012-13. Department of agriculture and cooperation, Ministry of Agriculture, Government of India. New Delhi. p. 4.

Anonymous 2013. Krishi Digdarshika. 2013. Directorate of Extension Services. *I.G.K.V., Raipur* (C.G.). p.6.

Falconar, D. S. and Mackay, T. F. C. 2004. Anecdotal, Historical and Critical Commentaries on Genetics. *Chapman and Hall. London,U.K.* **4:** 1529-1536.

Gawas, Y. K., Bhave, S. G., Bendale, V. W., Sawant, S. S. and Jadhav, B. B. 2007. Nature and magnitude of heterosis for growth yield and yield components in hybrid rice. *J. Maharashtra. Agric. Univ.* **32(1):** 52-56.

Hossain, Md. S, Singh, N. K. and Zaman, F. U. 2010. Gentics of fertility restoration of 'WA' based cytoplasmic male sterility system in rice (*Oryza sativa* L.) using indica/japonica derivative restorers. *Science Asia*. **36:** 94-99.

Kumar, A., Singh, S. and Singh, S. P. 2012. Heterosis for Yield and yield components in basmati rice. *Asian J. Agricultural Research*. **6:** 21-29.

Lokaprakash, R. G. Shivashankar, M. Mahadevappa, G. Shankre and Kulkarni, R.S.1992. Heterosis in rice, Oryza. **29:** 293-297.

Madakemohekar, A. H., Prasad, L. C., Lal, J. P., Bornare, S. S. and Prasad, R. 2015. study of heterosis and combining ability in exotic and indigenous crosses of barley (*hordeum vulgar*) under rainfed environment. *The Ecoscan.* **10(2):** 751-756.

Nuruzzaman, M., Alam, M. F., Ahmed, M. G., Shohael, A. M., Biswas, M. K., Amin, M. R. and Hossain, M. M. 2002. Studies on parental variability and heterosis in rice. *Pak. J. Biol. Sci.* **5:** 1006-1009.

Pankaj Garg, Saharan, R. P., Mamta, G. and Renu, M. 2015. Heterosis studies for grain yield and its components in wheat (*Triticum* ***aestivum***

l.) under normal and drought conditions. *The Ecoscan. Special issue*. **10(2):** 721-728.

Roy, B., Surje, D. T. and Mahato, S. 2013. Biodiversity of farmers' varieties of rice (Oryza sativa L.) at repository of uttarbanga krishiviswa vidyalaya: A reservoir of important characters. *The Ecoscan. Special issue*. **4:** 145-151.

Saidaiah, P., Sudheer Kumar, S. and Ramesha, M. S. 2010. Combining ability studies for development of new hybrids in rice over environments. *J. Agriculture Science*. **2(2):** 226-233.

Singh, S. P., Singhara, G. S., Parray, G. A. and Bhat, G. N. 2005. Genetic variability and heritability in rice (Oryza sativa L). *Environment and Ecology*. **23S(Special 3):** 549-551.

Soni, D. K., Kumer, A., Sunil, N. and Lakeswar, S. 2005. Study of heterosis by utilizing cytoplasmic-genetic male sterility system in rice (*Oryza sativa* L.). *Plant-Archives*. **5(2):** 617-621.

Tiwari, D. K., Pandey, P., Giri, S. P. and Dwivedi 2011. Heterosis Studies for Yield and its Component in Rice Hybrids using CMS system. *Asian. J. Plant Sciences*. **10(1):** 29-42.

Vaithiyalingan, M. and Nadarajan, N. 2010. Heterosis for yield and yield contributing characters in inter sub-specific crosses of rice. *Electronic J. Plant Breeding*. **1(3):** 305-310.

Wang, H. F., Wang, N. Y., Li. Y., Liang, K. J., Qiu, X. L., Zhou, W. Y., 2010. Genetic effects and heterosis analysis on yield-related traits of CMS-FA hybrid rice. *Scientia Agricultura Sinica*. **43(2):** 230-239.

Wynne, J. C., Emery, D. A. and Rice, P. W. 1970. Combiningability estimates in (Archis hypogeal.) II- Fieldperformance of F1 hybrids. *Crop Sci.* **10(15):** 713-715.