Madras Agric. J. 90 (10-12) : 633-636 October-December 2003

https://doi.org/10.29321/MAJ.10.A00150

Heterosis for yield and yield attributes in aromatic rice

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Abstract: Twenty five aromatic rice hybrids developed by line x tester mating design involving 8 scented and 2 non-scented parents were evaluated for heterosis over mid parent, better parent and standard variety, Pusa Basmati 1 for nine yield components. All the 25 hybrids exhibited significant negative heterobeltiosis for plant height and significant positive heterosis over mid parent, better parent and standard check for tiller number. IR 64/HBC 85, IR 64/Basmati 6129, PR 109/Basmati 410 and PK 1379-9-1-1/Basmati 6129 manifested high average heterosis, heterobeltiosis and standard heterosis for grain yield per plant. From this study it is revealed that heterosis for grain yield was mainly because of simultaneous manifestation of heterosis for tillers number, panicle length, fertile grains per panicle, total spikelets per panicle and test weight.

Key words : Rice, Heterosis, Line x Tester, Yield components.

Introduction

The Indian sub continent is blessed with rich diversity of basmati types and best source for aromatic rice trade which fetches three times higher price than the non-scented rice in domestic as well as in international markets. Majority of the exportable basmati varieties are of traditional type and low yielders. Eventhough some high-yielding dwarf basmati varieties were released through co-ordinated research efforts, they could not replace the traditional varieties to the full extent, indicating the need to develop better types. Information on the magnitude of hybrid vigour is a pre-requisite in the development of hybrids or varieties with desirable traits. The success of hybrid rice programme depends upon the magnitude of heterosis which also helps in the identification of potential cross combinations to be used in the conventional breeding programme to create wide array of variability in the segregating generations.

Materials and Methods

Eight aromatic, fine grained rice varieties/lines viz. HBC 85, Karnal Local Basmati 410, Basmati 6129, PGB, Gaurav, IR 62874-88-1-1 and PK 1379-9-1-1 and two popular high yielding non scented varieties (IR 64 & PR 109) were crossed among themselves in a line x tester mating design during Kharif 1998 at Directorate of Rice Research (DRR) farm to obtain 25 hybrids. All these F_1's along with their parents and one standard dwarf basmati variety Pusa Basmati 1 were evaluated in a randomized block design with 2 replications during *Kharif* 1999 at DRR farm, Hyderabad. Standard cultural practices and need based plant protection measures were undertaken to raise the crop. Observations for 8 yield and yield related traits *viz.* plant height, tiller number, panicle length, fertile grains/panicle, sterile grains/panicle, total spikelets/panicle, test weight and grain yield/plant were taken on 10 randomly selected plants per replication by following standard methods. Sterility percentage was calculated as the percentage ratio of sterile grains per panicle to the total number of grains per panicle. Heterosis was expressed as percentage increase or decrease of F_1, as heterosis over mid parent (average heterosis), over better parent (heterobeltiosis) and over standard check variety Pusa Basmati 1 (standard heterosis).

Results and Discussion

Shorter plant type is an important character of hybrid to withstand lodging. Nguyen Van Luat *et al.* (1985) observed negative heterobeltiosis for plant height. In the present study also all the 25 hybrids exhibited significant negative heterosis over better parent indicating that hybrids had lower plant height than the parents (Table). IR 62874-88-2-1/Karnal Local was the shortest of all hybrids recording -15.2%, -27.3% and 8.1% mean heterosis, heterobeltiosis and standard

Table. Estimates of heterosis (h) heterobeltiosis (h^1) and standard heterosis (h^2) of 25 hybrids for yield and yield components

Cross combination	Plant height (cm)			Tiller number			Fertile grains panicle^{-1}			Sterile grains panicle^{-1}		
	h	h^1	h^2	h	h^1	h^2	h	h^1	h^2	h	h^1	h^2
IR 64/HBC 85	-4.6**	-20.1**	0.09	116.0**	107.7*	100.3**	42.3**	23.4**	-0.5	-2.1	-38.8**	22.8
IR 64/Karnal Local	-3.3**	-19.8**	1.4	121.9**	114.5**	104.8**	-57.8**	-66.3**	-72.8**	525.1**	311.4**	555.3**
IR 64/Bas 410	8.1**	-11.5**	15.7**	114.9**	108.7**	85.9**	-55.4**	-56.6**	-65.0**	852.8**	547.2**	80.8.6**
IR 64/Bas 6129	-3.7**	-18.7**	-1.7	78.5**	74.0**	55.0**	67.9**	47.6**	19.1**	-41.3**	-58.5**	-49.3**
IR 64/PGB	2.6*	-6.1**	-5.9**	98.9**	96.1**	79.7**	11.5**	8.7**	-7.7**	37.2	-8.6	38.1*
Gaurav/HBC 85	-9.1**	-23.2**	-4.7**	106.1**	102.0**	94.9**	-72.9**	-76.4**	-81.2**	236.8**	155.1**	411.9**
Gaurav/Karnal Local	-10.2**	-24.7**	-4.7**	119.4**	116.2**	106.4**	-81.2**	-84.9**	-88.0**	460.3**	362.0**	635.8**
Gaurav/Bas 410	-11.9**	-27.1**	-4.7**	139.6**	128.5**	111.6**	-50.5**	-51.5**	-61.4**	233.2**	189.2**	306.0**
Gaurav/Bas 6129	-3.2**	-17.3**	0.0	137.7**	127.8**	110.9**	-22.7**	-31.7**	-45.7**	403.5**	364.8**	467.9**
Gaurav/PGB	1.0	-6.9**	-6.7**	119.5**	118.4**	102.3**	-31.4**	-33.6**	-43.6**	191.9**	145.8**	271.2**
PR 109/HBC 85	-12.1**	-25.7**	-7.8**	101.6**	96.7**	89.7**	-46.8**	-53.9**	-62.7**	216.2**	144.7**	391.1**
PR 109/Karnal Local	-9.0**	-23.6**	-3.3**	94.3**	90.4**	81.9**	-36.4**	-74.2**	-79.2**	408.3**	329.7**	584.3**
PR 109/Bas 410	-14.9**	-24.6**	-1.4	111.2**	103.5**	86.5**	16.2**	13.1**	-8.6**	86.2**	66.0**	133.0**
PR 109/Bas 6129	-13.8**	-26.3**	-10.9**	152.9**	144.9**	124.4**	-58.5**	-61.4**	-68.8**	311.9**	291.3**	378.1**
PR 109/PGB	-4.2**	-11.1**	-10.9**	95.4**	96.5**	80.1**	-36.4**	-37.9**	-47.3**	134.8**	102.9**	206.3**
IR 62874-88-2-1 HBC 85	-13.8**	-25.5**	-7.6**	79.2**	70.6**	64.0**	-81.4**	-82.9**	-87.9**	162.1**	154.3**	410.3**
IR 62874-88-2-1 /Karnal Local	-15.2**	-27.3**	-8.1**	83.3**	74.6**	66.7**	-94.4**	-95.3**	-96.7**	132.4**	114.3**	304.4**
IR 62874-88-2-1 /Bas 410	-13.9**	-27.2**	-4.9**	119.3**	116.1**	86.9**	-86.3**	-86.8**	-89.9**	181.4**	145.4**	363.2**
IR 62874-88-2-1 /Bas 6129	-12.7**	-23.7**	-7.8**	87.5**	85.9**	60.8**	-89.3**	-90.1**	-93.0**	138.5**	96.5**	270.9**
IR 62874-88-2-1 /PGB	-13.5**	-17.8**	-17.6**	94.1**	88.6**	72.8**	-89.2**	-90.1**	-91.6**	112.8**	91.5**	261.5**
PK 1379-9-1-1/ HBC 85	-13.1**	-21.9**	-3.2**	91.3**	81.0**	77.5**	-74.8**	-77.8**	-82.7**	108.9**	87.0**	276.8**
PK 1379-9-1-1/ Karnal Local	-13.3**	-22.8**	-2.3**	90.3**	83.9**	75.6**	-72.4**	-77.7**	-82.6**	186.6**	186.0**	357.4**
PK 1379-9-1-1/ Bas 410	-14.2**	-24.7**	-1.5	98.1**	98.6**	71.4**	-71.1**	-72.0**	-78.2**	188.1**	170.6**	332.8**
PK 1379-9-1-1/ Bas 6129	-11.1**	-19.2**	2.4**	128.4**	123.1**	98.7**	32.3**	17.9**	-7.9**	67.6**	47.8**	136.4**
PK 1379-9-1-1/ PGB	-8.5**	-9.2**	-8.9**	108.2**	105.3**	88.1**	-55.9**	-57.7**	-64.0**	148.1**	141.2**	285.8**

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

Table. Estimates of heterosis (h) heterobeltiosis (h¹) and standard heterosis (h²) of 25 hybrids for yield and yield components

Cross combination	Total spikelets panicle⁻¹			Grain yield plant⁻¹			Test weight			Sterility percentage		
	h	h¹	h²	h	h¹	h²	h	h¹	h²	h	h¹	h²
IR 64/HBC 85	33.8**	32.5**	2.6	297.9**	218.4**	138.5**	15.3**	7.1**	8.1**	-28.4**	-55.3**	16.7
IR 64/Karnal Local	44.3**	29.4**	0.2	21.3**	-3.8	-28.6**	13.0**	6.1**	7.1**	319.9**	153.3**	545.1**
IR 64/Bas 410	69.1**	62.3**	36.7**	38.1**	34.7**	0.9	11.9**	5.4**	6.4**	469.9**	297.5**	550.5**
IR 64/Bas 6129	52.9**	44.1**	11.6**	259.7**	235.2**	151.0**	8.6**	4.9**	5.9**	-61.9**	-74.1**	-54.6**
IR 64/PGB	15.6**	5.7**	-1.2	122.4**	102.3**	67.3**	2.5	0.2	1.2	19.7	-16.3*	35.4**
Gaurav/HBC 85	-4.3	-8.2**	-24.2**	-20.6*	-36.8**	-52.1**	4.8*	-0.8	-3.7*	238.6**	149.9**	552.4**
Gaurav/Karnal Local	32.5**	15.6**	-4.6	-55.8**	-65.1**	-73.6**	1.6	-3.0	-5.9*	300.5**	197.9**	658.8**
Gaurav/Bas 410	-1.8	-2.8	-18.1**	88.6**	80.7**	37.0**	3.7	-0.5	-3.4*	243.2**	202.0**	394.2**
Gaurav/Bas 6129	51.2**	38.3**	14.2**	114.5**	98.7**	50.6**	5.7*	3.8*	0.7	231.6	183.4**	396.0**
Gaurav/PGB	5.4	-0.7	-7.2**	55.2**	48.2**	22.6**	2.6	2.3	-0.7	187.6**	154.3**	311.3**
PR 109/HBC 85	12.2**	6.3*	-9.8**	40.9**	8.8	-10.0	4.8*	-1.0	-3.4*	175.1**	105.9**	437.4**
PR 109/Karnal Local	33.9**	15.5**	-2.0	25.3*	4.1	-20.7*	9.0**	3.5*	1.0	256.9**	169.4**	586.1**
PR 109/Bas 410	28.0**	27.5**	8.2**	210.0**	189.9**	139.7**	12.6**	8.3**	5.6*	44.1**	29.1**	111.4**
PR 109/Bas 6129	8.6*	-1.9	16.7**	11.5	-0.6	-17.8**	5.1*	3.3*	0.7	275.1**	227.0**	472.3**
PR 109/PGB	-7.6*	-11.8**	-17.6**	52.0**	52.0**	25.7**	7.6**	7.0*	4.4*	153.8**	128.6**	269.8**
IR 62874-88-2-1 HBC 85	-12.6**	-16.9**	-30.1**	-36.9**	-48.2**	-63.7**	8.1**	2.1	-1.2	198.0**	174.9**	617.6**
IR 62874-88-2-1 /Karnal Local	-31.3**	-40.6**	-50.0**	-81.4**	-84.9**	-89.4**	-1.1	-5.5*	-8.5**	230.8**	208.6**	686.0**
IR 62874-88-2-1 /Bas 410	-24.9**	-24.9**	-36.8**	-45.9**	-46.3**	-61.8**	2.1	-1.7	-4.9*	272.4**	224.4**	615.5**
IR 62874-88-2-1 /Bas 6129	-34.7**	-40.8**	-50.2**	-60.2**	-61.8**	-73.2**	0	-1.4	-4.6*	264.7**	227.0	621.3**
IR 62874-88-2-1 /PGB	-44.3**	-47.0**	-50.5**	-57.9**	-61.1**	-67.8**	-1.0	-1.1	-4.3	274.2**	224.2**	615.1**
PK 1379-9-1-1/ HBC 85	-29.0**	-33.7**	-42.0**	5.96	-14.3	-37.6**	18.1**	10.8**	9.1**	182.2**	140.5**	527.7**
PK 1379-9-1-1/ Karnal Local	-7.9*	-21.6**	-31.4**	-20.6	-36.4**	-53.7**	10.6**	4.4*	2.8*	195.1**	154.0**	546.8**
PK 1379-9-1-1/ Bas 410	18.9**	-20.4**	-30.3**	-13.5	-14.5	-37.7**	8.4**	3.8*	2.2	252.9**	233.7**	513.3**
PK 1379-9-1-1/ Bas 6129	39.3**	24.1**	8.7**	236.8**	219.4**	132.6**	16.3**	14.3**	12.6**	19.6	16.7*	114.5**
PK 1379-9-1-1/ PGB	-15.2**	-17.9**	-23.2**	11.4	4.8	-13.3**	7.1**	5.8*	4.2*	186.8**	169.6**	395.4**

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

heterosis respectively. For tiller number, all the 25 hybrids expressed significant and positive heterosis over mid, better and standard parents. PR 109/Basmati 6129 followed by Gaurav/Basmati 410 and Gaurav/Basmati 6129 recorded maximum heterosis for tillers. Obviously more number of productive tillers per plant would contribute to high yield. Rao *et al.* (1996) reported highly significant heterotic effect over better and standard parents with respect to tiller number per plant which are in accordance with the present results. However, a hybrid with longer panicle length is desirable, since the spikelets attached to primary and secondary branch would increase proportionately with the enhancement of panicle length. In the present study, out of 25, 13 hybrids exhibited positive and significant mean heterosis while 7 F_1's manifested positive and significant heterobeltiosis for panicle length. IR 64/Basmati 410 showed highh mean heterosis and heterobeltiosis to the extent of 26.9% and 20.9% respectively for panicle length. Interestingly all the crosses which had Basmati 410 as tester parent manifested high heterosis for panicle length. Total spikelets/panicle is one of the most important characters which directly influences the yield improvement. Among 25 hybrids tested, 13, 11 and 6 F_1's exhibited significant and positive heterosis, heterobeltiosis and standard heterosis respectively for fertile grains per panicle. Five cross combinations *viz.* IR 64/HBC 85, IR 64/ Basmati 6129, IR 64/PGB, PR 109/Basmati 410 and PK 1379-9-1-1/Basmati 6129 had positive heterosis over mid and parents for fertile grains per panicle as well as for total spikelets per panicle. Pandey *et al.* (1995) also reported high heterosis for panicle length and grains/ panicle. Rao *et al.* (1985), Prakash & Mahadevappa (1987) attributed low grain yield of hybrids primarily due to high spikelet sterility and this was the reason for most of the hybrids not showing significant positive heterosis for grain yield. Thus, any attempt to reduce spikelet sterility in the hybrids would be of utmost important in improving the grain yield substantially. In the present investigation, some hybrids with lower number of chaffy grains/panicle and spikelet sterility could be isolated based on highly significant and negative heterosis. IR 64/Basmati 6129 with heterobeltiosis and standard heterosis to the extent of -58.5% and -49.3% respectively could be isolated for its low chaffy grains/panicle Positive and significant heterosis over mid, better and standard parents were observed in 9 hybrids for test weight. Some of the hybrids possessing high heterosis for this trait include IR 64/ HBC 85, PK 1379-9-1-1/HBC 85 and PK 1379-9-1-1/Basmati 6129. Out of 25, 9 F_1s revealed average heterosis, heterobeltiosis and standard heterosis for grain yield per plant. To have practical value, standard heterosis is more important and it ranged from 22.6 to 151 per cent in this study. IR 64/Basmati 6129 showed maximum heterosis, heterobeltiosis and standard heterosis to the extent of 259.7, 235.2 and 151 per cent respectively for grain yield. Pandey *et al.* (1995) reported that the range of heterosis for seed yield per plant was -96.7 to 258.2% over better parent, -96.1 to 68.2% over mid parent and -96.3 to 301.6% over standard variety parent and. Four hybrids *viz.* IR 64/HBC 85, IR 64/Basmati 6129, PR 109/Basmati 410 and PK 1379-9-1-1/Basmati 6129 had high heterosis for grain yield per plant. All these hybrids manifested negative heterosis for plant height and positive heterosis for number of tillers, panicle length fertile grains/panicle, total spikelets/panicle and test weight which contributed for grain yield Hence these hybrids need to be exploited further to grain yield to develop heterotic hybrids for yield.

References

Nauyen Van Luat, Babin Bong and J. Chandra Mohan (1985). Evaluation of F1 hybrid on the Cuu long delta, *Vietnam I. IRRN* **10**: 19.

Pandey, M.P., Singh, J.K. and Harpal Singh, I (1995). Heterosis breeding for grain yield and other agronomic characters in rice. *Indian J. Genet.* **55**: 438-445.

Prakash, B.G. and Mahadevappa, M. (1987). Evaluation of some rice hybrids for field performance and standard heterosis. *Oryza* **24**: 75-78.

Rao, I.N., Rao, G.M., Murthy, P.S.S. and Seetha Raman, K.V. (1985). Performance of IRRI hybrid rices in Andhra Pradesh. *IRRN* **10**: 8.

Rao, A.M., Ramesh, S., Kulkarni, R.S., Savitharama D.L. and Madhusudan, K. (1996). Heterosis an combining ability in rice. *Crop Impro* **23**: 53-56.

(Received: September 2002; Revised: January 2003)