Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(2): 327-330
Received: 26-01-2017
Accepted: 27-02-2017

Bineeta Devi
Institute of Agricultural Sciences, Bundelkhand University Jhansi- 284001, Uttar Pradesh, India

Correspondence
Bineeta Devi
Institute of Agricultural Sciences, Bundelkhand University Jhansi- 284001, Uttar Pradesh, India

Magnitude of heterosis in some inter - Varietal crosses of Rice (*Oryza sativa* L.)

Bineeta Devi

Abstract
Heterosis in rice was studied in a set of seven line and three testers with twenty one hybrids. The magnitude of heterosis varied from cross to cross for all the quantitative traits using L x T analysis. Among the parents, M1-10-29VL and TM07280 were the best performing parents for seed yield per plant and its components traits. Cross combinations IR777629-72-2-1-3 X IR64, Basmati 370 X CR2703, Sonam X NDR118 and IR7734-4-0 X CR2703 exhibited high significant effects with high *per se performance* and standard heterosis over PHB71. High magnitude of heterobltiosis and standard heterosis were observed for almost all characters. Cross combinations M1-10-29 VL X NDR118, Basmati 370 X CR2703, TM07280 X NDR118, IR77629 -72-2-1-3 X IR-64 and TM07280 X IR-64 exhibited highly significant heterosis over PHB71.

Keywords: Heterosis, inter- varietal crosses, LxT, rice (*Oryza sativa* L.)

1. Introduction

Rice is a most important food crop for developing world. It provides up to two third calories for more than two billion people in Asia. Rice is a staple food of two third of the population of the world. In global scenario, India ranked first in area and second in production of rice (Chougule *et al.* (2012) [1]. All the commercial rice hybrids are currently being based on Cytoplasmic Genetic Male Sterility (CGMS) system. Even though system is very stable excessive dependence on a single source of cytoplasm, cumbersome process of hybrid seed production and parental line development warrant the development of alternate approaches to exploit hybrid vigor. Heterosis breeding is one such possibility. Commercial exploitation of heterosis in rice is being exploited at present in all rice growing countries (Yuan (1994) [9]. The present study was an attempt to access the possibilities of commercial exploitation of heterosis and to identify hybrids which can through better significant in future generations.

2. Materials and Methods

The experimental material consisted of ten parents including seven lines, three testers and 21 hybrids derived through line x tester mating design at the Field Experimentation Center, Department of Genetics and Plant Breeding, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, U.P., during *Kharif*, 2013. The parents and their F_1 were grown for generating data pertaining to various quantitative traits. Observations were recorded from 10 randomly selected plants in each plot ten characters *viz*., days to 50 per cent flowering, plant height, no.of tillers per plant, no. of panicles per plants, panicle length, spikelets per panicle, days to 50 per cent maturity , harvest index, test weight and seed yield per plant . The data were subjected to statistical analysis done by computer package Widostat 9.1 version.

3. Results and Discussion

Heterosis expressed as percent increase or decrease in the mean value of F_1 hybrid over better parent (heterobeltiosis) and over standard check PHB71 (Standard heterosis) are presented in table 1 out of 21 crosses 20 crosses depicted significant negative heterosis for days to 50 per cent flowering. The spectrum of variation was from 17.12 (Basnmati 370 x IR-64) to 0.67 (Basmati 370 x NDR118). Out of 21 crosses, only one crosses (M1-10-29 VL x NDR118) showed Significant negative heterosis (-6.27). For plant height, the heterobeltiosis ranged from -11.38 (TM07280 x NDR 118) to 32.23 (TM07280 x IR-64). Six Crosses exhibited significant heterobeltiosis in negative direction. Standard heterosis ranged from -6.95 (OM6073 x IR 64) to 29.19 (IR77734-93-2-3-2 x CR 2703) against check PHB71, out of 21 Crosses, 6 crosses expressed significant and negative heterosis over the check PHB71. Heterotic effect over better parent for No. of Tillers per plant varied from -39.03 (IR77734-93-2-3-2 x NDR118) To

16.89 (IR77629-72-2-1-3 x CR2703). Heterotic effect over PHB71 varied from -29.68 (IR77734-4-03-2-02-1-3 x NDR118) to 18.00 (M1-10-29VL X NDR118). Out of 21 crosses 10 crosses were found with negative and significant percentage of heterosis over check PHB71. In case of no of panicles per plant the range of heterosis over better parent was found from -44.44 (Basmati 370 x IR-64) to 35.70 (Sonam x CR2703). Out of 21 crosses 9 crosses exhibited positive and significant heterobeltiosis. Heterosis over check PHB71 ranged from -33.12 (Basmati 370 x IR-64) to 46.53 (M1-10-29VL x NDR118). Only three crosses showed negative and significant heterosis over PHB71. The range of heterosis over better percent for panicle length depicted from -12.56 (Sonam x NDR118) to 24.78 (IR77629-72-2-1-3- x IR-64). From crosses showed negative and significant heterobeltiosis. The range of heterosis over check PHB71 were found from -13.09 (Sonam x NDR118) to 17.55 (IR77629-72-2-1-3 x IR-64). Five crosses exhibited negative and significant heterosis over check. For no. of spikelet per panicle, out of 21 crosses, 17 crosses depicted positive and significant heterobeltiosis and it ranged from -37.97 (OM6073 x NDR118) to 63.13 (IR77629-72-2-1-3 x IR-64). The range of heterosis over PHB71 were found from -49.77 (OM6073 x NDR118) to 21.07 (IR77629-72-2-1-3 x IR-64). Fourteen crosses showed negative and significant heterosis over check.

The spectrum of variation for heterobeltiosis in days to maturity was from -8.21 (Basmati370 x IR-64) to 9.56 (IR 77629-72-2-1-3 x IR-64). Out of 21 crosses 9 crosses were found negative and significant. The heterosis over check ranged from -1.36 (IR77734-93-2-3-2 x NDR118) to 10.05 (IR77734-93-2-3-2 x IR-64). Eleven crosses were found with positive and significant heterosis over check. For harvest index only two crosses TM07280 X NDR118 (21.11%) and TM07280 x CR2703 (16.46) exhibited significant and positive heterosis over better parent. Heterosis over better parent range from -58.47 (IR77734-93-2-3-2 X NDR118) to 21.11 (TM07280 x NDR118). With respect to standard check PHB71, the ranged was from -52.90 (IR77734-93-2-3-2 x NDR118) to 17.55 (M1-10-29VL x NDR118). As many as two crosses expressed significant and positive heterosis over check PHB71. For test weight, out of 21 crosses, 8 crosses were found with positive and significant heterobeltiosis. The range varied from -21.96 (IR77629-72-2-1-3 x NDR118) to 52.57 (TM07280 x NDR118). Five crosses depicted positive and significant heterosis over check PHB71. The percentage of heterosis over check ranged from -13.57 (IR77629-72-2-1-3 x NDR118) to 35.46 (M1-10-29VL x CR2703). In case of seed yield, heterosis over better parent varied from – 62.61 (IR77734-93-2-3-2 x NDR118) to 60.52 (TM07280 x NDR118). Out of 21 crosses, three crosses exhibited positive and significant heterosis over better parent. The heterosis over check PHB71 varied from -45.75 (IR77734-93-2-3-2 x NDR118) to 45.65 (M1-10-29VL x NDR118). Out of 21 crosses, ten crosses were found with positive and significant heterosis ove check PHB71.

Out of 21 hybrids tested, 8 hybrids exhibited significant positive heterosis over their respective better parental values, while 10 crosses showed significant positive heterosis over standard check PHB71 for seed yield per plant. This revealed seed yield per plant was one of the most heterotic traits. Panicle length was found to be emerged as the first heterotic trait, because out of 21 crosses, 17 and 16 crosses showed significant positive desirable heterosis over the better parent and check PHB71, respectively. The second important trait was no. of spikelets per panicle which showed 17 positive heterosis over better parent , no. of tillers per plant (11 crosses) and no. of panicle per plant (18 crosses) were also found as the strong traits. On the basis of number of heterotic crosses in a trait, the trait like panicle length, no. of spikelet per panicle, seed yield per plant and no. of panicles per plant were categorized as possessing high heterosis, no. of tillers per plant under moderate heterosis and remaining all traits under low heterosis.

Significant positive heterosis for seed yield per plant has been reported by Durai (2002) [2] significant and positive heterosis for no.of tillers per plant was observed by Patil *et al* (2003) [3] and Suresh *et al*. (2000) [8]. Ramalingan *et al*. (2001) [5] observed significant positive heterosis for harvest index. Suresh *et al*. (2000) [8] significant positive heterosis for test weight, number of tiller per plant and harvest index. The negative heterosis for days to 50% flowering was reported by Singh and Kumar (2004) [7], for plant height by Peng and Virmani (1991) [4]. Singh and Babu (2012) [6] also observed the heterosis for various traits in various crosses in desirable direction. Thus the result obtained in the present study are in to the result reported by the above workers.

Six crosses which exhibited significant and positive heterosis over check PHB71 for seed yield per plant have been shown in table 2. As heterosis above 15 percent is considered to be commercially exploitable. The heterosis for seed yield per plant was associate with heterosis for harvest index (3 crosses), test weight (4 crosses), plant height (2 crosses) , no.of spikelet per spike (3 crosses), panicle length (2 crosses), no.of panicle per plant (single crosses), no.of tillers per plant (single cross) and days to maturity (single cross). It was evident that all the yield contributing traits did not contribute equally followed heterosis for seed yield per plant. For instance the cross M1-10-29VL x NDR118 with highest mean value as well as standard heterosis was associated with only five yield contributing traits i.e. days to maturity, no.of tillers per plant, no.of panicles per plant, harvest index and test weight. Similarly, cross Basmati 370 x CR2703 with higher seed yield per plant and heterosis was associated with three component traits viz., plant height, harvest index and test weight, however most of the heterotic crosses for seed yield were accompanied by heterosis for two or three component traits. This indicated that heterosis for seed yield in rice was associated with heterosis due to no. of spikelets per panicle test weight harvest index and panicle length. This was due to the fact that all the component characters are responsible for some total of metabolism substances produced by the plant and conditions, which for the development of one component, could have adverse effect on the other. Further all the heterotic crosses had close correspondence with mean value. Which suggested that per se performance of hybrids could be considered for using heterosis for seed yield.

A comparative study of six crosses with higher sca, gca effects of parents, heterosis over PHB71 and significant desirable heterosis and sca effects for other traits is presented in table 3. All the crosses in this comparison with high sca effects for seed yield per plant had also desirable and significant sca effects for other traits like panicle length, harvest index, plant height and no. of spikelets per panicle. The component traits panicle length and harvest index (There crosses) were found to be associated with maximum number of crosses possessing desirable and significant sca effects for seed yield per plant, followed by plant height and spikelets per panicle (two crosses). All the cross combinations with significant sca effects for all the component traits. Which suggested that at least significant and desirable sca effects of to three component traits resulted in significant sca effect for seed yield. Similar result have been reported by Ramalingam *et al.* (2001) [5] and Patil *et al.* (2003) [3], it was further noticed that out of 6 cross combinations. Two crosses had at least one parent as a good general combiner (Table -3).

Among the four crosses which depicted highly significant positive sca effects for seed yield per plant three crosses viz, IR77629-72-2-1-3 x IR-64, Basmati 370 x CR 2703 and Sonam x NDR118 showed high *per be performance* and high standard heterosis over PHB71 (Table 3) this suggested that high sca effects for seed yield are not necessarily associated with high heterotic effects. The cross combinations Basmati 370 x CR2703 and IR77734-93-2-3-2 x CR2703. had high sca effects for sed yield per plant high standard heterosis over the check these crosses may be exploited to obtain early desirable sergeants for seed yield by restoring pedigree breeding technique.

Table 1: Heterosis over better parents (BP) and standard check (SC) for ten characters.

Cross	Days to 50% flowering		Plant height (cm)		No. Of Tillers / plant		No. Of Panicles / plant		Panicle length (cm)	
	Better Parent	PHB71	Better Parent	PHB71	Better Parent	PHB71	Better Parent	PHB71	Better Parent	PHB71
Basmati 370*CR2703	-8.92**	9.23**	-2.50*	-3.13**	-20.83**	-21.41**	-25.13**	-9.87	-7.93*	-4.29
Basmati 370*IR-64	-17.12**	1.85	6.61**	5.93**	-27.70**	-28.22**	-44.44**	-33.12**	-11.46**	-7.96*
Basmati 370*NDRI118	0.67	11.44**	17.14**	25.10**	-12.66*	0.73	-7.41	11.46	3.73	7.83*
IR77734-93-2-3-2*CR2703	-11.08**	6.64*	27.76**	29.19**	-22.27**	-18.49**	-27.40**	-16.88	11.80**	15.95**
IR77734-93-2-3-2*IR-64	-7.81**	13.28**	14.54**	15.82**	-21.11**	-17.27**	-29.07**	-18.79*	-12.20**	-8.94*
IR77734-93-2-3-2*NDRI118	-11.33**	1.11	-5.17**	1.28	-39.03**	-29.68**	-30.65**	-17.83	3.28	7.12
IR77629-72-2-1-3*CR2703	-11.69**	5.90*	12.02**	9.70**	16.89*	6.08	10.85	4.14	6.47	0.30
IR77629-72-2-1-3*IR-64	-15.02**	4.43	12.61**	7.66**	0.30	-2.14	-1.33	9.04	24.78**	17.55**
IR77629-72-2-1-3*NDR118	-16.15**	-0.37	7.59**	14.90**	-19.62**	-7.30	-12.10	4.14	22.11**	15.04**
M1-10-29VL*CR2703	-14.15**	2.95	8.89**	6.63**	5.07	13.38*	-15.92*	10.51	-3.53	-3.55
M1-10-29VL*IR-64	-15.92**	3.32	-3.15**	-6.83**	-23.34**	-17.27**	-33.12**	-12.10	-0.25	-0.26
M1-10 -29VL*NDR118	-8.30**	-6.27*	-4.84**	1.63	2.32	18.00**	11.49	46.53**	-6.67	-6.69
OM6073*CR2703	-8.62**	9.59**	9.61**	12.38**	-0.54	-9.73	-1.36	-7.32	-9.64*	-4.19
OM6073*IR-64	-14.11**	5.54*	-9.24**	-6.95**	-0.12	-2.55	-1.99	8.31	-5.59	0.10
OM6073*NDR118	-5.32*	5.17*	7.62**	14.93**	-31.22**	-20.68**	-23.39**	-9.24	-1.69	4.24
Sonam*CR2703	-11.08**	6.64*	3.59**	6.76**	-26.51**	-25.79**	-35.70**	-19.11*	17.51**	16.80**
Sonam*IR-64	-12.61**	7.38**	-7.30**	-4.47**	-20.72**	-19.95**	-29.87**	-11.78	-7.23	-7.79*
Sonam*NDR118	-10.86**	2.95	-10.69**	-4.63**	-1.05	14.11*	-8.10	15.61	-12.56**	-13.09**
TM07280*CR2703	-9.85**	8.12**	22.51**	19.97**	-34.48**	-20.92**	-28.85**	-5.73	11.05**	4.04
TM07280*IR-64	-10.81**	9.59**	32.23**	18.31**	-18.95**	-2.19	-13.65	14.39	15.21**	7.94*
TM07280*NDR118	-12.58**	2.58	-11.38**	-5.36**	-22.18**	-6.08	-11.54	17.20	-2.40	-8.56*

*Significant at 5% level; **significant at 1% level

Cross	No. of Spikelets /panicle		Days to maturity		Harvest index %		Test weight (g)		Seed yield/ plant (g)	
	Better Parent	PHB71	Better Parent	PHB71	Better Parent	PHB71	Better Parent	PHB71	Better Parent	PHB71
Basmati 370*CR2703	-11.49**	-32.41**	-5.47**	3.26**	0.10	0.02	9.50*	11.10**	5.94	37.30**
Basmati 370*IR-64	-2.70**	-25.70**	-8.21**	0.27	-32.73**	-30.30**	20.41**	18.23**	-11.64*	-5.78
Basmati 370*NDR118	44.12**	16.69**	-3.48**	5.43**	-14.56*	-24.96**	-0.45	-2.26	-19.51**	-14.18*
IR77734-93-2-3-2*CR2703	-16.03**	-36.63**	-2.31*	3.53**	-23.67**	-13.43*	3.83	6.19	-26.17**	7.13
IR77734-93-2-3-2*IR-64	21.82**	-8.06**	3.85**	10.05**	-36.33**	-27.80**	4.04	6.41	-41.04**	-14.45*
IR77734-93-2-3-2*NDR118	12.49**	-8.92**	-6.92**	-1.36	-58.47**	-52.90**	-5.06	-2.90	-62.61**	-45.75**
IR77629-72-2-1-3*CR2703	21.00**	-10.20**	0.00	0.54	-42.28**	-42.32**	-16.76**	-7.81*	-43.11**	-26.26**
IR77629-72-2-1-3*IR-64	63.13**	21.07**	9.56**	8.97**	-9.59	-6.32	4.04	15.22**	51.27**	30.43**
IR77629-72-2-1 3*NDR118	24.45**	0.77*	2.14*	3.53**	-2.76	-14.61**	-21.96**	-13.57**	4.87	-14.68*
M1-10-29VL*CR2703	-49.69**	-39.86**	-2.93**	-1.09	-33.57**	-25.98**	33.51**	35.46**	-25.57**	6.98
M1-10-29VL*IR-64	-33.90**	-20.98**	-2.67**	-0.82	-41.89**	-35.26**	-1.39	-4.15	-46.15**	-22.60**
M1-10-29VL*NDR118	-16.48**	-0.15	-0.80	1.09	5.51	17.55**	9.00*	5.95	1.33	45.65**
OM6073*CR2703	-8.74**	-32.27**	0.52	4.08**	-19.84**	-19.90**	-4.04	2.00	-22.84**	0.00
OM6073*IR-64	35.40**	0.49	4.72**	8.42**	-12.56*	-9.41	-5.97	-0.05	1.50	-12.48*
OM6073*NDR118	-37.97**	-49.77**	-4.46**	-1.09	8.25	-4.93	-3.49	2.59	7.08	-12.88*
Sonam*CR2703	-5.86**	-15.13**	-1.85*	0.82	-9.23	-9.30	5.85	7.40	-36.01**	-17.07**
Sonam*IR-64	-30.29**	-37.15**	-1.32	1.36	-48.55**	-46.69**	-1.54	-4.50	-32.38**	-37.23**
Sonam*NDR118	-9.86**	-18.74**	1.59	4.35**	-12.11*	-22.81**	0.34	-2.80	7.30	-0.40
TM07280*CR2703	36.58**	1.36**	-0.80	1.09	16.46**	16.37**	0.69	2.16	4.63	35.61**
TM07280*IR-64	44.80**	7.46**	0.27	2.17*	3.98	7.74	8.25**	5.00	44.16**	24.30**
TM07280*NDR118	-31.71**	-44.71**	1.33	3.26**	21.11**	6.36	52.57**	25.21**	60.52**	30.60**

*Significant at 5% level; **significant at 1% level

Table 2: Comparative study of six most heterofic cross for seed yield for mean, heterosis over PHB71 and desirable heterosis for other traits.

Crosses	Grain yield per Plant (Mean)	Heterosis over PHB71	Desirable heterosis for other traits
M1-10-29VL X NDR 118	19.48	45.65**	DM,TP,PP,HI,TW
Basmati 370 X CR2703	18.37	37.30**	PH,HI,TW
TM07280 X CR 2703	18.14	35.61**	SP,HI
TM07280 X NDR118	17.47	30.60**	PH,TW
IR 777629-72-2-1-3 X IR-64	17.40	30.43**	PL,SP,TW
TM07280 X IR-64	16.63	24.30**	PL,SP

** significant at P=0.01

DM- Days to maturity, PH- Plant height, TP-tillers per plant, PP- Panicles per plant, HI- Harvest index, TW-Test weight, SP- Spikelet per panicle, PL- Panicle length.

Table 3: Comparative study of four crosses with higher sca, gca effect of parents, heterosis over PHB71 and significant desirable heterosis and sca effect for other traits.

Crosses	Heterosis over PHB71	sca effects	gca effects	Desirable heterosis for other traits	Desirable sca effects for other traits
IR77629-72-2-1-3 X IR-64	30.43**	5.22**	P-P	DF,TP,PH,PL,SP,TW	PL,SP,TW
Basmati 370 X CR 2703	37.30**	3.35**	A-G	DF,PL,SP,DM,TW	PH,PL,HI
Sonam X NDR118	18.43**	2.57**	P-P	DF,PH,TW	TP,SP
IR77734-93-2-3-2X CR2703	7.13	2.45**	P-G	DF,PH,PP,PL,SP,DM	PH,PL,HI

** Significant at P=0.1

G=good, A=average, P=poor, DF= days to flowering, DM= days to maturity, PH=plant height, TP= tillers per plant, PL= panicle length, SP=spikelet per panicle, TW= test weight, HI= harvest index, PP=panicles per plant.

4. Acknowledgement
The authors are very thankful to Hon'ble Vice- Chancellor and Directorate of Research, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed –To-Be-University), Allahabad to provide all the facilities for completion of this experiment.

5. References
1. Chougle GR, Mehta HD, Patil SA. Heterosis for qualitative and quantitative traits in rice (*Oryza sativa* L.) Crop Res. 2012; 44(3):389-390.
2. Durai AA. Heterosis for physiological traits in hybrid rice (*Oryza sativa* L.). Indian J Genet and Pant. Breed. 2002; 62(4):331-333.
3. Patil DV, Thiyagrajan K, Pushpa K. Combining ability of parents for yield and yield contributing traits in two line hybrids rice (*Oryza sativa* L.). Crop Research. 2003; 25(3):520-524.
4. Peng JY, Virmani SS. Heterosis in some intervarietal crosses of rice Oryza. 1991; 28:31-36.
5. Ramalingam J, Nadrayan N1, Vanniarayan C. Heterosisability involving cytoplasmic male sterile lines in rice. Mdras Agric. J. 2001; 87(1-3):140-141.
6. Singh CM, Babu GS. Magnitude of heterosis and combining ability in relation to yield and some morphological traits for improvement of upland rice (*Oryza sativa* L.). Madras Agric. J. 2012; 99(7-9):447-453.
7. Singh NK, Kumar A. Combining ability analysis to indentify suitable parents for heterosis rice hybrid breeding. IRRN. 2004; 29(1):21-22
8. Suresh S, Paramasivan KS, Muppidathi N. Study of heterosis for yield componenets in rice. Madras Agric J. 2000; 86(7-9):520-522
9. Yuan LP. Increasing yield potential in rice by exploitation of heterosis. In: Virmani, S.S. (ed.) Hybrid rice technology: New development and future prospects. Los Banos, Philippines: International Rice Research Institute, 1994, 1-6.