Electronic Journal of Plant Breeding, 1(6): 1464-1467 (Dec 2010)
ISSN 0975-928X

Research Note

Heterosis studies for yield and physiological traits in rice hybrids under shallow low land condition

Jayasudha S* And Deepak Sharma

Department of Plant Breeding & Genetics, Indira Gandhi Krishi Vishwa Vidhyalaya, Raipur-492006 (Chhattisgarh), India
*Email: deepakigkv@gmail.com

(Received: 01 Nov 2010; Accepted:26 Nov 2010)

Abstract:
Heterosis and heterobeltiosis were estimated for grain yield, its attributes and physiological traits in 33 cross combinations between rice cultivars (improved and landraces) and three male sterile parents (one wild abortive and two indigenous) generated through Line x Tester mating design, with the aim to develop physiologically efficient heterotic hybrid for this ecosystem. In general, the hybrids performed significantly better than the respective parents. Among the 33 hybrids, six hybrids *viz.*, IR 58025A/OR 1898-18RAU 729-12-44, IR58025A/R 304-34, CRMS 31A/RPHR 203-3, CRMS 31A/IR 68830-NDR-1-1, CRMS32A/RPHR-203-3 and IR 58025A/CHINIKAPOOR, had significant heterosis for yield, flag leaf angle, IInd leaf angle, IIIrd leaf angle and flag leaf area.

Key words: Heterosis, Yield, Flag Leaf Area, Leaf Angle, Rice

Chhattisgarh is known as the rice bowl of India. Rice is grown on 3.7 million ha of land in the state. However, average rice productivity in the state is quite low (1.3 t ha^{-1}). Since the state's creation in 2000, 11 high-yielding rice varieties have been released for commercial cultivation for the different agro ecological zones. The rainfed lowland ecosystem occupies about 40% of the state's total rice area. Yield in these areas has remained stagnant in the past decades. Several pockets within this system can be considered as favorable lowland. The adoption of rice hybrids in such areas, along with proper crop management practices, can increase rice productivity in the state (Anon, 2008)

Hybrid rice technology appears to be the most feasible and readily adoptable to increase the yield level in rice. Extensive research work is going throughout India and abroad on different aspects of hybrid rice. Several pioneer hybrids have shown a yield advantage of around 20% over current three-line hybrids on commercial scale. The average yield of rice hybrids is 6.3 t/ha while that of the inbred varieties is 4.5 t/ha (Long ping, 2004). Therefore, the breeders are now making concentrated efforts to evolve better hybrids for varying ecological situation and to develop appropriate agronomy along with augmenting seed supply by producing quality seeds of recommended hybrids. Therefore, the present piece of research work reports the results of magnitude of heterosis for yield, its attributes and important physiological traits under shallow low land condition.

The experimental material comprised 33 hybrids obtained by involving three CMS lines (CRMS 31A, CRMS 32A, IR 58025A) and eleven testers (WAR 120-1-5-6-2-B-B-3, RPHR 203-3, R 1130-102-3-88-1, IR 68830-NDR-1-1, CR 780-1937, R 1241-1856-1-1, R 304-34, R 1216-6, CHINIKAPOOR, OR1898-18RAU 729-12-44 and WAR 89-4-A9-1-B-B-B-2).The hybrids were generated in a line x tester pattern for the purpose and evaluated along with parents in Randomized Complete Block Design with two replications at Experimental Research Farm during *Kharif* 2006-07 under shallow low land condition. Twenty one days old seedlings of 33 hybrids and 14 parents were transplanted in the field. A standard spacing of 20 x 20 cm, was adopted for planting and 12 plants were maintained in a single row. Single seedling per hill was transplanted. Recommended package of practices were followed. Observations were recorded on five randomly selected plants in both the replications for thirteen traits *viz.*, Days to 50% flowering, plant height, tillers per plant, productive tillers per plant, panicle length, flag leaf angle, second leaf angle, third leaf angle, flag leaf area, pollen fertility (%), spikelet fertility (%), harvest index (%) and seed yield per plant. Heterosis for each trait was worked out by utilizing the overall mean of each hybrid over replications for each trait. The mean data of isogenic maintainer lines (of respective CMS lines) were used as values for female parents. Relative heterosis was estimated as per cent deviation of hybrid value from its mid-parental value.

Heterosis of F_1 hybrids over their respective mid parents and better parents are presented in Table 1. Heterosis for seed yield per plant was observed from -85.72 (CRMS 32A/ IR 68830-NDR-1-1) to 174.79 (IR 58025A/OR 1898-18RAU 729-12-44) per cent for mid parent and -88.78 (CRMS 32A/ R 1241-1856-1-1) to 164.95 (IR 58025A/OR 1898-18RAU 729-12-44) for heterobeltiosis. High percentage (91.8 to 150.4) of heterosis for yield per plant was also reported by Zhang et al. (1994).

Out of thirty three hybrids studied, eight cross combinations exhibited high *per se* performance, seven crosses shows significant positive mid parent heterosis and six crosses showed significant better parent heterosis for seed yield per plant. Some of the crosses which recorded highly significant positive heterosis for seed yield includes IR 58025A/OR 1898-18RAU 729-12-44, IR 58025A/R 304-34, CRMS 31A/RPHR 203-3, IR 58025A/ CHINIKAPOOR and CRMS 31A/IR 68830-NDR-1-1 (Table 2). All these crosses manifested significant positive heterosis for seed yield per plant and flag leaf area. It appears that heterosis for yield may be through heterosis for individual yield components or alternatively due to multiplication effects of non-additive gene effects of component characters. Similar results have been reported by Kshirsagar *et al*. (2005) and Sunil (2007).

The negative heterosis for leaf angle effects indicates their usefulness in breeding of narrow leaf angle genotypes. Leaves of these genotypes have more space and intercept more light due to their vertical orientation. This type of leaf angle play useful role in photosynthesis, ultimately yield. In rice, flag leaf area (length x breadth) had great contribution for high grain yield production. In the present study, twenty one hybrids recorded significant positive relative heterosis and eleven hybrids observed to be positively significant over better-parent for flag leaf area. Similar findings were reported by Chaudhry *et al*. (2007). Julfiquar and Tepora (1994) reported positive heterosis for flag leaf length in rice. Hybrids with narrow leaf angle and broad flag leaf area could make a significant contribution towards increasing grain yield. Among the superior crosses for yield, the crosses CRMS 31A/RPHR 203-3, IR 58025A/ RPHR 203-3 and CRMS 31A/IR 68830-NDR-1-1 showed significant negative heterosis for days to 50% flowering for both mid parent and better parent, which indicated the possibility of developing early maturing hybrid lines. Negative heterosis for earliness was also reported by Tang *et al.* (2002).

Shorter plant height is an important character of hybrid to withstand lodging. In the present study, three hybrids showed significant negative heterosis over mid-parent for plant height and none for heterobeltiosis. Three hybrids showed significant positive heterosis over mid-parent and two hybrids recorded significant positive heterosis over better-parent for productive tillers per plant. Twenty hybrids recorded significant positive heterosis over mid-parent and seventeen hybrids recorded positive heterosis over better-parent for panicle length. In the case of harvest index, nine hybrids recorded significant positive heterosis over mid-parent and seven hybrids showed significant positive heterosis over better-parent. Similar results have been reported by Khoyumthem *et al*. (2005) and Soni *et al*. (2005).

In conclusion, the three crosses, IR 58025A/OR 1898-18RAU 729-12-44, IR 58025A/R 304-34 and CRMS 31A/RPHR 203-3 were identified as the most promising combination for developing high yielding hybrid rice among the thirty three crosses (Table 1). However, the highest heterosis for seed yield per plant value was obtained from the cross IR 58025A/OR 1898-18RAU 729-12-44 (174.79) for mid parent heterosis and (164.95) over better parent heterosis. Hybrids IR 58025A/R 1130-102-3-88-1, IR 58025A/WAR 120-1-5-6-2-B-B-3, CRMS 32A/RPHR 203-3, IR 58025A/RPHR 203-3, CRMS 31A/OR 1898-18RAU 729-12-44 and CRMS 31A/IR 68830-NDR-1-1 were found promising on the basis of flag leaf angle, second leaf angle, third leaf angle, flag leaf area and seed yield per plant which indicated the dependence of heterosis for grain yield directly on key physiological traits viz, flag leaf angle, second leaf angle, third leaf angle and flag leaf area . These hybrids have efficient photosynthetic activity through both sides of leaf blades and have greater production potential for grain yield. The study therefore, suggests for greater importance of these physiological characters for higher yield potential in hybrid breeding for shallow low land condition.

References

Anonymous, 2008. ICAR Adhoc Project Final Report (2004-08), pp.7. Development of rice hybrids adapted to shallow low lands of Chhttisgarh. IGKV,Raipur.

Julfiquar , A.W. and Tepora, N.M., 1994. Heterosis in some quantitative characters in F_1 hybrid rice (*Oryza sativa* L.). *CLSU-Sci. J.,* **12**:30-36.

Khoyumthem ,P., Sharma, P.R., Singh, N.B. and Singh, M.R.K.2005. Heterosis for grain yield and its component characters in rice (*Oryza sativa* L.). *Environ. and Eco.,* **23**: 687-691.

Kshirsagar, R.M., Vashi, PS., Bagad, A.B., Dalvi, V.V. and Chauhan Digvijay. 2005. Combining ability for yield and its components in rice. *Madras Agric. J.,* **92**: 154-157.

Longping, Yuan. 2004. Hybrid rice for food security in the world. *FAO rice conference*, Rome, Italy.

Soni, D.K., Arvind, Kumar, Sunil Nag and Lakeswar, Sahu. 2005. Study of heterosis by utilising cytoplasmic-genetic male sterility system in rice (*Oryza sativa* L.). *Plant Arch.,* **5**: 617-621**.**

Sunil Issac, 2007. Heterosis for economic traits in early, mid early and very early rice cultivars for the cauvery delta zone. *Indian J.Agric.Res.,* **41**:249-255.

Tang, L., Xiao, G.Y., Yuan, L.P. and Deng, X.X., 2002. Studies on heterosis of Pei'ai 645/ Javanica rice. *Human Agric. Sci. and Tech. Newsl.,* **3:** 4-10**.**

Zhang, Q., Gao, Y.J., Yang, S.H., Raragab, M.A.S. Maroof and Li, Z.B. 1994. A diallel analysis of heterosis in elite hybrid rice based on RFLPs and micro satellites. *Theor. Appl. Genet.,* **89**:185-192.

Table 1. Promising hybrids based on *per se* performance, heterosis and heterobeltiosis for seed yield and important physiological components

Hybrids	Per se performance (yield per plant in gm)	Heterosis											
		Days to 50% flowering		Flag leaf angle (degree)		Second leaf angle (degree)		Third leaf angle (degree)		Flag leaf area (cm2)		Seed yield per plant(gm)	
		MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
IR 58025A/OR 1898-18 RAU 729-12-44	50.50	1.91**	9.23**	-4.57*	-0.85	-10.33**	-3.12	-13.78**	-9.44**	41.15	15.17**	174.79**	164.95**
CRMS 31A/RPHR 203-3	34.50	-6.29**	-2.42**	-9.28**	-42.60**	-98.07**	-84.93**	-33.58**	-39.41**	0.69	5.76	40.17**	18.96**
IR 58025A/R 304-34	31.67	9.18**	9.74**	-12.49**	-8.01**	-55.80**	-53.39**	-43.39**	-41.52**	34.49**	10.82**	103.37**	78.92**
CRMS 31A/IR 68830-NDR-1-1	29.83	-2.79**	0.96**	-34.72**	-30.88**	-7.84*	-46.41**	-12.11**	-1.71	9.98**	7.12**	31.93**	2.86**
CRMS 32A/RPHR 203-3	24.00	8.07**	8.86**	-59.20**	-54.08**	-3.36	13.80**	-5.67*	24.76**	15.57**	-4.68	-0.82**	-14.80**
IR 58025A/ Chinikapoor	22.00	1.23**	5.64**	-4.16*	12.28**	-14.85**	-9.66**	-3.36*	1.26	18.40**	41.88**	17.07**	10.60**
CRMR 32A/R 1130-102-3-88-1	20.83	8.82**	9.35**	-21.85**	-46.04**	-58.68**	-67.46**	-57.19**	15.57**	-4.09**	-8.57**	0.26	-26.05**
IR 58025A/RPHR 203-3	19.67	-7.23**	-4.61**	-0.65	-25.66**	-25.99**	-10.61**	-37.56**	-27.50**	36.95**	17.28**	3.70	-2.76

MP= Mid parent heterosis; BP= Better parent heterosis