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## Per se performance of parents and hybrids for quality traits in tomato (*Solanum lycopersicum* L.)

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### Abstract

The present study was carried out to know the performance of hybrids and their parents for the quality parameters in tomato. Six diverse lines of tomato were crossed with three testers in line x tester mating design. The resultant 18 hybrids were evaluated for quality traits in tomato. The experiment results revealed that the hybrids LE-65 × Punjab Chhuhara (Pericarp thickness), LE-62 × Pant T-3 (TSS), LE-56 × Pusa Gaurav (Ascorbic acid), LE-64 × Punjab Chhuhara (total carotenoids), LE-62 × Punjab Chhuhara (reducing and total sugars), LE-56 × Punjab Chhuhara (Lycopene content) recorded highest quality traits in tomato. The hybrids LE-64 × Punjab Chhuhara and LE-65 × Punjab Chhuhara recorded lowest number of locules per fruit and the lowest titrable acidity was recorded with LE-56 × Pant T-3. The best performing parents can be used for further breeding programmes and hybrids could be exploited for cultivation.

**Keywords:** Tomato, parents, hybrids, mean performance, cultivation

### Introduction

Tomato is the most important vegetable crop of the world, which is consumed as fresh as well as processed vegetable. In India, it has ample scope in the processing industry. The fruit quality and suitability for long distance transport, which has direct bearing on its effective utilization as processed vegetable, are determined by number of locules per fruit, pericarp thickness, total soluble solids and ascorbic acid content. The characters showing wide range of variation have more scope for improvement. Evaluation of hybrids and its parents helps to identify best combination of parents which are resulting in best hybrid with desirable quality traits. And it also helps us to understand the combining ability of parents.

### 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 three standard checks viz; Lakshmi, US-618 and Arka vikas. These lines were crossed in line x tester fashion (Kempthorne, 1957) <sup>[1]</sup> to develop 18 F1 hybrids, which were evaluated along with their parents in randomized block design (Panse and Sukhatme, 1967) <sup>[2]</sup> in three replications at the experimental farm of Vegetable Research Station, Dr. Y.S. R. Horticultural University, Rajendranagar, Hyderabad. Observations were recorded for number of locules per fruit, pericarp thickness (mm), total soluble solids (°Brix), titrable acidity (%), ascorbic acid (mg/100 g), total carotenoid content (mg/100 g), reducing sugars (%), total sugars (%) and lycopene content (mg/100 g). Pericarp thickness was measured with the help of a vernier caliper, total soluble solids with the help of hand refractometer, ascorbic acid, total carotenoid content, reducing sugars, total sugars and lycopene content was estimated by procedure as described by Ranganna (1986) <sup>[3]</sup>.

### Results and Discussion

The mean performance of hybrids and parents (lines and testers) for different quality traits are presented in Table 1.

Number of locules per fruit ranged from 2.20 (LE-56) to 4.67 (EC-165749) with a mean of 3.36 among lines, 2.93 (Punjab Chhuhara) to 4.80 (Pant T-3) with a mean of 3.64 among testers and 2.37 (LE-64 × Punjab Chhuhara and LE-65 × Punjab Chhuhara) to 4.13

(EC-165749 × Pant T-3) with a mean of 3.16 among hybrids. Among the lines LE-56 (2.20) recorded significantly lowest number of locules per fruit but was on par with LE-64 (2.67). While in testers lowest number of locules per fruit was recorded by Punjab Chhuhara (2.93) followed by Pusa Gaurav (3.20). The hybrids LE-64 × Punjab Chhuhara (2.37) and LE-65 × Punjab Chhuhara (2.37) recorded lowest number of locules per fruit, while the highest number of locules per fruit was recorded with EC-165749 × Pant T-3 (4.13). The checks Lakshmi, US-618 and Arka Vikas recorded 4.47, 3.92 and 3.47 locules per fruit, respectively. Sixteen hybrids were significantly superior in number of locules per fruit over the Lakshmi, fourteen hybrids over US-618 and six hybrids over Arka Vikas.

Pericarp thickness is a major trait controlling firmness and keeping quality of tomato fruits. Fruits having high pericarp thickness can withstand shipping and remain firm for more number of days as compared to thin fleshed fruits. Pericarp thickness varied from 2.83 mm (LE-67) to 4.14 mm (EC-165749) among lines, 4.26 mm (Pusa Gaurav) to 4.85 mm (Punjab Chhuhara) among testers and 3.03 mm (LE-67 × Pant T-3) to 6.64 mm (LE-65 × Punjab Chhuhara) among hybrids. The mean pericarp thickness was higher in hybrids (4.68 mm) compared to lines (3.40 mm) and testers (4.59mm). Among the lines EC-165749 (4.14 mm) recorded significantly highest pericarp thickness but was on par with LE-62 (3.92 mm). While in testers highest pericarp thickness was recorded by Punjab Chhuhara (4.85 mm) followed by Pant T-3 (4.66 mm). Among the hybrids the highest pericarp thickness was recorded by LE-65 × Punjab Chhuhara (6.64 mm) but was on par with LE-65 × Pant T-3 (6.46 mm) and LE-67 × Punjab Chhuhara (6.34 mm), while the lowest pericarp thickness was recorded with LE-67 × Pant T-3 (3.03 mm). The checks Lakshmi, US-618 and Arka Vikas recorded 5.33, 4.39 and 3.77 mm pericarp thickness of fruit, respectively. Three hybrids were significantly superior in pericarp thickness over the Lakshmi, nine hybrids over US-618 and twelve hybrids over Arka Vikas.

Total soluble solids (TSS) directly influences flavour of tomato and is an important quality parameter in the processing industry. TSS varied from 4.7 °Brix (LE-62) to 6.13 °Brix (LE-64) with a mean of 5.41°Brix among lines, 4.33°Brix (Pusa Gaurav) to 5.67 °Brix (Punjab Chhuhara) with a mean of 5.16 °Brix among testers and it varied from 4.43 °Brix (EC-165749 × Punjab Chhuhara and LE-67 × Punjab Chhuhara) to 6.4 °Brix (LE-62 × Pant T-3) among the hybrids. Among the lines significantly highest TSS was recorded by LE-64 (6.13) but was on par with EC-165749 (6.00). In testers Punjab Chhuhara (5.67) recorded highest TSS followed by Pant T-3 (5.47). The hybrid LE-62 × Pant T-3 (6.40) recorded significantly highest TSS but was on par with LE-62 × Punjab Chhuhara (6.10) and EC-165749 × Pusa Gaurav (6.00), while the lowest TSS was recorded with EC-165749 × Punjab Chhuhara (4.43) and LE-67 × Punjab Chhuhara (4.43). The checks Lakshmi, US-618 and Arka Vikas recorded 4.73, 4.97 and 5.07°Brix, respectively. Eleven hybrids were significantly superior in TSS over the Lakshmi, six hybrids over US-618 and three hybrids over Arka Vikas. Present findings are in accordance with the reports of Anita *et al.* (2005) [4], Shankar (2010) [5] and Sunil *et al.*, (2013) [6].

Titration acidity ranged from 0.40% (LE-56) to 0.59% (EC-165749 and LE-65) with a mean of 0.53% among lines,

0.40% (Punjab Chhuhara) to 0.45% (Pusa Gaurav) with a mean of 0.42% among testers and 0.34% (LE-56 × Pant T-3) to 0.53% (LE-65 × Punjab Chhuhara) with a mean of 0.43% among the hybrids. Among the lines LE-56 (0.40%) recorded significantly lowest titrable acidity followed by LE-62 (0.51%). While in testers lowest titrable acidity was recorded by Punjab Chhuhara (0.40%) followed by Pant T-3 (0.42%). Among the hybrids the lowest titrable acidity was recorded with LE-56 × Pant T-3 (0.34%) which was on par with LE-62 × Pant T-3 (0.35%), LE-67 × Pusa Gaurav (0.37%), LE-56 × Punjab Chhuhara (0.38%) and LE-56 × Pusa Gaurav (0.39%), while the highest titrable acidity was recorded with LE-65 × Punjab Chhuhara (0.53%). The checks Lakshmi, US-618 and Arka Vikas recorded 0.44, 0.42 and 0.36% titrable acidity, respectively. One hybrid was significantly superior in titrable acidity over the Lakshmi, two hybrids over US-618 and seven hybrids over Arka Vikas.

Ascorbic acid content of the fruit varied from 19.00 mg/100 g (LE-62) to 35.11 mg/100 g (LE-65) with a mean of 27.29 mg/100 g among lines, 23.33 (Pant T-3) to 28.00 mg/100 g (Punjab Chhuhara) with a mean of 25.55 mg/100 g among testers and 17.06 (EC-165749 × Pant T-3) to 41.67 mg/100 g (LE-56 × Pusa Gaurav) with a mean of 28.61 mg/100g among the hybrids. Among the lines significantly highest ascorbic acid content was recorded by LE-65 (35.11 mg/100 g) but was on par with EC-165749 (31.00 mg/100 g). In testers Punjab Chhuhara (28.00 mg/100 g) recorded highest ascorbic acid content followed by Pusa Gaurav (25.33 mg/100 g). The hybrid LE-56 × Pusa Gaurav (41.67 mg/100 g) recorded significantly highest ascorbic acid but was on par with LE-64 × Punjab Chhuhara (41.00 mg/100 g), LE-56 × Pant T-3 (40.67 mg/100 g), LE-56 × Pant T-3 (39.33 mg/100 g), LE-56 × Punjab Chhuhara (38.67 mg/100 g) and LE-67 × Pusa Gaurav (37.33 mg/100 g), while the lowest ascorbic acid content was recorded with EC-165749 × Pant T-3 (17.06 mg/100 g). The checks Lakshmi, US-618 and Arka Vikas recorded 22.00, 24.67 and 29.33 mg/100 g ascorbic acid, respectively. Eight hybrids are significantly superior in ascorbic acid over the Lakshmi, while seven hybrids were found to be significant over both the checks US-618 and Arka Vikas. The results are in agreement the results of Anita *et al.* (2005) [4] and Shankar (2010) [5].

Carotenoids are important factors in human health and essential for vision. The Carotenoids are the main dietary source of Vitamin A. Total carotenoid content of the fruit varied from 6.80 mg/100 g (EC-165749) to 11.80 mg/100 g (LE-64) with a mean of 9.13 mg/100 g among lines, 8.07 (Pusa Gaurav) to 10.10 mg/100 g (Punjab Chhuhara) with a mean of 9.21 mg/100 g among testers and 6.92 (LE 62 × Pusa Gaurav) to 11.53 mg/100 g (LE 64 × Punjab Chhuhara) with a mean of 9.02 mg/100 g among the hybrids. Among the lines LE-64 (11.80 mg/100 g) recorded significantly highest total carotenoid content followed by LE-65 (10.67 mg/100 g). While in testers highest total carotenoids was recorded by Punjab Chhuhara (10.10 mg/100 g) followed by Pant T-3 (9.46 mg/100 g). Among the hybrids the highest total carotenoids was recorded with LE-64 × Punjab Chhuhara (11.53 mg/100 g) which was on par with LE-56 × Punjab Chhuhara (11.14 mg/100 g) and LE-65 × Pusa Gaurav (10.90 mg/100g), while the lowest total carotenoid content was recorded with LE-62 × Pusa Gaurav (6.92 mg/100 g). The checks Lakshmi, US-618 and

Arka Vikas recorded 7.91, 7.21 and 8.50 mg/100 g total carotenoid content, respectively. Ten hybrids were significantly superior in total carotenoids over the Lakshmi, eleven hybrids over US-618 and six hybrids over Arka Vikas.

Reducing sugars ranged from 2.16% (LE-62) to 3.54% (EC-165749) with a mean of 2.85% among lines, 1.62% (Pusa Gaurav) to 3.26% (Punjab Chhuhara) with a mean of 2.61% among testers and 1.74% (EC-165749 × Punjab Chhuhara) to 3.74% (LE-62 × Punjab Chhuhara) with a mean of 2.80% among the hybrids. Among the lines significantly highest reducing sugars was recorded by EC-165749 (3.54%) but was on par with LE-67 (3.26%). In testers Punjab Chhuhara (3.26%) recorded highest reducing sugars followed by Pant T-3 (2.94%). The hybrid LE-62 × Punjab Chhuhara (3.74%) recorded significantly highest reducing sugars but was on par with LE-62 × Pant T-3 (3.69%) and EC-165749 × Pusa Gaurav (3.65%), while the lowest reducing sugars was recorded with EC-165749 × Punjab Chhuhara (1.74%). The checks Lakshmi, US-618 and Arka Vikas recorded 2.43, 2.24 and 2.43% reducing sugars, respectively. Twelve hybrids are significantly superior in reducing sugars over the US-618, while eight hybrids were found to be significant over both the checks Lakshmi and Arka Vikas.

Total sugars ranged from 2.66% (LE-62) to 4.19% (LE-64) with a mean of 3.33% among lines, 2.17% (Pusa Gaurav) to 3.68% (Punjab Chhuhara) with a mean of 3.10% among testers and 2.49% (LE-67 × Punjab Chhuhara) to 4.20% (LE-62 × Punjab Chhuhara) with a mean of 3.27% among the hybrids. Among the lines LE-64 (4.19%) recorded significantly highest total sugars followed by EC-165749 (3.58%). While in testers highest total sugars was recorded by Punjab Chhuhara (3.68%) followed by Pant T-3 (3.45%). Among the hybrids the highest total sugars was recorded with LE-62 × Punjab Chhuhara (4.20%) which was on par with LE-62 × Pant T-3 (4.03%), LE-56 × Pusa Gaurav (3.88%) and EC-165749 × Pusa Gaurav (3.87%), while the

lowest total sugars was recorded with LE-67 × Punjab Chhuhara (2.49%). The checks Lakshmi, US-618 and Arka Vikas recorded 2.53, 2.80 and 3.27% total sugars, respectively. Four hybrids are significantly superior in total sugars over the Arka Vikas, while twelve hybrids were found to be significant over both the checks Lakshmi and US-618.

Lycopene content varied from 4.31 mg/100 g (EC-165749) to 8.66 mg/100 g (LE-64) with a mean of 6.53 mg/100 g among lines, 5.47 (Pusa Gaurav) to 7.5 mg/100 g (Punjab Chhuhara) with a mean of 6.80 mg/100 g among testers and 4.03 mg/100 g (LE-62 × Pusa Gaurav) to 9.43 mg/100 g (LE-56 × Punjab Chhuhara) with mean of 6.81 mg/100 g among the hybrids. Among the lines LE-64 (8.66 mg/100 g) recorded significantly highest lycopene followed by LE-65 (7.55 mg/100 g). While in testers highest lycopene content was recorded by Punjab Chhuhara (7.50 mg/100 g) followed by Pant T-3 (7.44 mg/100 g). The hybrid LE-56 × Punjab Chhuhara (9.43 mg/100 g) recorded significantly highest lycopene content but was on par with LE-64 × Punjab Chhuhara (9.30 mg/100 g), LE-62 × Punjab Chhuhara (8.96 mg/100 g), LE-65 × Pusa Gaurav (8.60 mg/100 g) and LE-56 × Pusa Gaurav (8.58 mg/100 g), while the lowest lycopene content was recorded with LE-62 × Pusa Gaurav (4.03 mg/100 g). The checks Lakshmi, US-618 and Arka Vikas recorded 5.43, 5.0 and 6.69 mg/100 g, respectively. Five hybrids are significantly superior in lycopene content over the Arka Vikas, while twelve hybrids were found to be significantly superior over both the checks Lakshmi and US-618. The present results are getting support from the findings of Shankar (2010) [5].

From the present findings, it can be summarized that based on quality traits, top hybrids for quality parameters were viz., LE-65 × Punjab Chhuhara, LE-64 × Punjab Chhuhara, LE-62 × Pant T-3, LE-56 × Pusa Gaurav, LE-62 × Punjab Chhuhara, LE-56 × Punjab Chhuhara. Hence, these should be utilized for further breeding programmes for desirable trait improvement.

**Table 1:** Per se performance of hybrids, parents and commercial checks for quality characters in tomato.

S. No.	Hybrids	No of locules/fruit	Pericarp thickness (mm)	TSS (°Brix)	Titration acidity (%)	Ascorbic acid content (mg/100 g)	Total carotenoid content (mg/100 g)	Reducing sugars (%)	Total sugars (%)	Lycopene content (mg/100 g)
1	EC-165749 × Punjab Chhuhara	4.00	5.95	4.43	0.47	26.00	9.20	1.74	2.50	6.92
2	EC-165749 × Pant T-3	4.13	5.59	4.50	0.51	17.06	8.54	1.99	2.62	6.62
3	EC-165749 × Pusa Gaurav	3.80	4.66	6.00	0.49	18.00	7.97	3.65	3.87	6.48
4	LE-56 × Punjab Chhuhara	3.20	5.71	5.47	0.38	38.67	11.14	3.15	3.54	9.43
5	LE-56 × Pant T-3	3.40	3.97	5.50	0.34	40.67	7.85	3.05	3.44	5.42
6	LE-56 × Pusa Gaurav	3.00	5.40	5.53	0.39	41.67	10.63	3.31	3.88	8.58
7	LE-62 × Punjab Chhuhara	2.64	3.81	6.10	0.41	24.00	10.39	3.74	4.20	8.96
8	LE-62 × Pant T-3	3.44	4.84	6.40	0.35	17.33	9.00	3.69	4.03	7.14
9	LE-62 × Pusa Gaurav	2.63	4.18	5.33	0.42	34.33	6.92	2.82	3.43	4.03
10	LE-64 × Punjab Chhuhara	2.37	5.60	5.17	0.40	41.00	11.53	2.74	3.28	9.30
11	LE-64 × Pant T-3	3.13	5.32	5.00	0.43	39.33	7.33	2.33	2.71	4.63
12	LE-64 × Pusa Gaurav	2.80	3.46	5.33	0.41	22.67	10.15	2.74	3.29	7.55
13	LE-65 × Punjab Chhuhara	2.37	6.64	5.03	0.53	19.33	7.30	2.58	2.90	4.45
14	LE-65 × Pant T-3	3.60	6.46	5.43	0.47	26.00	9.34	2.99	3.35	6.90
15	LE-65 × Pusa Gaurav	3.20	3.21	5.43	0.49	21.00	10.90	2.91	3.30	8.60
16	LE-67 × Punjab Chhuhara	3.02	6.34	4.43	0.45	23.33	7.98	2.08	2.49	5.73
17	LE-67 × Pant T-3	3.37	3.03	5.40	0.40	27.33	7.35	2.75	3.31	5.41
18	LE-67 × Pusa Gaurav	2.83	4.88	4.97	0.37	37.33	8.84	2.20	2.68	6.34
	Hybrid mean	3.16	4.68	5.30	0.43	28.61	9.02	2.80	3.27	6.81



Table 1: Continued

S. No.	Lines	No of locules/fruit	Pericarp thickness (mm)	TSS (°Brix)	Titration acidity (%)	Ascorbic acid content (mg/100 g)	Total carotenoid content (mg/100 g)	Reducing sugars (%)	Total sugars (%)	Lycopene content (mg/100 g)
19	EC-165749	4.67	4.14	6.00	0.59	31.00	6.80	3.54	3.58	4.31
20	LE-56	2.20	2.96	4.93	0.40	30.00	7.68	2.29	2.91	5.40
21	LE-62	2.97	3.92	4.70	0.51	19.00	8.28	2.16	2.66	5.87
22	LE-64	2.67	3.16	6.13	0.54	21.31	11.80	3.14	4.19	8.66
23	LE-65	3.17	3.39	5.17	0.59	35.11	10.67	2.70	3.06	7.55
24	LE-67	4.50	2.83	5.53	0.53	27.33	9.55	3.26	3.57	7.37
	Lines mean	3.36	3.40	5.41	0.53	27.29	9.13	2.85	3.33	6.53
25	Punjab Chhuhara	2.93	4.85	5.67	0.40	28.00	10.10	3.26	3.68	7.50
26	Pant T-3	4.80	4.66	5.47	0.42	23.33	9.46	2.94	3.45	7.44
27	Pusa Gaurav	3.20	4.26	4.33	0.45	25.33	8.07	1.62	2.17	5.47
	Testers mean	3.64	4.59	5.16	0.42	25.55	9.21	2.61	3.1	6.8
28	Lakshmi	4.47	5.33	4.73	0.44	22.00	7.91	2.43	2.53	5.43
29	US-618	3.92	4.39	4.97	0.42	24.67	7.21	2.24	2.80	5.00
30	Arka Vikas	3.47	3.77	5.07	0.36	29.33	8.50	2.43	3.27	6.69
	Mean	3.33	4.56	5.27	0.45	27.72	8.95	2.75	3.22	6.64
	C.V.	8.56	8.37	5.31	10.29	9.67	6.05	8.65	8.24	7.90
	S.E.	0.16	0.22	0.16	0.03	1.55	0.31	0.14	0.15	0.30
	C.D. 5%	0.47	0.62	0.46	0.08	4.38	0.88	0.39	0.43	0.86
	C.D. 1%	0.62	0.83	0.61	0.1	5.83	1.18	0.52	0.58	1.14

### Conclusion

The present study revealed substantial variability among tomato hybrids and their parental lines for key quality traits such as locules number, pericarp thickness, TSS, titration acidity, ascorbic acid, total carotenoids, and reducing sugars. Several hybrids outperformed standard checks in one or more traits, indicating their potential for processing and market suitability. Hybrids like LE-65 × Punjab Chhuhara and LE-62 × Pant T-3 exhibited superior fruit quality parameters, highlighting the effectiveness of line × tester analysis in identifying promising parental combinations. These findings provide valuable insights into the combining ability of parents, facilitating future breeding programs focused on enhancing tomato fruit quality and processing attributes for both domestic and industrial use.

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