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Short communication

Heterosis in bitter gourd (*Momordica charantia* L.)

Murlee Yadav, Rashmi Chaudhary and D. B. Singh
Department of Horticulture
Allahabad Agricultural Institute - Deemed University
Allahabad – 211 007, India
E-mail : murli_y@yahoo.co.in

ABSTRACT

The present investigation was conducted to determine heterosis in 6 lines and 4 tester crosses of bitter gourd, where the six lines used were MC-84 (L_1), S-17 (L_2), JMC-21 (L_3), NDBT-15(L_4), VRBT-94 (L_5) and Gy-1 (L_6) and the four testers were VRBT-6-9 (T_1), JMC-22 (T_2), VRBT-89 (T_3) and MC-56 (T_4). Most of the crosses failed to manifest significant heterosis for many of the horticultural traits but traits, like vine length and fruit length showed positive significant heterosis, while, days to first appearance of female flower manifested negative significant heterosis in several crosses. Two crosses, namely, MC-84 x VRBT-6-9 and MC-84 x JMC-22 were identified to have potential in terms of yield, whereas two more crosses viz., S-17 x VRBT-6-9 and S-17 x JMC-22 were found superior in terms of powdery mildew resistance.

Key words : Bitter gourd, heterosis

Bitter gourd, being an important vegetable crop of the gourd family, is a highly cross-pollinated crop and its monoecious sex though governed by genetics, is highly influenced by soil and environmental factors. Therefore, the precise knowledge of combining ability and gene action responsible for yield and yield components is a pre-requisite for launching a successful crop improvement programme. Hybrids will be very easy to commercialise in bitter gourd due to its high seed content and easy seed extraction technique. Accordingly, the present investigation is oriented to gain further knowledge on the genetic aspect of yield and its component in bitter gourd for commercial exploitation of heterosis. The Line x Tester analysis have been proved to be very successful biometrical tool to study the improvement.

The experiment was conducted at Vegetable Research Farm, Department of Horticulture, Allahabad Agricultural Institute-Deemed University during the year 2003-2005. Evaluation and selection of germplasm were done during *Kharif* season of 2003. Among all the genotypes ten best parents were selected for the study. Six lines [(MC-84 (L_1), S-17 (L_2), JMC-21 (L_3), NDBT-15 (L_4), VRBT-94 (L_5) and Gy-1 (L_6)] and four testers [VRBT-6-9 (T_1), JMC-22 (T_2), VRBT-89 (T_3) and MC-56 (T_4)] were crossed to get 24 F_1 hybrid combinations (Kempthorne, 1957) during the *kharif* season of 2004. These 24 F_1 hybrids were grown and evaluated in the *kharif* season of 2005 in a Randomised Block Design with three replications. Each plant was grown at 1 x 1.5 m^2 spacing. Observations were recorded on five randomly selected competitive plants for vine length (cm), number of primary branches vine^{-1}, number of nodes vine^{-1}, internodal length (cm), days to first appearance of female flower, days to appearance of male flower, first effective node, fruit length (cm), fruit width (cm), fruit weight (g), number of fruits vine^{-1}, number of fruits plot^{-1}, yield plant^{-1}, yield plot^{-1} and yield (q/ha). Powdery mildew infestation was measured by following the scale given by Narasinghani and Tiwari (1995). Heterosis was estimated for all the characters over better parent (BP) and mid parent (MP).

The results are presented in Table 1 to 5. The heterobeltiosis and mean heterosis of two best crosses ranged from 41.93 (L_2 x T_4) to 35.25% (L_1 x T_1) and 9.86 (L_2 x T_4) to 5.03% (L_1 x T_1) for yield (q/ha), 39.91 (L_1 x T_3) to 36.01% (L_1 x T_1) and 5.62 (L_1 x T_1) to 2.20% (L_5 x T_1) for yield plot^{-1}, 48.62 (L_1 x T_3) to 58.51% (L_1 x T_1) and 34.75 (L_1 x T_4) to 23.10% (L_1 x T_1) for yield vine^{-1}, 56.22 (L_6 x T_3) to 63.95% (L_6 x T_2) and 18.73 (L_6 x T_3) to 23.00% (L_6 x T_4) for number of fruits per plot, 56.22(L_6 x T_3) to

Table 1. Estimates of heterobeltiosis and mean heterosis (%) for various traits in bitter gourd

Cross	Vine lngth		No. of primary branches/vine		No. of nodes		Internodal length	
	BP	MP	BP	MP	BP	MP	BP	MP
L_1 x T_1	0.62	13.15*	28.47	8.82	-12.62*	-15.12*	-7.33	-2.46
L_1 x T_2	-6.15*	18.68*	25.40	-1.86	-12.30*	-19.55*	-3.35	-1.77
L_1 x T_3	-4.06*	29.81*	22.13	-6.29	-10.24*	-33.53*	-9.33	-1.09
L_1 x T_4	-4.92*	21.41*	13.79	-15.38	-6.52*	-29.12*	-16.98*	-7.43
L_2 x T_1	-0.95	9.86*	7.64	-6.06	-2.96	-3.19*	1.45	11.60
L_2 x T_2	-2.86	21.43*	21.43	-1.92	1.64	-3.63*	8.30	11.69
L_2 x T_3	-6.35*	25.43*	7.38	-10.94	12.20*	-13.64*	6.78	11.42
L_2 x T_4	-6.67*	17.84*	-9.48	-30.46	13.77*	-7.92*	0.00	6.78
L_3 x T_1	-16.21*	-6.40*	0.00	-4.00	6.00*	4.95*	4.11	18.98*
L_3 x T_2	-0.50	2.31	293.65*	251.77*	9.02*	4.18*	12.28	20.66*
L_3 x T_3	-4.50	7.48*	-3.28	-15.11	22.44*	-4.89*	16.44	16.44
L_3 x T_4	-6.00*	-2.08	-6.03	-19.85	23.91*	1.18	7.51	10.14
L_4 x T_1	-13.83*	-3.54	-11.11	-11.72	27.73*	-1.51	-24.05*	-12.19
L_4 x T_2	-1.01	1.55	-3.17	-10.29	16.02*	-4.50*	-17.30*	-10.00
L_4 x T_3	-2.51	9.48	-7.38	-15.67	-16.93*	-17.25*	-10.49	-9.26
L_4 x T_4	-19.76*	3.81	-11.21	-21.37	-5.08	-8.65*	-15.87	14.97*
L_5 x T_1	-3.17	-6.67*	3.52	2.80	31.40*	-2.15	-12.33	0.19
L_5 x T_2	-1.65	-1.35	3.17	-2.99	21.90*	-2.96	-5.89	1.13
L_5 x T_3	-0.54	6.11	1.64	-6.06	-14.41*	-16.48*	3.39	3.39
L_5 x T_4	-24.51*	0.00	-1.72	-11.63	-1.24	-7.72	-6.40	-4.12
L_6 x T_1	-11.64*	-8.31*	5.80	3.55	45.26*	-0.65	-34.34*	-21.92*
L_6 x T_2	-1.59	-5.28	-1.54	-6.06	33.96*	-1.73	-26.92*	-18.02*
L_6 x T_3	-9.13*	0.94	0.00	-6.15	-9.91*	-18.03*	-18.54*	-15.08*
L_6 x T_4	2.20	-3.80	1.72	-7.09	7.55*	-6.56*	-22.42*	-20.62*
S. Em. (±)	0.10	0.93	0.15	0.13	0.12	0.10	0.52	0.45

* Significant at 5% level

69.77% (L_6 x T_2) and 31.30 (L_5 x T_4) to 26.32% (L_1 x T_4), for number of fruits per vine respectively.

Kushwaha and Ram (2002) reported two potential crosses for heterosis breeding based on better parent heterosis ranging from –24.04 to 50.25 and 44.50 to 77.98% over the season for number of fruits plant^{-1} and for yield plant^{-1} in bottle gourd. Singh and Kumar (2002) also reported similar results in bitter gourd for number of fruits plant^{-1}. In contrast to our findings, Sirohi *et al* (1985) recorded 115% higher yield plant^{-1} in the best F_1 hybrids over the commercial cultivar PSPL.

However, heterobeltiosis of two best crosses varied from 15.12 (L_2 x T_1) to 20.76% (L3 x T_1), 39.53 (L_1 x T_1) to 31.62% (L_1 x T_2), 82.68 (L_6 x T_2) to 88.57% (L_2 x T_4) and mean heterosis 37.57 (L_1 x T_4) to 31.79% (L_5 x T_4), 24.19 (L_3 x T_3) to 23.88% (L_6 x T_4), 2.02 (L_6 x T_1) to 7.42% (L_1 x T_1) for fruit length, fruit width and fruit weight, respectively.

Similar results were reported by Kushwaha and Ram (2002) in bottle gourd, Sirohi *et al* (1978) in bitter gourd for fruit length. Significant heterosis over better parent and standard check was observed particularly for fruit weight, fruit length and fruit diameter by Singh and Kumar (2002) in bitter gourd.

Table 2. Estimates of heterobeltiosis and mean heterosis (%) for various traints in bitter gourd

Crosses	Days to appearance of first male flower		Days to appearance of first female flower		First effective node	
	BP	MP	BP	MP	BP	MP
L_1 x T_1	-3.85	1.74	-23.00*	-17.65*	-15.52	8.89
L_1 x T_2	3.98	8.28*	-19.50*	-14.36*	-10.34	8.33
L_1 x T_3	-7.43*	2.75	-14.50*	-14.50*	-25.00*	-11.27
L_1 x T_4	0.00	9.50*	-10.68*	-9.36*	-26.67*	-10.81
L_2 x T_1	-1.65	-0.56	-14.85*	-8.51*	-10.48	42.31*
L_2 x T_2	6.74*	7.34	-12.87*	-6.88*	-7.26	41.98*
L_2 x T_3	-4.95*	1.05	-10.85*	-10.45*	-4.84	13.46*
L_2 x T_4	3.57	8.56*	-9.22*	-8.33*	-2.42	13.08*
L_3 x T_1	-2.15	-1.09	-14.29*	-6.25*	-21.15	-2.38
L_3 x T_2	8.60*	11.60*	-14.76*	-7.25*	-21.15	-8.89
L_3 x T_3	-1.98	2.06	-14.25*	-12.20*	-41.67*	-27.94*
L_3 x T_4	2.55	5.24*	-13.33*	-12.50*	-38.89*	-22.54*
L_4 x T_1	6.91*	8.65*	-12.96*	-5.24*	-6.94	28.85*
L_4 x T_2	8.51*	12.09*	-11.54*	-4.17	-2.78	27.27*
L_4 x T_3	1.98	5.64*	-9.62*	-7.84	-11.90	-5.13
L_4 x T_4	6.12*	8.33*	-8.65*	-8.21	-14.40	-4.94
L_5 x T_1	-1.92	4.62*	-13.08*	-4.12	-16.18	14.00
L_5 x T_2	-0.98	7.81*	-6.07*	3.08	-4.41	22.64
L_5 x T_3	0.56	2.44	-6.07*	-2.90	-19.05*	-10.53
L_5 x T_4	0.96	3.91*	-5.61*	-3.81	-15.56	-38.00
L_6 x T_1	-	-100*	-2.22	-0.56	-23.21	-2.27
L_6 x T_2	-	-100*	-3.33	-2.25	-16.07	0.00
L_6 x T_3	-	-100*	-9.50*	-4.74	-33.33*	-20.00*
L_6 x T_4	-	-100'*	-12.62*	-6.71*	-33.33*	-17.81
S. Em. (±)	0.77	0.67	0.96	0.83	0.13	0.11

* Significant at 5% level

Table 3. Estimates of heterobeltiosis and mean heterosis (%) for various traits in bitter gourd

Cross	Fruit length		Fruit width		Fruit weight (g)		No. of fruits/ vine	
	BP	MP	BP	MP	BP	MP	BP	MP
L_1 x T_1	11.63	-8.13	39.53*	17.14*	31.30	7.42	-3.51	-6.78
L_1 x T_2	2.03	-23.35*	31.62*	1.00	5.28	1.07	22.91	1.54
L_1 x T_3	-13.10*	-29.47*	6.10	-13.38	15.61	-2.37	2.22	-12.21
L_1 x T_4	-10.61	-37.57*	14.71	-16.52*	46.00	-9.56	-19.67	-26.32*
L_2 x T_1	15.12*	-1.00	-19.77	3.65	42.78*	-3.02	22.37	-2.11
L_2 x T_2	9.46	-13.83*	-20.77	-4.81	18.06	-3.95	-6.58	-12.35
L_2 x T_3	9.29	-7.27	6.10	-10.71	21.05	-14.81	-22.37	-28.92
L_2 x T_4	-6.06	-31.11*	13.24	-14.92	88.57*	-5.71	10.53	-23.64*
L_3 x T_1	20.76*	4.87	-6.98	-6.98	19.63	-0.62	14.13	1.94
L_3 x T_2	4.52	-1.43	-6.76	-13.75	2.50	-0.27	-5.81	-8.99
L_3 x T_3	9.09	-4.00	-22.39*	-24.19*	7.37	-7.97	-21.11	-21.98
L_3 x T_4	1.52	1.52	-12.06	-22.34'*	40.00	-11.71	-20.65	-38.14
L_4 x T_1	-9.52	-10.59	0.51	-0.64	37.96*	-0.67	18.06	-8.60
L_4 x T_2	-19.05*	-24.18*	-4.59	-12.84	14.72	-1.67	-8.33	-16.46
L_4 x T_3	-25.48*	-25.48*	-2.44	-5.88	29.82	-3.27	-18.60	-27.16
L_4 x T_4	-15.15	-25.33*	0.88	-13.59	71.43*	-8.40	13.89	-24.07*
L_5 x T_1	-22.35*	-22.81*	-2.33	-2.33	20.00	-3.28	1.16	-13.00
L_5 x T_2	-20.95*	-26.42*	-2.86	-10.15	-0.83	-6.05	-17.44	-17.44
L_5 x T_3	-30.95*	-31.36*	-14.05	-16.10	9.65	-8.76	-13.95	-15.91
L_5 x T_4	-21.97*	-31.79*	-10.29	-20.78*	41.71	-13.74	-8.14	-31.30*
L_6 x T_1	-1.52	-14.47*	10.30	-4.12	59.45	2.02	45.61*	-10.27
L_6 x T_2	-19.70*	-24.29*	-8.42	-13.66	82.68*	-4.72	69.77*	-14.62
L_6 x T_3	-21.21*	-30.67*	7.39	-4.22	40.94	-13.11	56.22*	-18.73*
L_6 x T_4	-29.70*	-20.7*	-22.73	23.88*	31.50	-13.25	6.94	-23.00*
S. Em. (±)	0.89	0.77	0.72	0.62	0.14	0.12	0.24	0.21

* Significant at 5% level

Table 4. Estimates of heterobeltiosis and mean heterosis (%) for various traits in bitter gourd

Cross	No. of fruits/ plot		Yield/ vine		Yield/ plot		Yield	
	BP	MP	BP	MP	BP	MP	BP	MP
L_1 x T_1	-3.51	-6.78	58.51*	23.10	36.01*	5.62	35.25*	5.03
L_1 x T_2	22.79	1.54	34.77	4.41	30.16	0.84	30.24	0.90
L_1 x T_3	2.22	-13.21	48.62*	4.43	39.91*	-1.69	37.22	-3.58
L_1 x T_4	-19.67*	-26.32*	-4.55	-34.75*	36.36	-6.79	38.29	-5.97
L_2 x T_1	22.37	-2.11	36.99*	19.35	14.09	-0.60	12.26	-2.19
L_2 x T_2	-6.58	-12.35	23.58*	7.43	12.97	-1.79	9.78	-4.56
L_2 x T_3	-22.37	-28.92	43.35	13.84	17.49	-6.69	15.94	-7.92
L_2 x T_4	10.53	-23.64*	28.95	-0.19	5.56	-18.29	41.43	9.86
L_3 x T_1	14.13	1.94	6.85	-0.36	2.98	-3.97	1.64	-5.22
L_3 x T_2	-5.81	-8.99	-4.72	-11.33	3.00	-4.16	1.67	-5.39
L_3 x T_3	-21.11	-21.98	8.49	-7.35	0.24	-14.35	1.84	-13.02
L_3 x T_4	-20.65	-38.14*	-1.44	-17.85	0.78	-16.00	1.88	-15.08
L_4 x T_1	18.06	-8.60	8.81	3.25	3.77	-1.53	7.82	2.31
L_4 x T_2	-8.33	-16.46	1.38	-4.00	-1.77	-6.98	2.01	-3.40
L_4 x T_3	-4.17	-14.81	9.40	-4.79	8.37	-5.69	-1.26	-14.70
L_4 x T_4	13.89	-24.07*	-10.29	-23.78	5.86	-10.06	5.28	-10.55
L_5 x T_1	1.16	-13.00	11.55	6.54	7.00	2.20	2.64	-1.98
L_5 x T_2	-17.44	-17.44	4.52	-0.37	6.29	1.31	1.87	-2.90
L_5 x T_3	-13.95	-15.91	8.94	-4.52	8.08	-5.28	4.59	-8.34
L_5 x T_4	-8.14	-31.30*	9.81	-6.04	10.05	-5.83	2.91	-11.94
L_6 x T_1	45.61*	-10.27	8.61	5.31	4.21	1.04	6.07	2.85
L_6 x T_2	63.95*	-17.54*	0.59	-2.66	2.75	-0.57	2.45	-0.86
L_6 x T_3	56.22*	-18.73*	5.50	-6.03	4.64	-6.79	3.32	-7.97
L_6 x T_4	6.94	-23.00*	7.66	-6.35	3.77	-9.73	0.48	-12.59
S. Em. (±)	0.10	0.87	0.30	0.267	0.13	0.11	0.23	0.20

* Significant at 5% level

Table 5. Estimates of heterobeltiosis and mean heterosis (%) for various traits in bitter gourd

Cross	Vitamin C content		Powdery mildew infestation	
	BP	MP	BP	MP
L_1 x T_1	1.16	-1.13	-12.12	27.01*
L_1 x T_2	6.56*	-0.72	-23.23*	4.11
L_1 x T_3	32.97*	9.75*	-12.12*	15.23*
L_1 x T_4	0.34	0.19	-6.06	14.81*
L_2 x T_1	14.86*	-18.85*	-20.00*	8.47
L_2 x T_2	22.3*	-18.65*	-10.00	13.39
L_2 x T_3	8.11	-3.03	-5.00	15.15*
L_2 x T_4	16.22*	-15.27*	-2.50	9.09
L_3 x T_1	2.98	-2.72	-7.91	44.63*
L_3 x T_2	5.35*	-5.19*	-4.32	43.01*
L_3 x T_3	26.92*	8.71*	-2.88	41.36*
L_3 x T_4	0.00	-2.99*	-1.44	35.64*
L_4 x T_1	2.49	-3.52*	-7.32	41.61*
L_4 x T_2	5.39*	-5.58	-5.28	37.06*
L_4 x T_3	28.02*	10.17*	-3.66	35.43*
L_4 x T_4	0.00	-3.41*	-3.25	27.96*
L_5 x T_1	3.69	0.90	-7.03	43.37*
L_5 x T_2	0.00	-1.89	-5.04	38.29*
L_5 x T_3	52.20*	18.38*	-5.08	35.00*
L_5 x T_4	8.53*	2.94*	-3.91	28.50*
L_6 x T_1	0.38	-1.12	-10.95*	39.43*
L_6 x T_2	1.52	-4.64*	-8.03	36.96*
L_6 x T_3	38.46*	13.26*	-6.20	35.98*
L_6 x T_4	1.16	0.19	-3.65	32.00*
S. Em. (±)	0.21	0.19	0.19	0.16

* Significant at 5% level

For vine length, number of primary branches vine^{-1}, number of nodes, internodal length, heterobeltiosis and mean heterosis of two best cross combinations ranged from 24.51 (L_5 x T_4) to –1976% (L_4 x T_4), 28.47 (L_1 x T_1) to 293.65% (L_3 x T_2), 33.96 (L_6 x T_2) to 45.28% (L_6 x T_1), -26.92 (L_6 x T_2) to –34.34% (L_6 x T_1) and 29.81 (L_1 x T_3) to 25.43% (L_2 x T_3), 8.82 (L_1 x T_1) to 251.77% (L_3 x T_2), 4.18 (L_3 x T_2) to 4.95% (L_3 x T_1), -20.62 (L_6 x T_4) to –21.92% (L_6 x T_1), respectively. The above investigation was also in agreement with the work of Rao *et al* (2000) for branches vine^{-1} and vine length in ridge gourd. Heterosis over better parent was also reported by Abusaleha and Dutta (1994) for branches per vine and vine length in ridge gourd. Maurya *et al* (2003) also found all negative heterosis over better parent for internodal length in bitter gourd.

The heterobeltiosis of two best crosses, such as L_2 x T_3 and L_1 x T_3 was of the order of –4.95 and –7.43% and mean heterosis of two best crosses L_6 x T_1 and L_6 x T_2 are of the order of –100 and –100% for days to first appearance of male flower. The heterobeltiosis for days to first appearance of female flower of two best crosses viz., L_1 x T_2 and L_1 x T_1 are of the order of –19.50 and –23.00% and mean heterosis –14.50 (L_1 x T_3) to –17.65% (L_1 x T_1) for days to first female flower appearance. The heterobeltiosis for first effective node of two best crosses such as L_5 x T_4 and L_3 x T_3 are of the order of –38.89 to –41.67%. The mean heterosis of two best crosses for first effective node of two best crosses L_3 x T_4 and L_3 x T_3 in the order of 38.00 and –27.94%. Similar finding was also reported by Maurya *et al* (2003) for earliness for days to first male and female opening in bitter gourd. It was interpreted that days to first appearance of male flowers, days to first female flower and node number to first female flower negative heterosis is desirable.

The heterobeltiosis for vitamin C of two best crosses such as L_6 x T_3 and L_5 x T_3 was of the order of 38.46 and 52.20% and mean heterosis of two best crosses like L_6 x T_3 and L_5 x T_3 was of the order of 13.26 and 18.38%. However, the heterobeltiosis for powdery mildew resistance of two best crosses such as L_1 x T_2 and L_2 x T_1 was of the order of –20.00 to –23.23% and mean heterosis of crosses L_1 x T_1 and L_2 x T_1 was of the order of 4.11 and 8.47%.

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