Study of heterosis in rice (*Oryza sativa* L.) using line x tester mating system

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ABSTRACT

The nature and magnitude of heterosis over better parent (heterobiltiosis) and over standard variety (Economic heterosis) in rice was studied using 60 F_1 hybrids involving 30 lines and 2 testers in a line x tester analysis. A total of 60F_1s, their 32 parents (30 males + 2 females) and a standard check. Sarjoo-52, were evaluated. The findings indicated that, the heterosis over better parent was 30.56 percent and 70.67 percent over standard parent for panicle length; 14.62 per cent over better parent and 11.07 per cent over standard parent for total number of spikelets panicle^{-1}; 54.73 per cent over better parent and 11.86 over standard variety for number of sterile spikelets panicle^{-1} 42.48 per cent over better parent and non of the crosses showed economic heterosis for 1000 grain weight and 139.43 per cent over better parent and 22.64 per cent over standard parent heterosis recorded for grain yield plant^{-1}.

Key words: *Hetrosis, line x tester, irrigated ecosystem*

Development of hybrid rice is the turning point for increasing the productivity. The present study was carried out to workout the nature and magnitude of heterosis. The work was carried out at the Crop Research Station, Masodha Faizabad. The experimental materials consisted of 30 lines (NDRSB 96006R, NDRSB 9730015R, NDRSB 9830099R, OR 1537-15R, OR 1543-11 R, OR 1547-9-1R, OR 1564-5R, OR 1898--17R, CR 792-B_2-2-1R, IR 54112-B_2- CR-6-2R, BARO 5-1-B-6-3-34-1-1-1-1R, RAU 1441-4R, IR 31917R, TTB-517-17-SBTR-67401-17-2R, TTB-517-17-SBIR-70149-35R, CN, 1035-36R, CN 1045-6R, OR 1537-6R, R 710-437-1-1R, IR 70R, IR600-76-1R, IR 55838-B-2-3-2-3R, IR 21567-18-3R, IR 10198-66-2R, IR 65515-47-2-1-19R, R-971-2505-2-1R, UPRI 92-79R, CSR 21R, RP 2932-2528R and JR 82-1-10R) and two testers (IR58025 A and NDMS 4A). The 60F_1s hybrids obtained through a line x tester alongwith their 32 parents were grown in Randomized Block Design with three replications. The observations were recorded on 6 characters such as panicle length, total number of spikelets panicle^{-1}, number of fertile spikelets panicle^{-1}, number of sterile spikelets plant^{-1}) 1000 grain weight and grain yield Plant^{-1}.

Positive heterosis is more desirable for panicle length as long us panicle is generally associated with higher productivity. Twenty-five crosses over better parent and thirty four crosses over standard variety Jal-Lahri showed significant disirable heterosis for panicle length. The present findings are in accordance with the earlier findings of Purohit (1972), Ishkumar and Saini (1983), Patel *et al.* (1994) and Pandey *et al.* (1995).

Number of spikelets panicle^{-1} is one of the important components of yield and probably in future this character will help in breaking the yield ceiling thus the hybrids with positive heterosis were desirable for this character. The result revealed that the 12 crosses each showed significant positive heterosis over better parent and standard variety. The significant positive heterosis for number of spikelets panicle^{-1} was also recorded by Pillai 1961, Carnahan 1972 and Pandey *et al.* 1995.

For number of fertile spikelets panicle^{-1}, it was observed that the, hybrids which had higher fertility of more than 80% exhibited generally non-significant value either in positive or in negative directions because the standard variety and better parent also exibited spikelet fertility more than 80 per cent. (Kumar 1987).

The significant hetrosis in negative directions was observed in 13 crosses over better parent and 17

Table 1. Extent of heterosis over better parent and standard variety in sixty rice hybrids for six different characters.

Crosses	Panicle length (cm)		Total no. of spikelets panicle^{-1}		No. of fertile spikelets panicle^{-1}		No of sterile spikelets panicle^{-1}		1000 grain weight (g)		Grain yield plant^{-1} (g)	
	BP	SV	BP	SV	BP	SV	BP	SV	BP	SV	BP	SV
IR 58025 A / NDRSB-95006R	-16.52**	5.05**	6.80**	3.91**	0.19	0.13	6.80**	3.91	7.63*	-43.11**	31.97**	17.85**
IR 58025 A / NDRSB-9730015R	-18.18**	2.97	-2.16	-2.64	1.51	-0.97	0.06	-2.64	24.64**	-34.12**	10.75**	-1.10
IR 58025 A / NDRSB-9830099R	-35.52**	-31.98**	-4.82**	-1.56	9.02**	6.36**	-4.82*	-1.56	-20.25**	-52.57**	19.64**	0.29
IR 58025 A / OR-1537-15R	-16.46**	-14.33**	3.26	6.80**	49.86**	-4.09	3.26	6.80**	-8.42**	-45.54**	5.05	-11.94**
IR 58025 A / OR-1543-11R	-8.65**	-3.64*	1.84	-2.70	54.73**	-0.97	54.10**	-2.70	0.35	-46.30**	-19.41**	-15.86**
IR 58025 A / OR-1547-9-1R	-13.65**	-11.45**	-7.24**	-7.69**	0.55	0.49	46.19**	-7.69**	-1.86	-47.49**	-29.85**	-26.75**
IR 58025 A / OR-1564-5R	4.54**	10.28**	1.73	-1.08	-0.91	-0.97	1.73	-1.08	-1.34	-44.46**	116.36**	-17.19**
IR 58025 A / OR-1898-17R	4.17*	6.83**	-2.10	-2.58	32.96**	7.28**	0.19	-2.58	12.16**	-36.85**	134.64**	-10.19**
IR 58025 A / CR-792-B_4-2-1R	-6.16**	-1.01	11.10**	6.14**	22.96**	-0.79	37.25**	6.14**	40.19**	-34.04**	103.31**	22.64**
IR 58025 A / IR-54112-B_2-CR-1-6-2R	-11.20**	-8.93**	-1.50	-1.98	0.37	-0.97	26.75**	-1.98	14.88**	-45.95**	54.46**	-6.82
IR 58025 A / BARO-5-1-B-6-3-34-1-1-1-1R	30.42**	37.57**	1.97	-2.58	6.69**	5.26**	2.27	-2.58	35.25**	-36.79**	4.36	-34.94**
IR 58025 A / RAU-1411-4R	-17.92**	-15.83**	-2.06	-2.54	2.17	3.61*	2.32	-2.54	39.06**	-35.01**	53.32**	-4.41
IR 58025 A / IR 31917R	23.94**	30.84**	0.00	-0.60	9.94**	11.49**	0.00	-0.60	-3.74	-50.67**	-11.70**	-12.99**
IR 58025 A / TTB-517-17-SBIR-67401-17-2R	7.24**	13.21**	9.98**	9.45**	1.77	5.26**	10.10**	9.45	21.34**	-37.82**	1.50	0.02
IR 58025 A / TTB-517-17-SBIR-70149-35R	8.53**	14.48**	1.32	5.65**	4.26**	7.83**	1.32	5.65**	2.68	-47.57**	71.56**	7.74*
IR 58025 A / CN-1035-36R	-14.11**	-11.91**	-0.58	3.67*	3.70	-2.44	-0.58	3.67	-8.81**	-53.43**	49.81**	-5.92
IR 58025 A / CN-1045-6R	-6.95**	-1.84	2.47	-2.10	17.93**	10.94**	7.03**	-2.10	13.79**	-34.25**	-46.41**	-42.05**
IR 58025 A / OR-1537-6R	-13.43**	-11.22**	8.71**	8.18**	14.20**	1.78	18.28**	8.18**	-10.00**	-48.00**	-33.99**	-28.61**
IR 58025 A / R-710-437-1R	9.45**	15.45**	3.92*	-0.72	16.25**	3.61*	10.15**	-0.72	0.31	-42.40**	-22.06**	-45.86**
IR 58025 A / IR 70R	14.48**	17.40**	-0.53	-1.02	23.33**	8.56**	9.81**	-1.02	-15.73**	-51.62**	6.64	-25.93**
IR 58025 A / IR 600-76-IR	-4.79**	0.43	14.62**	9.51**	12.50**	-0.97	27.97**	9.51**	16.97**	-46.64**	77.74**	-6.18
IR 58025 A / IR 55838-B-2-3-2-3R	3.14	5.78*	-1.74	-2.22	2.52	11.86**	14.27**	-2.22	16.31**	-46.94**	47.13**	-22.33**
IR 58025 A / IR 21567-18-3R	2.59	25.84**	-0.49	9.75**	-10.25**	-2.08	-4.49	9.75**	33.28**	-36.78**	121.51**	4.46
IR 58025 A / IR 10198-66-2R	-2.47	19.64**	-12.76**	-3.78*	40.15**	5.63**	-12.76**	-3.78	35.80**	-35.58**	-3.03	-54.27**
IR 58025 A / IR 65515-47-2-1-19R	-34.64**	-31.05**	6.38**	1.63	48.18**	11.68**	36.73**	1.63	2.58	-49.11**	-13.44**	-4.42
IR 58025 A / R-971-2505-2-1R	-3.01	-0.53	11.62**	11.07**	-1.34	-18.77**	49.44**	11.07**	16.72**	-42.09**	-41.06**	-34.92**
IR 58025 A / UPRI 92-79R	-43.88**	-27.43	-14.84**	-18.64**	23.83**	1.96	1.57	-18.64**	12.67**	-35.50**	99.34**	-9.39**
IR 58025 A / CSR 21R	-28.37**	-7.38**	-0.66	-1.14	-23.47**	-17.48**	23.42**	-1.14	-8.57	-47.66**	42.60**	-35.18**
IR 58025 A / RP 2932-2528R	-22.72**	-18.48**	-30.94**	-23.75**	-14.46**	-7.76**	-30.94**	-23.75**	4.01	-45.59**	139.43**	-0.77
NDMS 4A / JR 82-1-10R	-5.03**	-2.60	-15.14**	-6.31**	-11.31**	-0.79	-15.14**	-6.31**	17.23**	-38.67**	79.13**	-25.77**
NDMS 4A / NDRSB-96006R	-7.88**	-2.83	-10.77**	-2.34	-11.15**	-0.61	-10.77**	-2.34	18.74**	-37.00**	-32.66**	-21.81**
NDMS 4A / NDRSB-9730015R	14.43**	17.34**	-8.08**	0.60	-16.08**	-12.90**	-8.08**	0.60	0.03	-46.93**	-14.51**	-0.72
NDMS 4A / NDRSB-9830099R	17.29**	23.72**	-13.10**	-13.41**	-4.60**	-0.97	-13.10**	-13.41**	6.01*	-39.30**	-11.62**	-22.03**
NDMS 4A / OR-1537-15R	1.31	3.90*	-0.91	-1.26	23.99**	-10.88**	-0.91	-1.26	-5.02	-45.61**	-0.60	-12.31**

NDMS 4A / OR-1543-11R	30.56**	70.67**	-10.43**	-14.43**	28.83**	-7.40**	21.82**	-14.43**	-6.23	-52.47**	-22.80**	-28.84**
NDMS 4A / OR-1547-9-1R	-38.68**	-19.84**	-9.17**	-9.62**	32.58**	-3.73	28.67**	-9.62**	-2.53	-50.59**	-50.84**	-54.68**
NDMS 4A / OR-1564-5R	0.29	5.79**	6.12**	1.39	31.31**	-4.64*	37.86**	1.39	-27.17**	-51.77**	50.45**	-38.15**
NDMS 4A / OR-1898-17R	7.75**	10.50**	-4.22**	-4.69**	36.54**	1.41	29.60**	-4.69*	-28.62**	-52.74**	20.11**	-50.62**
NDMS 4A / CR-792-B_4-2-1R	-3.91*	1.36	6.31**	1.57	45.43**	8.01**	42.89**	1.57	-3.98	-39.39**	125.72**	17.39**
NDMS 4A / IR-54112-B_2-CR-1-6-2R	27.35**	30.60**	9.47**	9.20**	4.27*	-1.34	53.64**	9.20**	2.89	-35.06**	62.30**	-15.60**
NDMS 4A / BARO-5-1-B-6-3-34-1-1-1-1R	4.27*	9.98**	2.35	-2.22	-18.60**	-22.98**	2.85	-2.22	-1.61	-48.43**	93.09**	-9.33**
NDMS 4A / RAU-1411-4R	19.13*	22.17**	-20.77**	-21.16**	6.57**	-19.68**	-17.08**	-21.16	6.01	-44.43**	10.68	-48.03**
NDMS 4A / IR 31917R	8.35**	30.45**	-12.26**	-16.17**	38.20**	4.16*	11.43**	-16.17**	3.15	-51.20**	-7.74	-56.96**
NDMS 4A / TTB-517-17-SBIR-67401-17-2R	-18.33**	-1.67	1.40	0.91	-0.54	0.49	34.13**	0.91	12.51**	-46.77**	135.33**	9.79**
NDMS 4A / TTB-517-17-SBIR-70149-35R	0.56	6.07**	12.10**	7.10**	-7.44**	-6.48**	17.71**	7.10**	17.73**	-43.21**	99.09**	3.64
NDMS 4A / CN-1035-36R	25.00**	28.19**	-5.37**	-5.83**	1.13	3.61*	3.50	-5.83**	0.09	-51.72**	12.43	-41.47**
NDMS 4A / CN-1045-6R	12.86**	19.05**	-0.37	-0.30	-7.82**	-5.56	-0.37	-0.30	-21.51**	-56.31**	17.26**	-9.00**
NDMS 4A / OR-1537-6R	14.73**	17.74**	-2.29	-2.22	14.48**	-0.97	-2.29	-2.22	-7.60*	-48.57**	-5.75	-26.86**
NDMS 4A / R-710-437-1-1R	-17.38**	6.53**	3.54	-1.08	7.70**	-6.84**	10.57**	-1.08	9.24**	-47.84**	-22.18**	-42.93**
NDMS 4A / IR 70R	-16.09**	8.21**	-7.36**	-7.81**	15.17**	-1.16	3.05	-7.81**	3.71	-50.48**	-15.32**	-37.90**
NDMS 4A / IR 600-76-1R	12.39**	18.55**	2.54	-2.04	-5.56**	-18.95**	15.37**	-2.04	-13.71**	-54.34**	-40.99	-60.35**
NDMS 4A / IR 55838-B-2-3-2-3R	-23.64**	-21.69**	-18.90**	-19.30**	-13.41**	4.16*	-4.96**	-19.30**	-7.92*	-51.27**	-23.89**	-48.86**
NDMS 4A / IR 21567-18-3R	5.54**	11.33**	-13.31**	0.00	-16.92**	-0.06	13.31**	0.00	1.85	-35.05**	-3.52	-10.56**
NDMS 4A / IR 10198-66-2R	3.55*	6.19**	-15.29**	-2.28	5.99*	-20.60**	-15.29**	-2.28	-13.41*	-44.78**	-41.86**	-46.10**
NDMS 4A / IR 65515-47-2-1-19R	27.26**	34.24**	-21.26**	-24.77**	32.19**	-0.97	0.52	-24.77**	-6.63*	-46.78**	-40.57**	-37.28**
NDMS 4A / R-971-2505-1R	-7.45**	-5.09**	-3.43	-3.90*	12.66**	1.23	28.40**	-3.90	-14.67**	-51.37**	-19.36**	-14.89**
NDMS 4A / UPRI 92-79R	15.64**	21.98**	3.16	-1.44	1.43	-8.86**	13.38**	-1.44	0.55	-46.26**	-32.94**	-52.56**
NDMS 4A / CSR 21R	-15.74**	-7.50**	-13.22**	-13.65**	-21.41**	-20.23**	-0.67	-13.65**	-10.93**	-52.39**	-41.14**	-58.35**
NDMS 4A / RP 2932-2528R	8.73**	14.69**	-19.69**	-21.34**	-29.90**	-28.85**	-19.69**	-21.34**	42.48**	-47.22**	-53.57**	-55.24**
NDMS 4A / JR 82-1-10R	-5.46**	-3.05	-27.73**	-28.08**	2.22	2.19	-26.57**	-28.08**	34.19**	-50.29**	-54.69**	-56.32**
Mean heterosis (%)	-3.76	12.12	-6.77	-6.94	17.59	-7.63	18.28	5.97	9.23	90.40	35.59	-42.25
No. of hybrids with significant + ve value	25	34	12	12	32	16	27	10	23	00	25	05
No. of hybrids with significant + ve value	27	16	24	20	15	19	13	17	15	60	24	43
Range heterosis	-43.88 -30.56	-31.98 -70.67	-30.94 -16.62	-28.08 -11.07	-29.90 -54.73	-28.85 -11.86	-30.94 -54.10	-28.08 -11.07	-28.62 -42.48	-56.31 -0.00	-54.69 -139.43	-60.35 -22.64

crosses over standard variety. Lesser spikelet sterility enhanced the yield of hybrids. (Nijaguna and Mahadevappa 1983). Heterosis with respect to 1000 grain weight was expressed in positive as well as in negative directions, which is in confirmity with the findings of Karunakaran 1968, Carnahan *et al*. 1972 and Srivastava and Sheshu 1982.

The better parent heterosis for grain yield plant^{-1} ranged from – 54.69 (NDMS 4 A /R 82-1-10R) to 139.43 (IR 58025A / RP 2932-2528R) per cent with the mean value of 35.59 per cent. Twenty five crosses exhibited better parent heterosis with significant positive value. The standard variety heterosis ranged from – 60.35 (NDMS 4A / IR 600-76-1R) to 22.64 (IR 58025 A / CR 792-B_4-2-IR) per cent. Only five crosses namely IR 58025 / NDRSB-96006R, IR 58025 A / CR-792-B_4-2-1R, IR 58025 A / TTB-517-17-SBIR-70149-35R, NDMS 4A / CR-792-B_4-2-1R, NDMS 4A / IR 31917R were significantly superior to the standard variety. Grain yield is a complex trait that is multiplicative end product of several attributes of yield. The perusal (Table 1) of the data indicated that heterosis for yield of most hybrids were due to increased heterosis in number of fertile spikelets panicle^{-1}, 1000 grain weight and panicle length. Increased yield in rice due to various component traits as observed in the present investigation is in close conformity the finding observed by the other workers-Karunakaran 1968, Maurya and Singh 1978.

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