Heterosis studies in bitter gourd (*Momordica charantia* L.) for yield and yield related attributes

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SUMMARY

An experiment was carried out during 2008-09 at Vegetable section, Division of Horticulture, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore on heterosis studies in bitter gourd for yield and yield related attributes by using six lines and four testers in line x tester mating design. The parents Panurthy, Coimbatore Long and VRBT-100 were observed to be top performing parent for fruit yield per vine. The negative heterosis which was desirable for days to first male and female flower appearance, number of node at first female flower appears, days to first harvest, days to fifty per cent flowering, number of seeds per fruit, were common in most of the cross. Appreciable heterosis was recorded over better parent and standard parent for all the traits studied. The hybrids Coimbatore Long x Panurthy, VRBT-100 x Panurthy and Green Long x Panurthy were recorded to be three best performing F$_1$ hybrids for fruit yield per vine with an yield of 2.32, 2.19 and 2.06 kg and also these hybrids exhibited higher standard parent heterosis of 55.10, 46.90 and 37.65 per cent, respectively. These hybrids can be commercially exploited for higher yield.

Among the cultivated cucurbits, bitter gourd (*Momordica charantia* L.) is one of the most important vegetable grown throughout the country for its high nutritive value and medicinal properties. In our country, a wide range of variability in vegetative and fruit characters is available in this crop. But unfortunately very little attention has been paid for its general improvement by using wild genotypes. A speedy improvement can be brought about by assessing the genetic variability and exploitation. The heterosis is much easier in cross pollinated crops and bitter gourd being monoecious, provides ample scope for the utilization of hybrid vigour on commercial scale. The present investigations were, therefore, undertaken to study the nature and magnitude of heterotic effects among the economic characters in bitter gourd.

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MATERIALS AND METHODS

The present investigation was undertaken at Vegetable section, Horticultural Research Station, Division of Horticulture, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore, during the year 2008-09. The experimental material comprised of six lines *viz.,* VRBT-100 (L$_1$), Arka Harit (L$_2$). White Long (L$_3$), Coimbatore Long (L$_4$). Green Long (L$_5$) and VRBT-103 (L$_6$)} and four testers *viz.,* IC-42261 (T$_1$), Chidambaram Small (T$_2$). Nanjangood Local (T$_3$) and Panurthy (T$_4$). Twenty four hybrids were generated by using line x tester mating design; MBTH-101 was used as a standard check. These materials were replicated thrice in a randomized block design. The plants were spaced at 1.5m apart between rows and 0.75m apart between plants. The standard agronomical practices were followed according to package of practices at University of Agricultural Sciences, Bangalore. Data were recorded from five randomly selected plants in each treatment over the replications for the characters *viz.,* vine length at 45, 60 and 90 days after sowing (DAS), productive vine length, days taken for first male and female flower appearance, days taken for fifty per cent flowering, node at first female flower appearance, number of primary branches, days to first harvest, fruit length, sex ratio, per cent fruit set, number of seeds per fruit, number of fruits per vine, fruit

weight and fruit yield per vine. Data were averaged and subjected to statistical analysis. Heterosis was calculated as the percentage of F_1 s performance in the favourable direction over the better parent and standard parent as suggested by Turner (1953) and Hays *et al.* (1956).

RESULTS AND DISCUSSION

Performance of ten parents and 24 hybrids is given in Table 1. Among the parents Panurthy was recorded highest fruit yield per vine (2.60 kg), productive vine length (359.22 cm), average fruit weight (103.13 g), vine length at 45 (109.66 cm), 60 (152.15 cm) and 90 (291.26 cm) DAS and second highest for per cent fruit set (87.34) and fruit length (17.86 cm) and third best for number of fruits per vine (25.28). Chidambaram Small exhibited high performance for days to first female flower appearance (59.88), number of node at first female flower appears (5.41), days to first harvest (63.75), days to fifty per cent flowering (83.86), number of primary branches (10.3), less number of seeds per fruit (7.15), more number of fruits per vine (53.09) and second best for days to first male flower appears (38.49). Coimbatore Long for per cent fruit set (88.01), Nanjangood Local for sex ratio (20.28 per cent) and VRBT-103 for fruit length (18.09).

With respect to the performance of F_1 hybrids Coimbatore Long x Panurthy exhibited highest performance for days to first male flower appears (37.32), days to first female flower appears (50.13), days to fifty per cent flowering (83.12), per cent fruit set (93.28), average fruit weight (85.15 g) and fruit yield per vine (2.32 kg). Coimbatore Long x Chidambaram small shown highest performance for less number of node at first female flower appears (5.86), Arka Harit x Chidambaram Small for days to first harvest (26.27) and less number of seeds per fruit (12.3). VRBT-103 x Chidambaram Small for primary branches (12.3) and it was second best for less number of seeds per fruit (13.30) and third best for number of fruit per vine (28.1). Green Long x Nanjangood Local for sex ratio (21.95), VRBT-100 x Chidambaram Small for number of fruits per vine (32.6), VRBT-100 x Panurthy for productive vine length (345.98 cm), and it was second best for vine length at 90 DAS (281.54 cm), days to first male (37.39) and female (50.25) flower appears, days to fifty per cent flowering (84.36), per cent fruit set (92.33), number of fruits per vine (30.94), fruit yield per vine (2.06 kg). Green Long x Panurthy showed high value for fruit length (25.15 cm).

Range of mean values of characters of parents, F_1 hybrids and per cent heterosis are given in Table 2. The mean of F_1 crosses were higher than those of the parents in all the characters except in days to first harvest, number

of fruit per vine, fruit weight and fruit yield per vine. The range of heterosis percentage in F_1 cross varied from 8.86 to -38.74 and 58.00 to -40.66 for vine length at 45 DAS, 10.68 to -26.45 and 30.99 to -20.94 for vine length at 60 DAS, 117.53 to -16.55 and 18.09 to -13.02 for vine length at 90 DAS, 6.86 to -36.64 and 52.45 to -28.32 for productive vine length, 4.72 to -49.07 and 36.59 to -15.99 for number of primary branches, -8.79 to 4.31 and -6.27 to 2.46 for days to first male flower appears, -18.60 to 11.48 and -16.97 to 7.01 for days to first female flower appears, -36.39 to 20.93 and -41.93 to 44.41 for node at first female flower appears, -19.93 to 17.73 and -20.95 to 7.84 for days to fifty per cent flowering, -15.31 to 12.26 and -11.55 to 14.18 for days to first harvest, 40.86 to -35.73 and 30.72 to-65.72 for fruit length, 19.02 to -34.53 and 20.80 to -42.60 for sex ratio, 11.50 to -10.81 and 11.11 to -7.62 for per cent fruit set, -43.61 to 26.51 and -43.84 to 29.11 for number of seeds per fruit, -34.61 to -55.01 and 53.92 to -8.62 for number of fruit per vine, 19.90 to -34.61 and 20.48 to -57.82 for fruit weight and 56.90 to -35.06 and 55.10 to -52.46 for fruit yield per vine, over their respective better parent and standard check (MBTH-101), respectively. Danareddy (2005) and Laxuman (2005) also reported better parent and standard parent heterosis for yield attributing characters.

The best performing hybrids over the better parent and standard parent for the different characters included White Long x Nanjangood Local (18.86) and Arka Harit x Chidambaram Small (10.68 and 17.53) for vine length at 45, 60 and 90 DAS, White Long x Panurthy (4.72) and VRBT-103 x Chidambaram Small (36.59) for number of primary branches, Coimbatore Long x Panurthy (-8.70) and VRBT-100 x Panurthy (-6.27) for days to first male flower appears, VRBT-103 x Chidambaram Small (-18.60) and Coimbatore Long x Panurthy (-16.76) for days to first female flower appears, Green Long x Panurthy (-36.39) and Green Long x Chidambaram Small (-41.93) for node at first female flower appears, VRBT-103 x Chidambaram Small (-19.93) and Coimbatore Long x Panurthy (-20.95) for days to fifty per cent flowering, VRBT-103 x Chidambaram Small (-15.31) and Arka Harit x Chidambaram Small (-11.55) for days to first harvest, Green Long x Panurthy (40.86 and 30.72) for fruit length, Coimbatore Long x IC-42261 (19.02) and Green Long x Nanjangood Local (20.80) for sex ratio, Green Long x IC-42261 (11.50) and Coimbatore Long x Panurthy (11.11) for per cent fruit set, Green Long x Chidambaram Small (-43.61) and Arka Harit x Chidambaram Small (-43.84) for umber of seeds per fruit, Arka Harit x Nanjangood Local (34.61) and VRBT-100 x Chidambaram Small (53.92) for number of fruits per vine, Green Long x

Sr. No.	Crosses	Vine length at 45 DAS	Vine length at 60 DAS	Vine length at 90 DAS	Productive vine length	Number of primary branches	Days to first male flower appearance	Days to first female flower appearance	Node at which first female flower appears	Number of days for 50 per cent flowering
	Table 1: *Per se* performance of parents and crosses for growth, earliness and yield parameters in bitter gourd									
1.	$L_1 \times T_1$	84.26	124.84	259.50	283.08	9.11	39.32	61.33	8.07	98.67
2.	$L_1 \times T_2$	81.33	118.01	249.01	259.10	9.33	37.70	51.35	8.75	90.27
3.	$L_1 \times T_3$	97.71	129.76	264.38	338.13	8.16	39.79	64.60	7.99	102.05
4.	$L_1 \times T_4$	101.84	143.46	281.54	345.98	9.06	37.39	50.25	12.60	84.36
5.	$L_2 \times T_1$	55.90	96.87	232.99	226.26	9.20	39.31	59.29	8.16	94.16
6.	$L_2 \times T_2$	43.00	86.14	218.22	162.69	9.84	38.35	50.40	7.37	84.70
7.	$L_2 \times T_3$	59.02	102.94	237.39	220.64	8.85	39.59	58.92	6.39	102.60
8.	$L_2 \times T_4$	67.18	112.98	243.04	227.60	10.55	40.32	57.58	10.60	101.17
9.	$L_3 \times T_1$	78.63	126.31	258.06	286.09	9.01	39.75	57.58	8.54	104.22
10.	$L_3 \times T_2$	72.96	122.13	252.16	209.78	10.60	38.95	50.66	9.65	87.88
11.	$L_3 \times T_3$	103.26	147.36	279.21	322.56	8.80	40.08	58.67	11.96	102.98
12.	$L_3 \times T_4$	114.47	159.91	296.28	325.55	9.31	38.89	59.87	10.92	102.35
13.	$L_4 \times T_1$	71.89	108.06	244.11	273.08	9.14	38.87	60.58	14.58	108.19
14.	$L_4 \times T_2$	61.24	102.90	236.37	258.17	11.80	39.68	51.62	8.68	87.47
15.	$L_4 \times T_3$	84.07	132.99	264.32	307.79	9.44	39.91	63.14	10.63	113.40
16.	$L_4 \times T_4$	84.73	137.15	278.18	321.12	10.15	37.32	50.13	11.42	83.12
17.	$L_5 \times T_1$	78.05	121.40	251.21	262.58	7.56	40.32	59.68	7.71	105.87
18.	$L_5 \times T_2$	69.80	107.95	232.99	231.97	8.86	37.44	50.69	5.86	87.25
19.	$L_5 \times T_3$	87.10	134.37	261.05	284.77	8.15	40.29	61.08	10.92	105.65
20.	$L_5 \times T_4$	88.62	137.93	273.05	296.21	8.29	37.41	59.15	9.06	98.52
21.	$L_6 \times T_1$	66.89	107.06	248.16	260.74	10.15	39.97	61.30	10.07	108.52
22.	$L_6 \times T_2$	60.42	103.09	234.05	219.68	12.30	38.31	51.50	8.51	87.15
23.	$L_1 \times T_1$	76.71	128.00	263.76	261.30	9.15	40.87	63.95	10.07	111.47
24.	$L_1 \times T_2$	92.15	142.21	276.11	309.15	10.60	40.46	62.40	14.55	110.27
	Lines									
1.	L_1	84.84	118.16	233.65	286.70	8.09	38.14	59.95	8.99	96.39
2.	L_2	39.72	77.83	185.67	152.25	9.11	39.11	55.33	7.59	87.15
3.	L_3	85.68	125.86	254.36	292.74	9.08	38.62	53.70	10.87	107.98
4.	L_4	67.41	108.80	231.40	267.77	9.68	40.91	60.92	13.50	99.84
5.	L_5	72.93	112.21	235.21	253.99	7.09	39.69	57.25	7.34	94.78
6.	L_6	65.63	102.96	227.88	243.11	9.89	39.59	63.27	11.97	108.86
	Testers									
1.	T_1	62.32	102.16	220.94	255.07	8.01	40.56	64.82	10.89	94.66
2.	T_2	31.00	57.17	161.56	101.36	10.30	38.50	51.88	5.42	83.86
3.	T_3	94.86	139.96	267.95	342.71	7.12	42.24	70.97	9.03	98.36
4.	T_4	109.66	152.16	291.26	359.22	8.74	41.54	65.91	14.25	98.42
	Mean	76.33	118.56	248.38	266.14	9.25	39.57	58.83	9.79	99.11
	S.E±	0.3692	0.3808	0.4306	0.5644	0.0797	0.2406	0.2226	0.1874	1.5129
	C.D. (P=0.05)	1.0338	1.0662	1.2058	1.5803	0.2230	0.6738	0.6233	0.5248	4.2363

Contd… Table 1

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Table 1 Contd...

Sr. No.	Crosses	Days to first harvest	Fruit length (cm)	Sex ratio	Per cent fruit set	Number of Seeds per fruit	Number of fruits per vine	Fruit weight (g)	Fruit yield per vine (kg)
1.	$L_1 \times T_1$	73.70	17.05	16.15	83.52	23.47	24.66	62.50	1.54
2.	$L_1 \times T_2$	68.59	10.22	10.49	89.32	16.22	32.60	37.05	1.20
3.	$L_1 \times T_3$	76.20	14.34	17.54	81.62	20.38	27.70	56.15	1.55
4.	$L_1 \times T_4$	65.22	20.69	17.88	92.33	28.27	30.94	72.35	2.19
5.	$L_2 \times T_1$	74.43	14.00	17.32	77.55	14.95	23.55	63.03	1.48
6.	$L_2 \times T_2$	62.27	6.59	11.60	86.68	12.30	23.88	29.81	0.71
7.	$L_2 \times T_3$	72.66	10.80	16.88	77.57	16.47	27.15	54.19	1.47
8.	$L_2 \times T_4$	73.39	12.30	18.56	81.29	17.80	23.97	74.13	1.77
9.	$L_3 \times T_1$	71.60	20.70	13.97	82.50	24.86	24.16	69.15	1.67
10.	$L_3 \times T_2$	63.20	11.69	12.10	82.50	17.30	26.67	41.43	1.10
11.	$L_3 \times T_3$	72.91	16.00	21.86	83.22	23.15	21.61	65.36	1.41
12.	$L_3 \times T_4$	74.16	19.34	18.57	85.67	28.22	23.56	77.75	1.83
13.	$L_4 \times T_1$	72.83	21.99	18.96	78.50	17.15	20.39	69.13	1.40
14.	$L_4 \times T_2$	66.51	10.73	10.43	89.62	15.95	27.25	52.18	1.42
15.	$L_4 \times T_3$	80.39	15.05	17.06	83.29	22.80	19.35	72.26	1.39
16.	$L_4 \times T_4$	64.07	19.74	14.27	93.28	24.10	27.27	85.15	2.32
17.	$L_5 \times T_1$	76.65	23.70	16.64	91.04	21.40	22.37	69.90	1.56
18.	$L_5 \times T_2$	66.42	13.09	13.01	80.06	14.35	27.10	39.65	1.07
19.	$L_5 \times T_3$	77.38	14.39	21.95	83.61	21.78	25.65	71.05	1.82
20.	$L_5 \times T_4$	75.54	25.15	19.21	84.70	27.55	27.65	74.71	2.06
21.	$L_6 \times T_1$	76.16	15.55	16.88	83.93	21.95	23.15	63.07	1.45
22.	$L_6 \times T_2$	66.65	13.05	12.63	81.86	13.50	28.41	40.69	1.15
23		77.14	16.00	21.85	82.96	20.53	22.55	55.55	1.25
24		76.66	20.20	18.97	84.99	20.69	23.20	73.15	1.69
	Lines								
1.	L_1	74.30	15.44	14.15	87.24	22.25	27.85	48.28	1.34
2.	L_2	68.23	8.11	15.52	72.20	13.45	20.17	45.59	0.92
3.	L_3	66.06	15.55	17.23	79.95	22.17	18.36	56.39	1.03
4.	L_4	73.45	16.70	15.93	88.01	21.99	22.86	60.73	1.39
5.	L_5	72.77	17.64	18.21	81.45	25.45	18.66	59.02	1.10
6.	L_6	78.70	18.09	18.80	78.64	17.19	19.56	51.00	1.00
	Testers								
1.	T_1	79.09	16.30	15.12	81.65	18.70	18.77	58.65	1.10
2.	T_2	63.75	4.54	6.44	84.24	7.15	53.09	8.23	0.44
3.	T_3	83.70	13.60	20.28	78.55	18.35	19.59	59.26	1.16
4.	T_4	79.85	17.86	16.97	87.34	22.35	25.29	103.13	2.61
	Mean	73.17	15.48	16.28	83.56	19.83	24.97	59.40	1.43
	S.E±	0.3723	0.2493	0.1247	0.4186	0.2019	0.2359	0.2919	0.0173
	C.D. (P=0.05)	1.0424	0.6981	0.3493	1.1722	0.5654	0.6607	0.8173	0.085

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Nanjangood Local (19.90) and Coimbatore Long x Panurthy (20.80) for fruit weight and Green Long x Nanjangood Local (56.90) and Coimbatore Long x Panurthy (55.10) for fruit yield per vine. Ram *et al.* (1997) recorded 41.23, 30.61 and 98.17 per cent better parent heterosis for plant height, number of fruits per plant and total yield per plant, respectively in their study.

Out of 24 hybrids, as many as ten and eight crosses were found to be superior to their respective better and standard parent for fruit yield per vine. In the order of merit three hybrids namely Coimbatore Long x Panurthy, VRBT-100 x Panurthy and Green Long x Panurthy were noted to be the best performing hybrids for fruit yield per vine and they showed significant heterosis of 55.10, 46.91 and 37.65 per cent, respectively over standard parent. Singh *et al.* (2000) recorded 100 per cent heterosis over standard parent.

The higher yield per vine recorded in the best performing hybrids Coimbatore Long x Panurthy (2.32 kg), VRBT-100 x Panurthy (2.19 kg) and Green Long x Panurthy (2.06 kg) could be attributed due to its increased fruit weight, per cent fruit set, fruit length, relatively lower number of days to first harvest, days to first female flower appears and days to fifty per cent flowering. These hybrids can be commercially exploited for higher yield.

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