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Studies on heterosis for different fruit characters in tomato (*Solanum lycopersicum* L.)

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Abstract

A set of 18 F₁ hybrids developed as a result of line x tester mating design involving six lines and three testers were evaluated in randomized block design in three replications for heterosis in tomato fruit characters. Heterosis to the extent of 25.48, 37.75, 28.59 and 18.94 over mid parent and 20.61, 25.35, 28.38 and 16.54 over better parent was recorded for number of flowers per cluster, fruit length, fruit width and pulp yield respectively. Standard heterosis over Lakshmi to the extent of 11.76, 36.30, 17.17 and 21.03 was recorded for number of locules per fruit, pericarp thickness, total soluble solids and ascorbic acid content respectively and over US-618 to the extent of 13.61, 40.19, 20.18 and 22.17 was recorded for number of flowers per cluster, fruit length, fruit width and pulp yield respectively. Studies on heterosis revealed that majority of the hybrids exhibited relative heterosis, heterobeltiosis and standard heterosis in desirable direction. The crosses like LE-62 × Pant T-3, LE-64 × Punjab chhuhara, LE-67 × Pant T-3 and LE-56 × Punjab chhuhara for number of flowers per cluster, fruit length, fruit width and pulp yield respectively exhibited high standard heterosis, which offers scope for commercial exploitation through heterosis breeding.

Keywords: Tomato, heterosis, fruit, line x tester

Introduction

Tomato is one of the most important vegetable crops cultivated all over the world for both table and processing purposes. Estimation of heterosis is an important way to assess the performances of the hybrids compared to their parents and is essential to develop high yielding varieties of different crop plants. The development of hybrid varieties with desired characters has proven to be an effective strategy to increase tomato production in the world. The phenomenon of heterosis in tomato was first observed by Hedrick and Booth (1907) ^[1]. Since then, heterosis for yield, its components and quality traits were extensively studied by many workers. Choudhary *et al.* (1965) ^[2] emphasized the extensive utilization of heterosis to step up tomato production. Recently heterosis breeding is considered as an important method of crop improvement for improving the productivity and quality of vegetables.

Materials and Methods

The experimental material for the present study comprised six lines *viz.*, EC-165749, LE-56, LE-62, LE-64, LE-65, LE-67, three testers *viz.*, Punjab Chhuhara, Pant T-3 and Pusa Gaurav and two standard checks *i.e.* Lakshmi and US-618. These lines were crossed in line x tester fashion (Kempthorne, 1957) ^[3] to develop 18 F₁ hybrids, which were evaluated along with their parents in randomized block design in three replications at the experimental farm of Vegetable Research Station, Dr. Y.S. R. Horticultural University, Rajendranagar, Hyderabad during kharif, 2011. The data was subjected to the analysis of variance for randomized block design as suggested by Panse and Sukhatme (1967) ^[4]. Observations were recorded for number of flowers per cluster, fruit length, fruit width and pulp yield in F₁s, parents and checks. The mean over the replications for all parents and hybrids for each character was calculated and used in estimation of heterosis. Heterosis was calculated as the percentage increase or decrease of F₁ mean (F₁) over the mean of mid parent (MP) and better parent (BP) of the respective crosses. Whereas for calculating standard heterosis for various characters, mean of the best yielding commercial F₁ hybrid was used. Significance for heterosis was tested by using error mean square as suggested by Turner (1953) ^[5].

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Results and Discussion

Heterosis was estimated for flower and fruit characters studied in 18 hybrids and was expressed as increase or decrease over mid parental value (relative heterosis), over better parent (heterobeltiosis) and over commercial checks (standard heterosis). The results are presented in the table 1, 2, 3 and 4.

Number of flowers per cluster

The relative heterosis ranged from -10.12 (LE-62 × Pusa Gaurav) to 25.48 percent (LE-56 × Punjab Chhuhara). Significant positive relative heterosis was recorded by 7 out of 18 hybrids for number of flowers per cluster. Heterobeltiosis ranged from -11.21 (LE-62 × Pusa Gaurav) to 20.61 percent (LE-56 × Punjab Chhuhara) and six hybrids expressed significant positive heterobeltiosis. The range of standard heterosis was from -21.65 (LE-62 × Pusa Gaurav) to 11.76 percent (LE-62 × Pant T-3) over Lakshmi and -20.36 (LE-62 × Pusa Gaurav) to 13.61 percent (LE-62 × Pant T-3) over US-618. Significant positive standard heterosis was recorded by one hybrid over Lakshmi and 3 hybrids over US-618. For number of flowers per cluster positive heterosis is desirable. The cross LE-62 × Pant T-3 (11.76% and 13.61%) and LE-67 × Pusa Gaurav (37.92% and 42.55%) recorded highest standard heterosis over Lakshmi and US-618 for number of flowers per cluster. Patil (1997) [6] for number of flowers per cluster reported significant positive standard heterosis.

Fruit length

The relative heterosis ranged from -9.07 (LE-62 × Pant T-3) to 37.75 percent (LE-64 × Punjab Chhuhara). The range of heterobeltiosis was from -16.85 (LE-56 × Pant T-3) to 25.35 percent (LE-64 × Punjab Chhuhara). Significant positive relative heterosis and heterobeltiosis were exhibited by 8 and 4 hybrids respectively for fruit length. The range of standard heterosis was from -14.87 (LE-62 × Pant T-3) to 36.30 percent (LE-64 × Punjab Chhuhara) over Lakshmi and -12.45 (LE-62 × Pant T-3) to 40.19 (LE-64 × Punjab Chhuhara) over US-618. Significant positive standard heterosis was recorded by 4 hybrids over Lakshmi and 5 hybrids over US-618.

Fruit width: The relative heterosis ranged from -0.44 (LE-62 × Punjab Chhuhara) to 28.59 percent (LE-65 × Pusa Gaurav). Positive significant relative heterosis was noticed in 12 out of 18 hybrids for fruit width. The heterobeltiosis was ranged from -2.94 (LE-62 × Pant T-3) to 28.38 percent (LE-65 × Pusa Gaurav) with 11 hybrids showing positive significant heterobeltiosis. Standard heterosis over Lakshmi ranged from -17.60 (LE-64 × Pant T-3) to 17.17 percent (LE-67 × Pant T-3) and over US-618 ranged from -15.48 (LE-64 × Pant T-3) to 20.18 percent (LE-67 × Pant T-3). Significant positive standard heterosis expressed by 6 and 9 hybrids over Lakshmi and US-618 respectively.

Fruit length and fruit width are considered to be associated directly with fruit yield per plant, for which positive heterosis is desirable. The cross LE-64 × Punjab Chhuhara (36.30% and 40.19%) for fruit length and LE-67 × Pant T-3 (17.17% and 20.18%) for fruit width recorded highest significant standard heterosis over Lakshmi and US-618. These results are in accordance with the findings of Sharma *et al.* (2001) [7] and Padma *et al.* (2002) [8] for fruit length, Lakshmi (1997) [9] and Sharma *et al.* (2001) [7] for fruit width.

Pulp yield: The range of relative heterosis was from 5.37 (LE-56 × Pusa Gaurav) to 18.94 percent (LE-64 × Punjab Chhuhara) with 16 hybrids exhibiting significantly positive relative heterosis. The heterobeltiosis ranged from 1.66 (LE-56 × Pusa Gaurav) to 16.54 percent (LE-64 × Punjab Chhuhara) and 14 hybrids recorded positive significant heterobeltiosis for pulp yield. Standard heterosis ranged from 10.34 (EC-165749 × Punjab Chhuhara) and 7.69 percent (LE-56 × Pusa Gaurav) to 21.03 and 22.17 (LE-56 × Punjab Chhuhara) over Lakshmi and US-618 respectively. Among 18 hybrids studied, 10 hybrids over Lakshmi and 11 hybrids over US – 618 exhibited significant desirable standard heterosis. The hybrids LE-56 × Punjab Chhuhara (21.03), LE-64 × Punjab Chhuhara (18.89), LE-62 × Punjab Chhuhara (17.82) LE-65 × Punjab Chhuhara (15.59) and LE-67 × Punjab Chhuhara (11.78) recorded high standard heterosis over best commercial check Lakshmi. For pulp yield positive heterosis is desirable. The cross LE-56 × Punjab Chhuhara recorded highest standard heterosis over Lakshmi and US-618 for pulp yield (21.03% and 22.17%).

Table 1: Estimates of heterosis over mid parent (MP), better parent (BP) and standard check for number of flowers per cluster in tomato

S. No	Cross	Number of flowers per cluster			
		MP	BP	Lakshmi	US-618
1	EC -165749 × Punjab Chhuhara	4.75	-5.62	0.70	2.37
2	EC -165749 × Pant T-3	-8.17*	-13.26**	-7.45*	-5.92
3	EC -165749 × Pusa Gaurav	-2.54	-11.95**	-6.05	-4.50
4	LE-56 × Punjab Chhuhara	25.48**	20.61**	3.20	4.91
5	LE-56 × Pant T-3	22.44**	12.15**	6.40	8.17*
6	LE-56 × Pusa Gaurav	17.46**	12.58**	-3.08	-1.48
7	LE-62 × Punjab Chhuhara	3.62	2.04	-9.95**	-8.46*
8	LE-62 × Pant T-3	22.06**	17.79**	11.76**	13.61**
9	LE-62 × Pusa Gaurav	-10.12**	-11.21**	-21.65**	-20.36**
10	LE-64 × Punjab Chhuhara	6.60	5.09	-7.45*	-5.92
11	LE-64 × Pant T-3	15.81**	11.66**	5.94	7.69*
12	LE-64 × Pusa Gaurav	5.61	4.43	-8.03*	-6.51
13	LE-65 × Punjab Chhuhara	5.91	3.67	-11.29**	-9.82**
14	LE-65 × Pant T-3	10.60**	3.07	-2.21	-0.59
15	LE-65 × Pusa Gaurav	17.77**	14.94**	-1.05	0.59
16	LE-67 × Punjab Chhuhara	6.39	-2.22	-0.17	1.48
17	LE-67 × Pant T-3	-7.09*	-10.38**	-8.50*	-6.98
18	LE-67 × Pusa Gaurav	-1.64	-9.35*	-7.45*	-5.92
	S.Ed	0.17	0.20	0.20	0.20

* Significant at 5% level, ** Significant at 1% level

Table 2: Estimates of heterosis over mid parent (MP), better parent (BP) and standard check for fruit length in tomato

S. No	Cross	Fruit length			
		MP	BP	Lakshmi	US-618
1	EC -165749 × Punjab Chhuhara	6.22	-6.96	1.18	4.06
2	EC -165749 × Pant T-3	14.57**	7.05	0.76	3.63
3	EC -165749 × Pusa Gaurav	15.38**	9.62	-0.42	2.42
4	LE-56 × Punjab Chhuhara	21.52**	18.62**	35.46**	39.33**
5	LE-56 × Pant T-3	-8.83*	-16.85**	-5.04	-2.33
6	LE-56 × Pusa Gaurav	-4.02	-13.83**	-1.60	1.21
7	LE-62 × Punjab Chhuhara	13.57**	5.41	14.62**	17.89**
8	LE-62 × Pant T-3	-9.07	-9.55	-14.87**	-12.45*
9	LE-62 × Pusa Gaurav	-3.33	-4.51	-11.09*	-8.56
10	LE-64 × Punjab Chhuhara	37.75**	25.35**	36.30**	40.19**
11	LE-64 × Pant T-3	20.04**	16.88**	10.00*	13.14*
12	LE-64 × Pusa Gaurav	3.64	2.68	-6.72	-4.06
13	LE-65 × Punjab Chhuhara	8.79	-5.33	2.94	5.88
14	LE-65 × Pant T-3	24.93**	15.89**	9.08	12.19*
15	LE-65 × Pusa Gaurav	6.42	0.37	-8.82	-6.22
16	LE-67 × Punjab Chhuhara	3.39	-5.64	2.61	5.53
17	LE-67 × Pant T-3	0.91	-1.43	-7.23	-4.58
18	LE-67 × Pusa Gaurav	11.03*	10.36	0.25	3.11
	S.Ed	0.17	0.19	0.19	0.19

* Significant at 5% level, ** Significant at 1% level

Table 3: Estimates of heterosis over mid parent (MP), better parent (BP) and standard check for fruit width in tomato

S. No	Cross	Fruit width			
		MP	BP	Lakshmi	US-618
1	EC -165749 × Punjab Chhuhara	12.68**	6.67*	6.44	9.17**
2	EC -165749 × Pant T-3	4.30	1.72	1.50	4.11
3	EC -165749 × Pusa Gaurav	17.54**	10.25**	10.01**	12.84**
4	LE-56 × Punjab Chhuhara	14.93**	14.61**	2.15	4.77
5	LE-56 × Pant T-3	17.89**	14.03**	8.15*	10.93**
6	LE-56 × Pusa Gaurav	10.52**	9.77**	-2.72	-0.22
7	LE-62 × Punjab Chhuhara	-0.44	-0.95	-10.80**	-8.51*
8	LE-62 × Pant T-3	-0.43	-2.94	-7.94*	-5.58
9	LE-62 × Pusa Gaurav	18.58**	16.84**	5.22	7.92*
10	LE-64 × Punjab Chhuhara	2.84	-0.15	-5.51	-3.08
11	LE-64 × Pant T-3	-13.02**	-13.12**	-17.60**	-15.48**
12	LE-64 × Pusa Gaurav	15.83**	11.41**	5.44	8.14*
13	LE-65 × Punjab Chhuhara	28.16**	27.13**	13.30**	16.21**
14	LE-65 × Pant T-3	4.62	0.68	-4.51	-2.05
15	LE-65 × Pusa Gaurav	28.59**	28.38**	12.59**	15.48**
16	LE-67 × Punjab Chhuhara	21.21**	19.15**	9.94**	12.77**
17	LE-67 × Pant T-3	25.23**	23.53**	17.17**	20.18**
18	LE-67 × Pusa Gaurav	9.63**	6.74	-1.50	1.03
	S.Ed	0.13	0.15	0.15	0.15

* Significant at 5% level, ** Significant at 1% level

Table 4: Estimates of heterosis over mid parent (MP), better parent (BP) and standard check for pulp yield in tomato

S. No	Cross	Pulp yield			
		MP	BP	Lakshmi	US-618
1	EC -165749 × Punjab Chhuhara	14.92**	8.15*	10.34**	11.38**
2	EC -165749 × Pant T-3	13.45**	9.61*	5.82	6.82
3	EC -165749 × Pusa Gaurav	16.62**	12.12**	9.38*	10.41**
4	LE-56 × Punjab Chhuhara	16.96**	15.34**	21.03**	22.17**
5	LE-56 × Pant T-3	7.17*	2.88	7.96*	8.98*
6	LE-56 × Pusa Gaurav	5.37	1.66	6.68	7.69*
7	LE-62 × Punjab Chhuhara	16.23**	15.48**	17.82**	18.93**
8	LE-62 × Pant T-3	5.51	3.32	4.05	5.04
9	LE-62 × Pusa Gaurav	11.48**	9.74*	10.51**	11.56**
10	LE-64 × Punjab Chhuhara	18.94**	16.54**	18.89**	20.02**
11	LE-64 × Pant T-3	9.30**	8.54*	6.26	7.27
12	LE-64 × Pusa Gaurav	9.06**	8.87*	6.58	7.59
13	LE-65 × Punjab Chhuhara	17.20**	13.30**	15.59**	16.68**
14	LE-65 × Pant T-3	8.87*	8.14*	4.39	5.38

15	LE-65 × Pusa Gaurav	12.42**	11.08**	8.36*	9.39*
16	LE-67 × Punjab Chhuhara	18.24**	8.97*	11.18**	12.23**
17	LE-67 × Pant T-3	16.50**	10.17*	6.35	7.36
18	LE-67 × Pusa Gaurav	12.19**	5.56	2.98	3.96
	S.Ed	2.22	2.56	2.56	2.56

* Significant at 5% level, ** Significant at 1% level

Conclusion

Studies on heterosis revealed that majority of the hybrids exhibited relative heterosis, heterobeltiosis and standard heterosis in desirable direction. The crosses like LE-62 × Pant T-3, LE-64 × Punjab chhuhara, LE-67 × Pant T-3 and LE-56 × Punjab chhuhara for number of flowers per cluster, fruit length, fruit width and pulp yield respectively exhibited high standard heterosis, which offers scope for commercial exploitation through heterosis breeding.

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