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Heterosis for morphological and yield traits in bitter gourd (*Momordica charantia* L.)

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Abstract

In present experiment 36 F_1 hybrids of bitter gourd were studied to investigate the extent of heterosis for yield and its contributing traits. For yield per vine significant estimates of heterosis in positive direction were recorded in 25 hybrids over the mid parent, ranged from 18.01% ($L_{10} \times T_2$) to 112.92% ($L_9 \times T_1$) and in 12 hybrids over the better parent varied from 10.73% ($L_1 \times T_1$) to 64.10% ($L_9 \times T_1$). The estimates of significant economic heterosis in positive direction against the best check "Charles" were found in 6 hybrids *viz*., $L_9 \times T_1$, $L_9 \times T_3$, $L_8 \times T_1$, $L_5 \times T_1$, $L_{11} \times T_1$ and $L_4 \times T_1$ across the environments, having the range varied from 17.45% ($L_4 \times T_1$) to 48.82% ($L_9 \times T_1$). These best performing F_1 hybrids may be exploited for commercial cultivation.

Keywords: Better parent heterosis, Standard heterosis, Bitter gourd, F_1 Hybrids

Introduction

Bitter gourd (*Momordica charantia* L.) is an important commercial cucurbit belonging to the family cucurbitaceae. Inspite of the potential economic and medicinal importance of the crop, due attention was not given towards a need based crop improvement programme. However, cultivation of bitter gourd is gaining popularity among vegetable growers, because of the awareness about the medicinal property and nutritive value of the crop among the consumers. Sufficient improvement in yield has been achieved and various numbers of new varieties and hybrids have been developed due to the efforts of the many vegetable breeders. The primary objective of heterosis breeding is to achieve a quantum jump in yield and quality aspects of crop plants. It is a monoecious and highly cross-pollinated crop in which a large amount of variation is observed in quantitative and qualitative characters. The exploitation of hybrid vigour in any crop depends on substantial heterosis for yield coupled with an economical method of producing hybrid seed. The objective of the study was to investigate the magnitude of heterosis of bitter gourd F_1 hybrids with desirable traits to improve yield and other quality factors.

Materials and Methods

The present investigation was carried out during 2015-16, in three environments *viz., Kharif* 2015 (E_1), Summer 2016 (E_2) and *Kharif* 2016 (E_3) at Horticulture farm, Rajasthan College of Agriculture, Udaipur (Rajasthan). The experimental material comprised of 12 inbred lines *viz.,* IC-599421 (L_1), IC-599431 (L_2), IC-566983 (L_3), IC-599423 (L_4), IC-599410 (L_5), IC-68344 (L_6), IC-596981 (L_7), IC-599434 (L_8), IC-599429 (L_9), IC-599424 (L_{10}), IC-50520 (L_{11}), IC-50527 (L_{12}) and 3 testers *viz*., Pusa Do-Mosmi (T_1), Pusa Vishesh (T_2), Pusa Rasdar (T_3) and their 36 F_1s with 3 checks *viz.,* Apoorva, Charles and US-6214. These 36 F_1s were obtained by crossing 12 inbred lines and 3 testers in line × tester mating. Observations were recorded on 15 characters *viz*., days to anthesis of first male flower, days to anthesis of first female flower, node at which first female flower appeared, days to maturity, fruit length (cm), fruit diameter (cm), fruit weight (g), number of male flower per vine, number of female flower per vine, vine length (m), number of primary branches, number of fruits per vine, number of seeds per fruit, yield per vine (g) and ascorbic acid content (mg/100 g) and pooled data of all three environments of above characters were subjected to statistical analysis to derive information on genetic parameters *viz*., mid parent heterosis (MP), heterobeltiosis/ better parent heterosis (BP) and standard heterosis (SH).

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Results and Discussion

In bitter gourd, earliness is a useful character for realizing the potential economic yield in a short time. The characters like days to anthesis of first male and female flower and node number at which first female flower appeared are considered as criterion for earliness and in negative direction are desirable. In the present study, the cross $L_6 \times T_3$ for days to anthesis of first male flower and L_8 x T_1 and L_6 x T_3 for days to anthesis of first female flower (Table 1) showed negative standard heterosis. The results are in agreement with those of Tewari and Ram (1999) and Rani et al. (2014). For node at first female flower appeared, the significant negative heterosis was exhibited by 24 crosses over mid parent and 20 crosses over better parent. These results are in agreement with those of Singh *et al.* (2000) and Jadhav et al. (2009) in bitter gourd.

In case of days to maturity, heterosis in desirable negative direction was exhibited by 23 hybrids over mid parent and 16 hybrids over better parent whereas all hybrids were late in maturity than standard checks. Maximum estimated value of average heterosis exhibited by hybrid $L_1 \times T_3$ (-14.85%) and highest negative heterobeltiosis was revealed by hybrid $L_6 \times T_3$ (-14.28%) on pooled basis, indicating that there was less time to the first harvest. A similar result was reported by Chaudhary (1987) in bitter gourd. Among 36 hybrids, significant positive heterosis for fruit length was reported by 15 hybrids over mid parent, 10 hybrids over better parent and 4 hybrids over standard check as presented in Table 1. For fruit diameter, 16 hybrids exhibited positive significant heterosis over mid parent, 10 hybrids expressed positive significant heterobeltiosis and seven hybrids exhibited significant standard heterosis in positive direction varied from 10.14% ($L_3 \times T_3$) to 35.35% ($L_4 \times T_1$) on pooled basis (Table 2). Similar results were also reported by Singh et al. (2013). With regard to average fruit weight, significant positive heterosis over mid, better parent and standard check was noticed in 16, 10 and 6 crosses, respectively. The range of economic heterosis recorded from 11.62% ($L_5 \times T_2$) to 22.35% ($L_8 \times T_1$) on pooled basis (Table 2). Similar results were also reported by Rani et al. (2014).

Sex ratio (male to female) in negative direction is advantageous as lower sex ratio is obtained when number

Table 1: Extent of heterosis for different characters in bitter gourd

S. No.	Crosses	Days to anthesis of first male flower			Days to anthesis of first female flower			Node at which first female flower appeared			Days to maturity			Fruit length		
		MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
1.	L1 × T1	-9.06**	-8.54**	-	-13.14**	-13.10**	-4.97	-15.25**	-9.22**	-	-10.63**	-8.75**	-	18.86**	-	-
2.	L2 × T1	-5.82*	-3.96	-	-4.44	-2.32	-	-22.57**	-16.16**	-0.24	-3.72	-0.79	-	28.84**	18.93**	13.58**
3.	L3 × T1	-12.83**	-9.32**	-	-10.07**	-8.43**	-	-25.17**	-22.28**	-	-10.38**	-9.32**	-	56.32**	18.36**	13.05**
4.	L4 × T1	4.33	-	-	7.20*	-	-	-11.63**	-6.67**	-	1.49	-	-	22.71**	-	-
5.	L5 × T1	-2.53	-1.22	-	-2.66	-2.13	-	21.10**	-	-	3.18	-	-	-4.90	-	-
6.	L6 × T1	-10.20**	-8.70**	-	-4.50	-2.13	-	-16.83**	-13.61**	-	-2.95	-1.41	-	-36.47**	-	-
7.	L7 × T1	-13.44**	-12.17**	-	-13.73**	-11.91**	-3.66	-12.60**	-4.18*	-	-12.89**	-10.53**	-0.78	3.50	-	-
8.	L8 × T1	-16.58**	-12.09**	-	-20.21**	-19.25**	-11.69**	-5.59**	-5.26**	-	-13.94**	-13.09**	-3.62	-3.44	-	-
9.	L9 × T1	-6.65*	-3.85	-	-2.20	-	-	-15.56**	-5.24**	-	4.42*	-	-	37.18**	6.92*	2.12
10.	L10 × T1	-23.04**	-17.76**	-6.22	-12.95**	-10.17**	-1.76	-19.46**	-15.79**	-	-12.99**	-11.31**	-1.64	-20.18**	-	-
11.	L11 × T1	-15.48**	-15.26**	-3.87	-1.06	-	-	-7.34**	-7.02**	-	-1.59	-0.24	-	5.17*	3.83	-
12.	L12 × T1	-8.47**	-6.35*	-	-7.74**	-5.84	-1.09	-1.67	-	-	-5.92**	-5.19*	-	10.30**	-	-
13.	L1 × T2	-5.63*	-5.36	-	-4.84	-3.48	-	20.13**	-	-	-14.64**	-13.87**	-2.24	14.03**	-	-
14.	L2 × T2	-6.92*	-5.35	-	-4.28	-3.50	-	10.43**	-	-	-11.07**	-7.25**	-3.06	-40.40**	-	-
15.	L3 × T2	-2.17	-	-	-6.31*	-3.26	-	-19.74**	-6.30**	-	-2.01	-2.01	-	-13.28**	-	-
16.	L4 × T2	-4.18	-1.37	-	1.10	-	-	-3.66*	-	-	0.68	-	-	58.10**	21.47**	18.29**
17.	L5 × T2	-14.17**	-13.27**	-3.70	-9.44**	-7.68*	-1.76	-0.34	-	-	-9.79**	-8.77**	-	35.69**	9.61**	6.75
18.	L6 × T2	-10.36**	-8.59**	-	-8.94**	-5.36	-	22.35**	-	-	-4.62*	-4.24	-	-11.80**	-	-
19.	L7 × T2	-11.83**	-10.27**	-	-4.70	-1.32	-	12.79**	-	-	-7.24**	-5.85*	-	-12.23**	-	-
20.	L8 × T2	-17.97**	-13.30**	-1.70	-8.94**	-6.57*	-0.57	5.42**	-	-	-8.18**	-8.02**	-	-38.25**	-	-
21.	L9 × T2	-6.11*	-3.57	-	-4.08	-2.86	-	-1.74	-1.53	-	1.05	-	-	43.00**	10.68**	7.74
22.	L10 × T2	-14.78**	-8.64**	-	-7.28**	-2.95	-	-25.69**	-12.61**	-2.19	-4.75*	-4.04	-	-4.01	-	-
23.	L11 × T2	-0.75	-0.72	-	3.31	-	-	-1.35	-	-	-0.95	-0.76	-	-9.62**	-	7.34
24.	L12 × T2	-4.72	-2.80	-	-0.88	-0.23	-	-10.52**	-5.65**	-	-2.06	-0.14	-	-4.16	-	-
25.	L1 × T3	-10.60**	-8.54**	-	-10.80**	-9.81**	-1.28	-23.24**	-18.24**	-0.73	-14.85**	-13.85**	-2.72	-10.72**	-	-
26.	L2 × T3	-16.82**	-13.70**	-5.34	-9.37**	-6.26	-1.85	-0.09	-	-	-10.31**	-6.71**	-2.50	-1.43	-	-
27.	L3 × T3	-4.84	-2.71	-	0.70	-	-	-10.36**	-6.38**	-	-2.14	-1.88	-	-19.36**	-	-
28.	L4 × T3	6.30*	-	-	16.46**	-	-	-25.88**	-21.28**	-	2.71	-	-	50.16**	31.01**	-
29.	L5 × T3	-11.83**	-9.09**	-	-11.11**	-10.58**	-1.14	-9.54**	-	-	-12.65**	-11.90**	-2.20	0.22	-	-
30.	L6 × T3	-21.44**	-21.41**	-7.39*	-18.64**	-17.59**	-7.79*	-3.39*	-0.19	-	-14.84**	-14.28**	-3.21	-3.69	-	-
31.	L7 × T3	-5.77*	-5.55	-	-5.81*	-4.93	-	23.80**	-	-	-6.25**	-4.59	-	30.09**	14.52**	-
32.	L8 × T3	-13.01**	-9.93**	-	-11.08**	-11.05**	-0.48	-23.02**	-22.34**	-	-6.88**	-6.81**	-	-2.12	-	-
33.	L9 × T3	-12.87**	-8.67**	-1.76	-12.11**	-8.68**	-5.23	-21.14**	-12.01**	-1.95	-6.58**	-0.67	-0.45	60.98**	41.73**	-
34.	L10 × T3	-23.17**	-19.33**	-4.87	-14.66**	-12.96**	-2.61	-16.19**	-11.88**	-	-13.04**	-12.16**	-0.82	-9.97**	-	-
35.	L11 × T3	-9.35**	-7.55*	-	-8.40**	-3.96	-2.04	-2.81*	-1.95	-	-7.66**	-7.24**	-	-36.94**	-	-
36.	L12 × T3	-13.37*	-4.52	-	-11.02**	-8.12*	-3.49	-17.50**	-13.14**	-	-5.76**	-4.17	-	95.47**	69.93**	19.20**

of female flowers is more. In present study, heterosis in negative direction for number of male flower per vine was depicted by 10 hybrids over mid parent, 7 hybrids over better parent and 6 hybrids over best check, whereas positive significant heterosis for number of female flower per vine exhibited by 16 hybrids over mid parent, 5 hybrids over better parent and 1 hybrid over best check. Thangamani and Pugalendhi (2013) also reported similar results in bitter gourd. In the present study out of 36 crosses, 10 over mid parent and 4 over better parent showed significantly positive heterosis for vine length (Table 2). Regarding number of primary branches, 8 crosses over mid parent, 3 crosses over better parent and 12 over standard check recorded significant positive heterosis. Results are in conformity with Jadhav et al. (2009).

Heterosis for number of fruits per vine is important because it contribute toward total yield. In present study, positive significant heterosis for this trait exhibited by 21 crosses over mid parent, 14 crosses over better parent and 3 over standard check. Similar results were also reported by Singh et al. (2013) and Verma et al. (2013). Number of seeds per fruit should be less to make it more acceptable to the consumers. In the present study, significant negative heterosis exhibited by 24 hybrids over mid parent and 12 over better parent. The estimates of significant economic heterosis in negative direction against the best check were found in seven hybrids across the environments, having the range varied from -17.57% ($L_5 \times T_3$) to -39.85% ($L_3 \times T_3$). Similar results were reported by Celine and Sirohi (1996).

Fruit yield per vine is the most important trait. In present study, the significant estimates of heterosis in positive direction were recorded in 25 hybrids over the mid parent ranged from 18.01% ($L_{10} \times T_2$) to 112.92% ($L_9 \times T_1$) and in 12 hybrids over the better parent varied from 10.73% ($L_1 \times T_1$) to 64.10% (L_9 x T_1). The estimates of significant economic heterosis in positive direction against the best check "Charles" were found in 6 hybrids *viz*., $L_9 \times T_1$, $L_9 \times T_3$, $L_8 \times T_1$, $L_5 \times T_1$, $L_{11} \times T_1$ and $L_4 \times T_1$ across the environments, having the range varied from 17.45% ($L_4 \times T_1$) to 48.82% ($L_9 \times T_1$) (Table 3). Significant values of heterosis over better parent and standard check was also reported by Khattra et al. (1994), Ram et al. (1997), Behera et al. (2009), Jadhav et al., (2009) and Rani et al. (2014).

The majority of the hybrids exhibited positive significant

Table 2: Extent of heterosis for different characters in bitter gourd

S. No.	Crosses	Fruit diameter			Fruit weight			Number of male flower per vine			Number of female flower per vine			Vine length		
		MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
1.	L1 × T1	3.04	-	-	6.53	-	-	1.56	-	-2.89	11.48**	8.55	-	31.80**	0.96	-
2.	L2 × T1	8.71	-	8.29	9.39**	-	2.84	9.85**	-	-9.74	2.35	-	-	11.06*	8.44*	-
3.	L3 × T1	28.04**	22.54**	10.96*	24.92**	1.50	6.49	-7.30*	-	-	33.50**	-	-	13.27*	-	-
4.	L4 × T1	48.92**	48.39**	35.35**	34.01**	11.91**	17.42**	-7.79*	-	-	15.24**	-	-	-1.52	-	-
5.	L5 × T1	8.40	1.74	5.03	18.21**	0.60	5.55	12.80**	-	-8.85	-14.00**	-	-	5.15	10.26**	4.95
6.	L6 × T1	12.56*	10.47	3.89	-19.53**	-	-	11.84**	-	-3.01	-0.87	-	-	2.37	11.78**	1.60
7.	L7 × T1	24.59**	18.75**	7.53	4.28	-	-	1.38	-6.23	-15.27**	-15.42**	-	-	-19.68**	-	-
8.	L8 × T1	55.19**	39.24**	26.09**	26.85**	16.60**	22.35**	5.81	-	-	-4.63	-	-	3.51	0.80	1.22
9.	L9 × T1	7.26	3.85	-	37.99**	13.26**	18.84**	-2.03	-	-2.32	10.97**	5.57	-	19.26**	-	-
10.	L10 × T1	5.47	-	10.57*	-16.73**	-	-	-8.27**	-23.82**	-31.17**	-34.70**	-	-	-24.39**	-	-
11.	L11 × T1	12.19*	3.43	-	-10.96**	-	-	4.27	-	-	41.43**	12.52*	-	21.59**	0.68	-
12.	L12 × T1	1.60	-	-	3.65	-	-	-7.47*	-	-0.65	6.14	-	-	-11.16*	-	-
13.	L1 × T2	-12.32*	-	-	14.06**	-	-	-4.32	-	-	21.17**	5.72	-	24.16**	-	-
14.	L2 × T2	2.37	-	3.34	-15.17**	-	-	-3.35	-	-	16.07**	37.37**	11.68*	51.97**	-	-
15.	L3 × T2	22.94**	16.05**	8.19	-11.08**	-	-	-3.47	-	-	36.28**	19.76**	-	33.53**	-	-
16.	L4 × T2	10.18	8.99	1.60	37.01**	20.09**	12.13*	10.39**	-	-	18.28**	2.17	-	4.44	2.68	1.53
17.	L5 × T2	29.64**	23.35**	27.34**	33.65**	19.54**	11.62*	5.96*	-18.98**	-16.52**	-25.69**	-	-	1.88	3.98	7.64
18.	L6 × T2	6.42	5.96	-	-9.40*	-	-	13.49**	-	-	17.04**	19.65**	-	27.58**	8.85**	6.16
19.	L7 × T2	13.32*	6.54	-	11.45**	-	-	-4.10	-18.48**	-16.01**	-21.14**	-	-	-3.03	-	-
20.	L8 × T2	32.65**	17.51**	9.55	-21.06**	-	-	-8.78**	-14.01**	-11.40	-21.53**	-	-	-4.12	-	-
21.	L9 × T2	19.29**	13.89*	6.17	25.48**	7.98*	0.82	-6.74*	-	-	27.97**	7.67	-	17.23**	-	-
22.	L10 × T2	-5.17	-	-	-0.36	-	-	-4.96	-	-	-6.94*	-	-	1.90	-	-
23.	L11 × T2	28.26**	16.70**	8.79	-6.18	-	-	-12.5**	-	-	14.82**	10.58	-	14.93**	-	-
24.	L12 × T2	1.05	-	-	-10.05**	-	-	9.48**	-	-	20.93**	24.84**	1.50	35.76**	5.71	4.53
25.	L1 × T3	5.18	2.83	8.79	-0.84	-	-	2.99	-	-	25.34**	2.35	3.08	30.59**	-	-
26.	L2 × T3	-9.97*	-	-	7.77*	2.94	-	-4.81	-	-	17.22**	-	-	2.90	-	-
27.	L3 × T3	16.83**	4.12	10.14*	-13.15**	-	-	7.86**	-	-1.44	4.19	8.63	9.40	32.41**	2.89	4.32
28.	L4 × T3	8.95	1.44	7.32	54.47**	49.04**	12.74**	-1.61	-	-	0.96	-	-	-18.49**	-	-
29.	L5 × T3	-0.55	-	3.94	5.02	3.65	-	-7.38*	-	-	-4.95	-	-	-9.19	-	-
30.	L6 × T3	-1.47	-	-	0.11	-	-	-5.77	-	-	11.99**	4.88	5.62	22.88**	-	-
31.	L7 × T3	13.50*	0.77	6.61	48.05**	35.28**	2.32	4.49	-	-	0.31	-	-	-14.44**	-	-
32.	L8 × T3	4.16	-	-	2.53	-	-	-15.3**	-31.91**	-25.89**	-36.01**	-	-	-18.88**	-	-
33.	L9 × T3	12.74*	1.54	7.42	53.74**	45.28**	9.90	-10.7**	-	-	25.20**	6.89	7.64	27.58**	-	-
34.	L10 × T3	-8.05	-	1.65	-4.13	-	-	9.18**	-9.34*	-1.32	-13.94**	-	-	-21.03**	4.33	5.79
35.	L11 × T3	30.65**	12.50*	19.02**	-12.42**	-	-	-11.7**	-11.78**	-18.00**	-18.73**	-	-	-23.71**	-	-
36.	L12 × T3	-5.38	-	-	50.23**	44.87**	9.58	3.44		-0.79	-3.54	-	-	1.98	-	0.07

Table 3: Extent of heterosis for different characters in bitter gourd

S. No.	Crosses	Number of primary branches			Number of fruits per vine			Number of seeds per fruit			Yield per vine			Ascorbic acid content		
		MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH	MP	BP	SH
1.	L1 × T1	-7.94**	-	1.90	45.50**	27.40**	-	-15.48**	-	-	50.84**	10.73*	0.43	-6.86**	-	-
2.	L2 × T1	-19.53**	-	-	20.25**	7.56	-	-19.90**	-7.43	-	28.03**	4.21	-	19.54**	10.14**	1.32
3.	L3 × T1	12.01**	-	19.06**	37.05**	17.95**	-	21.81**	-	-	65.07**	19.82**	8.66	15.40**	12.09**	3.11
4.	L4 × T1	-29.06**	-	-	25.98**	16.06*	-	15.16**	-	-	65.81**	29.50**	17.45**	-13.57**	-	-
5.	L5 × T1	6.76*	1.33	27.52**	63.80**	39.69**	-	-18.38**	-	-	86.53**	39.56**	26.57**	-8.81**	-	-
6.	L6 × T1	4.43	-	10.90**	9.81	-	-	-50.59**	-45.84**	-24.46**	-13.90*	-	-	3.45**	-	-
7.	L7 × T1	-13.99**	-	6.09	-10.17	-	-	0.43	-	-	-8.52	-	-	10.14**	9.24**	2.15
8.	L8 × T1	13.82**	5.00	31.83**	16.82**	12.55*	-	11.98**	-	-	49.00**	41.94**	28.73**	1.74	-	-
9.	L9 × T1	1.19	-	15.71**	56.56**	44.72**	2.45	-2.56	-	-	112.92**	64.10**	48.82**	-0.38	-	-
10.	L10 × T1	-29.86**	-	-	-3.32	-	-	-18.00**	-	-	-21.19**	-	-	21.58**	11.98**	3.01
11.	L11 × T1	-29.57**	-	-	56.67**	51.92**	14.49**	-26.05**	-14.67**	-	40.11**	35.57**	22.95**	-12.92**	-	-
12.	L12 × T1	-19.93**	-	-	-23.19**	-	-	-6.93	-	-	-21.56**	-	-	8.60**	4.82**	3.65
13.	L1 × T2	28.86**	25.76**	20.53**	22.06**	7.31	-	-29.11**	-5.89	-	34.78**	2.67	-	9.24**	8.35**	-
14.	L2 × T2	-1.39	-	-	64.96**	48.17**	3.90	-39.16**	-26.86**	-7.25	38.57**	17.92**	-	31.56**	29.29**	3.80
15.	L3 × T2	47.42**	44.04**	31.48**	60.99**	39.11**	-	-48.24**	-33.86**	-24.27**	38.52**	4.24	-	-6.98**	-	-
16.	L4 × T2	-6.96*	-	-	5.50	-	-	-0.38	-	-	43.37**	16.74**	-	-0.52	-	-
17.	L5 × T2	3.18	-	5.25	4.55	-	-	47.37**	-	-	35.07**	5.02	-	-8.77**	-	-
18.	L6 × T2	2.70	0.23	-	25.16**	11.92	-	-41.81**	-33.77**	-7.61	10.54	-	-	5.45**	4.36**	-
19.	L7 × T2	-10.74**	-	-	26.86**	16.38*	-	-21.45**	-	-	37.72**	6.76	-	20.21**	11.71**	4.46**
20.	L8 × T2	-13.89**	-	-	-30.44**	-	-	-36.63**	-24.93**	-2.35	-45.92**	-	-	-11.99**	-	-
21.	L9 × T2	33.69**	25.96**	29.94**	36.13**	26.39**	-	-21.06**	-	-	67.24**	34.23**	8.89	29.06**	28.34**	4.21**
22.	L10 × T2	16.60**	4.35	20.53**	20.70**	9.38	-	-26.74**	-	-	18.01**	-	-	30.76**	28.47**	3.14
23.	L11 × T2	7.41*	6.42	-	10.65	6.80	-	-24.75**	-9.69	-	3.65	1.39	-	-15.23**	-	-
24.	L12 × T2	-25.40**	-	-	45.70**	38.63**	-	-22.67**	-	-4.53	29.18**	8.00	-	15.56**	4.69**	3.52
25.	L1 × T3	-17.07**	-	-	40.49**	9.03	5.02	-32.18**	-30.98**	-25.72**	37.12**	1.41	-	-7.41**	-	-
26.	L2 × T3	4.72	1.12	13.83*	28.79**	1.74	-	-25.02**	-19.84**	-10.69	40.63**	15.49**	2.36	17.50**	8.56**	-
27.	L3 × T3	-23.27**	-	-	50.23**	14.93**	10.70*	-46.75**	-46.02**	-39.85**	28.16**	-	-	-5.83**	-	-
28.	L4 × T3	8.30**	5.26	25.55**	-25.66**	-	-	70.20**	-	-	13.88*	-	-	-6.57**	-	-
29.	L5 × T3	4.36	4.27	17.59**	-9.91	-	-	-19.68**	-12.16	-17.57**	-5.71	-	-	-2.07*	-	-
30.	L6 × T3	-7.45*	-	-	36.03**	7.06	3.12	-20.72**	-10.73	-0.54	36.30**	3.90	3.32	-6.83**	-	-
31.	L7 × T3	-18.17**	-	-	-11.59*	-	-	27.22**	-	-	28.37**	-	-	14.96**	13.69**	6.31**
32.	L8 × T3	-15.79**	-	-	-18.66**	-	-	-38.33**	-33.17**	-25.54**	-16.10**	-	-	-23.03**	-	-
33.	L9 × T3	-27.06**	-	-	36.28**	10.65*	6.58	71.29**	-	-	107.61**	61.31**	42.97**	19.35**	12.67**	3.01
34.	L10 × T3	-31.56**	-	-	-31.49**	-	-	-21.59**	-16.39*	-17.75**	-34.48**	-	-	-2.81*	-	-
35.	L11 × T3	-10.77**	-	-	-41.95**	-	-	-25.89**	-20.65**	-11.59	-48.63**	-	-	-15.54**	-	-
36.	L12 × T3	-13.25**	-	0.02	-8.66	-	-	90.55**	-	-	35.75**	9.62	-	1.15	-	-

*, ** Significant at 5% and 1%

MP-Mid parent heterosis, BP- Better parent heterosis, SH- Standard Heterosis

relative heterosis, thereby indicating that for these traits the genes with positive effect were dominant. While for flowering characters and number of seeds, majority of the hybrids exhibited negative significant relative heterosis, thereby indicating that for these traits the genes with negative effect were dominant. For other remaining traits variable number of hybrids depicted relative heterosis in both positive and negative direction, thereby indicating that the genes with negative as well as positive effects were dominant.

सारांश

करेला की 36 संकरों में उपज एवं उपज संबंधित लक्षणों के लिए संकर ओज का अध्ययन किया गया। उपज/पौध के प्रति ओज विश्लेषण किया गया एवं कुल 25 संकरों में माध्य पित्र् ओज धनात्मक दिशा में पाया गया, जिसका विस्तार 18.01 प्रतिशत (एल.10 × टी2) से 112.92 प्रतिशत (एल.9 × टी1) एवं 12 संकरों में उत्तम पित्र् ओज विस्तार 10.73 प्रतिशत (एल.1 × टी1) से 64.10 प्रतिशत (एल.9 × टी1) पाया गया। सार्थक आर्थिक ओज विश्लेषण उत्तम नियंत्रक ''चार्ल्स'' के सापेक्ष 6 संकरों जैसे– एल.9 × टी1, एल.9 × टी3, एल. 8 × टी1, एल.5 × टी1, एल.11 × टी1 एवं एल.4 × टी1 सभी वातावरणों में उत्तम पाया गया जिसका विस्तार 17.45 प्रतिशत (एल. 4 × टी1) से 48.82 प्रतिशत (एल.9 × टी1) रहा। उत्तम निष्पादन करने वाले इन सभी संकरों को व्यवसायिक खेती हेतु उपयोग किया जा सकता है।

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