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Mean Performance of the Parents and Hybrids for Yield and Yield Contributing Traits in Tomato

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A B S T R A C T

A field experiment was conducted during early *Summer*, 2017 in Randomized Block Design with three replications at College of Horticulture, SKLTSHU, Telangana. Seven diverse lines of tomato were crossed with three testers in line x tester mating design. The resultant 21 hybrids were evaluated for twenty yield and yield contributing traits in tomato. The experiment results revealed that hybrid EC 620494 x ArkaVikas performed best for characters *viz.*, fruit yield per plant (3.13 kg), average fruit weight (58.80 g), days to first flowering (30.67) and days to last harvest (131.06) when compared to all other hybrids. Besides, other hybrid EC 620494 x Pusa Ruby also showed superior performance for fruit yield per plant (3.10kg), average fruit weight (57.41 g), yield per hectare(111.05 t/ha), plant height (92.73 cm), days to last harvest (131.13) and fruit pH (4.03).

Introduction

Tomato (*Solanum lycopersicum* L.) belongs to the family Solanaceae. Tomato has acquired the status of world's most popular vegetable crop due to its wider adaptability to various agro climatic conditions (Gupta *et al.*, 2015). Tomato is a perennial plant but commonly cultivated as an annual (Rick, 1978), and ranks second to potato in many countries.). In Telangana tomato cultivated in an area of 0.053 million hectares with a production of 1.08 million tonnes and productivity of20.37tonnes per hectare. (Anonymous, 2015-2016). Tomato is considered as protective food crop because of having rich source of minerals, vitamins and organic acids. Tomatoes are important source of lycopene, ascorbic acid and carotene valued for their colour, flavour and antioxidant properties. The increasing consumption of tomato makes it, a high value crop for generating income to the farmers. Since tomato is an important crop both from production and industry point of view there is a necessity to improve the productivity per

unit area to achieve the increased production from a limited land. Improving the productivity through traditional plant breeding method means, it is sustainable, affordable and ecofriendly. Generally, diverse parents are expected to give high hybrid vigour and it is also often possible to combine desired alleles in regular fashion without waiting for longer term as in case of development of an open pollinated cultivars. Usually, the hybrids show better fitness and breeding value as compared to parents from which they are made. Higher yield and better fruit quality are universally desired.

Materials and Methods

The experimental material consists of seven diverse genotypes of tomato *viz.,* EC 620408, EC 620494, EC 654289, EC 620639, EC 631410, EC 631407 and LA 3667, which were crossed with three testers *viz.,* Pusa Ruby, ArkaVikas and ArkaMegahli in line x tester mating design to obtain twenty one cross combinations. The 21 hybrids along with parents and three standard checks (Arka Rakshak, US 440 and Punjab Chhuhara) were evaluated during early *Summer,* 2017 at PG students Research farm, College of Horticulture, Sri Konda Laxman Telangana State Hortcultural University, Rajendranagar, Hyderabad-30. The experiment was laid out in a Randomized Block Design with three replications. The mean performance of twenty yield and yield related traits *viz.,*plant height (cm), number of primary branches per plant, number of flower clusters per plant, number of flowers per cluster, days to first flowering, days to 50% flowering, days to first harvest, days to last harvest, number of fruits per cluster, number of fruits per plant, number of marketable fruits per plant, fruit length (cm), fruit width (cm), fruit weight (gm), fruit yield per plant (kg), yield per hectare (tons), TSS (°Brix), pH, ascorbic acid (mg/100g) and lycopene (mg/100g). The data was subjected to subject to statistical analysis (Panse and Sukhatme, 1985).

Results and Discussion

The results revealed significant variation among genotypes for the characters. High vegetative vigour in the hybrids in terms of increased plant height is desirable. Among parents plant height ranged (Table 1) from 53.73 cm in EC654289 to 94.87 cm in EC 620408. Among hybrids, it ranged from 54.00 cm in LA 3667 x Pusa Ruby to 106.20 cm in EC 620494 x ArkaMeghali with an average of 71.27 cm. Hybrids *viz.,* EC 620494 x ArkaMeghali (106.20 cm) and EC 620494 x Pusa Ruby (92.73 cm) were recorded maximum plant height. Results are confirmed with earlier reports of Ravindra Kumar *et al.,* (2012), Narasimha Murthy *et al.,* (2013), Sunil *et al.,* (2013) and Sujeet Kumar and Ramanjini Gowda (2016). The numbers of branches in parents ranged from 4.39 in EC 620494 to 7.13 in Pusa Ruby. Among the crosses, it ranged from 3.84 in EC 631407 × Arka Vikas to 7.68 in EC 654289 × Pusa Ruby with an average of 5.82. Among 21 hybrids, 8 hybrids showed significant superior mean performance than the standard check US440 for number of branches per plant. The present result getting support from the findings of Shankar *et al.,* (2014) and Sujeetkumar and Ramanjinigowda (2016). The number of flower clusters per plant ranged from 6.73 in ArkaMeghali to 12.07 in Pusa Ruby. Among hybrids, this character was ranged from 5.80 in EC 620639 × Arka Vikas to 14.07 in EC 620639 × Pusa Ruby with an average of 9.46. The hybrids *viz.,* EC 654289 x Pusa Ruby (13.60), EC 654289 x ArkaVikas (13.47), EC 654289 x ArkaMeghali (13.40) and EC 631410 x Arka Vikas (13.07) were significantly on par with the hybrid EC 620639 x Pusa Ruby (14.07). Results for number of flower clusters per plan are in agreement with result of Vilas *et al.,*

(2015). Among parents, the number of flowers per cluster ranged from 3.65 in Pusa Ruby to 8.15 in EC 654289. Among the hybrids, numbers of flowers per cluster were ranged from 4.06 (EC 631410 × ArkaMeghali) to 8.79 (EC 654289 × ArkaVikas) with an average of 5.44, which is superior to standard checks Arka Rakshak and Punjab Chhuhara. The results are in close conformity with the findings of Shankar *et al.*, (2014) and Vilas *et al.*, (2015).

Among parents, EC 620639 and among hybrids EC 620494 x Pusa Ruby was showed early flowering. The hybrids *viz.*, EC 620494 x Pusa Ruby (30.73 days), EC 620494 x ArkaMeghali (30.87 days), and EC 654289 x ArkaMeghali (31.07 days) showed earliness in flowering compared to all other hybrids. Days to 50% flowering was ranged from 32.67 days in Pusa Ruby and Arka Vikas to 34.00 days in ArkaMeghali. Among hybrids, this character was ranged from 31.33 in EC 620494 × Arka Vikas to 35.67 in LA 3667 × ArkaMeghali. The hybrids *viz.*, EC 620494 x Pusa Ruby (31.67 days), EC 654289 x Arka Vikas (32 days) were on par with the early flowering hybrid EC 620494 × Arka Vikas (31.33 days). The results are in accordance with the results of Ravindra Kumar *et al.*, (2012) and Shankar *et al.*, (2014). Earliness was observed in EC 631407 (63.50 days) and in hybrid EC 631407 × Pusa Ruby (61.30 days). Among 21 hybrids, 9 hybrids significantly superior for early harvest when compared to best check US 440 (64.63 days). Longer harvesting period was desirable for getting higher yields. Higher mean value for days to last harvest was recorded in EC 631410 (126.17 days) and EC 654289 (125.82 days), EC 620494 (125.71 days)

Number of fruits per cluster was ranged from 1.29 in LA 3667 to 4.40 in EC 631410 with an average of 2.93 among parents. In hybrids, the number of fruits per cluster was ranged from 2.05 in LA 3667 × Arka Meghali to 4.49 in EC 654289 × Arka Vikas with an average of 3.09.Among 21 hybrids, 7 hybrids were showed significantly more number of fruits per cluster in comparison with best check US 440.These results are in agreement with the previous findings of Vilas *et al.*, (2015) and Sujeet Kumar and Ramanjini Gowda (2016). Higher mean value for number of fruits per plant was recorded in EC 620639 (60.09) and EC 654289 (60.51). Eight hybrids *viz.*, EC 620639 x Pusa Ruby (76.78), EC 654289 x Pusa Ruby (73.21), EC 631410 x Pusa Ruby (70.00), LA 3667 x ArkaVikas (67.51), LA 3667 x Pusa Ruby (64.93), EC 631410 x ArkaMeghali (62.83), EC 620639 x ArkaVikas (61.76) and EC 620639 x ArkaMeghali (60.89) were significantly superior to the best check US 440 (60.83) for number of fruits per plant considered. The number of marketable fruits per plant was ranged from 31.95 in EC 620494 to 49.53 in EC 620639 among parents. Among hybrids, this character was ranged from 32.08 in EC 631407 × Arka Vikas to 62.08 in EC 620639 × Pusa Ruby with an average of 45.67.

Fruit length was ranged from 2.65 cm in EC 654289 × Pusa Ruby to 4.08 cm to LA 3667 × Pusa Ruby, with an average of 3.50 cm. None of the hybrids were significant and superior with respect to fruit length (cm) compared to best check Arka Rakshak (5.27 cm). The mean values of hybrids for fruit length (cm) were presented in Table 1b. The results are in close conformity with the findings of Gul *et al.*, (2010) and Sunil *et al.*, (2013). Five hybrids *viz.*, LA 3667 x Pusa Ruby (4.92 cm), EC 631410 x ArkaMeghali (4.89 cm), LA 3667 x Arka Vikas (4.82 cm), EC 620408 x ArkaMeghali (4.54 cm) and EC 620494 x Pusa Ruby (4.40 cm) showed significantly higher fruit width compared to best check US 440 (4.32 cm). Similar results were also reported by Gul *et al.*, (2010) and Sunil *et al.*, (2013).

Table.1a Mean performance of crosses for plant height (cm), number of primary branches per plant, number of flower clusters per plant, number of flowers per cluster, days to first flowering, days to 50% flowering, days to first harvest, days to last harvest, number of fruits per cluster and number of fruits per plant in Tomato

Treatments	Plant height (cm)	Number of primary branches	No of flower clusters per plant	Number of flowers per cluster	Days to first flowering	Days to 50% flowering	Days to first harvest	Days to last harvest	Number of fruits per cluster	Number of fruits per plant
CROSSES										
EC 620408 x Pusa Ruby	64.27	5.60	6.33	4.66	32.53	33.33	64.53	118.90	3.14	40.83
EC 620408 x ArkaVikas	66.93	6.57	9.67	5.30	33.87	33.00	65.32	122.19	2.27	42.59
EC 620408 x ArkaMeghali	68.13	5.37	9.33	4.84	32.20	33.33	64.67	122.10	2.65	57.30
EC 620494 x Pusa Ruby	92.73	6.42	11.00	4.75	30.73	31.67	66.17	131.13	3.10	52.05
EC 620494 x ArkaVikas	83.53	7.27	11.20	5.29	30.67	31.33	64.50	131.06	2.42	51.63
EC 620494 x ArkaMeghali	106.20	7.28	8.33	4.55	30.87	33.00	64.50	131.36	3.81	49.44
EC 654289 x Pusa Ruby	75.47	7.68	13.60	6.20	31.60	33.33	64.53	119.27	4.41	73.21
EC 654289 x ArkaVikas	58.13	4.35	13.47	8.79	31.80	32.00	61.73	124.23	4.49	54.23
EC 654289 x ArkaMeghali	55.93	4.35	13.40	7.12	31.07	33.00	62.48	119.57	3.94	53.77
EC 620639 x Pusa Ruby	85.17	7.41	14.07	5.92	31.27	33.00	63.21	121.37	4.40	76.78
EC 620639 x ArkaVikas	64.40	4.20	5.80	5.35	31.80	33.00	63.60	118.87	2.89	61.76
EC 620639 x ArkaMeghali	66.37	5.50	8.27	4.34	30.67	33.00	62.55	117.86	2.41	60.89
EC 631407 x Pusa Ruby	75.93	5.50	7.13	4.31	32.07	32.67	61.30	129.08	2.51	52.87
EC 631407 x ArkaVikas	54.80	3.84	7.27	5.06	32.60	32.67	64.23	126.58	3.25	38.47
EC 631407 x ArkaMeghali	66.60	4.79	9.47	7.04	31.07	32.67	64.60	126.67	4.07	48.33
EC 631410 x Pusa Ruby	86.97	5.95	6.13	4.65	32.60	33.00	64.47	128.07	3.21	70.00
EC 631410 x ArkaVikas	66.53	5.40	13.07	5.36	31.47	33.67	65.40	119.60	2.43	57.86
EC 631410 x ArkaMeghali	58.53	6.40	8.80	4.06	33.13	34.67	68.70	118.53	2.89	62.83
LA 3667 x Pusa Ruby	54.00	4.76	6.53	4.29	33.27	35.00	73.13	118.98	2.43	64.93
LA 3667 x ArkaVikas	74.60	7.08	8.13	6.18	33.07	35.00	75.13	121.85	2.19	67.51
LA 3667 x ArkaMeghali	71.53	6.57	7.62	6.14	34.18	35.67	71.81	118.29	2.05	40.83
Crosses mean	71.27	5.82	9.46	5.44	32.03	33.24	65.55	123.12	3.09	56.10
CHECKS										
ArkaRakshak	68.60	5.59	8.20	4.45	31.93	32.33	71.70	135.67	3.07	56.06
US440	61.30	5.80	9.20	5.94	30.73	31.67	64.63	133.66	3.21	60.83
Punjab Chhuhara	67.93	5.49	6.67	4.81	33.93	34.67	82.73	130.79	2.17	50.46
SE.D	0.78	0.09	0.40	0.17	0.66	0.63	0.40	6.20	0.11	1.22
CD (0.05)	2.21	0.26	1.11	0.50	1.89	1.79	0.99	17.52	0.33	3.43
CD (0.01)	2.94	0.34	1.48	0.66	2.50	2.38	1.31	23.27	0.44	4.56

Table.1b Mean performance of crosses for number of marketable fruits per plant, fruit length (cm), fruit width (cm), average fruit weight (g), fruit yield per plant (Kg), yield per hectare (tons.), pH, TSS (°Brix), ascorbic acid (mg/100g) and lycopene (mg/100g) in Tomato

Treatments	Number of marketable fruits per plant	Fruit length (cm)	Fruit width (cm)	Average fruit weight (g)	Fruit yield per plant (Kg)	Yield per hectare (t)	TSS (°Brix)	pH	Ascorbic acid (mg/100g)	Lycopene (mg/100g)
Crosses										
EC 620408 x Pusa Ruby	32.35	3.51	3.67	27.23	1.13	40.82	6.17	4.02	23.67	3.56
EC 620408 x ArkaVikas	33.44	3.64	3.97	28.87	1.25	44.52	6.10	4.15	22.80	8.15
EC 620408 x ArkaMeghali	45.63	3.74	4.54	50.74	2.67	108.31	6.40	4.03	20.79	3.65
EC 620494 x Pusa Ruby	42.14	3.64	4.40	57.41	3.10	111.05	5.47	4.03	21.35	2.65
EC 620494 x ArkaVikas	40.96	3.87	4.15	58.80	3.13	78.06	5.63	4.12	21.90	3.38
EC 620494 x ArkaMeghali	39.73	3.16	3.18	30.58	1.67	55.53	5.40	4.06	23.43	7.71
EC 654289 x Pusa Ruby	58.00	2.65	3.07	30.50	2.20	82.60	5.77	4.13	26.05	3.54
EC 654289 x ArkaVikas	43.22	3.44	2.82	15.94	0.95	31.30	5.73	4.10	25.73	4.52
EC 654289 x ArkaMeghali	42.42	3.24	2.36	30.64	1.66	59.33	7.33	4.04	24.28	9.27
EC 620639 x Pusa Ruby	62.08	2.97	3.51	25.77	2.02	74.04	6.23	3.95	27.02	3.31
EC 620639 x ArkaVikas	49.13	3.28	3.65	31.60	1.80	69.96	6.23	4.11	26.69	3.87
EC 620639 x ArkaMeghali	48.31	3.45	3.92	30.93	1.87	68.09	5.33	4.08	26.57	3.14
EC 631407 x Pusa Ruby	42.26	3.27	3.85	33.60	1.87	69.13	5.40	4.05	26.72	5.74
EC 631407 x ArkaVikas	32.08	4.04	4.12	28.73	1.17	41.32	6.40	4.19	24.68	4.13
EC 631407 x ArkaMeghali	40.21	3.70	3.10	20.94	1.08	37.72	6.60	4.22	25.27	5.12
EC 631410 x Pusa Ruby	51.15	3.54	3.86	38.96	2.32	91.15	5.63	3.97	24.63	3.54
EC 631410 x ArkaVikas	47.77	3.58	3.94	41.97	2.35	91.47	5.07	4.10	25.22	3.69
EC 631410 x ArkaMeghali	50.95	4.06	4.89	41.40	2.41	94.02	5.73	4.12	24.20	8.11
LA 3667 x Pusa Ruby	52.64	4.08	4.92	30.19	2.01	72.62	4.30	3.85	21.75	5.89
LA 3667 x ArkaVikas	54.89	3.34	4.82	32.84	2.33	82.39	5.50	3.93	23.00	7.28
LA 3667 x ArkaMeghali	49.71	3.24	4.10	32.04	2.01	73.03	5.25	3.41	23.04	7.07
Crosses mean	45.67	3.50	3.85	34.27	1.95	70.31	5.79	4.03	24.23	45.67
CHECKS										
ArkaRakshak	48.56	5.27	4.22	48.45	2.78	101.14	5.55	4.05	25.34	4.78
US-440	49.12	3.92	4.32	45.01	2.84	101.63	5.59	4.15	20.09	6.59
Punjab Chhuhara	40.78	4.57	3.84	40.48	1.69	74.26	4.24	4.25	26.99	6.53
SE.D	0.76	0.098	0.087	0.379	0.110	5.70	0.09	0.042	0.33	0.09
CD (0.05)	2.137	0.28	0.25	1.07	0.31	16.10	0.27	0.19	0.93	0.25
CD (0.01)	2.84	0.37	0.33	1.42	0.41	21.39	0.36	0.16	1.24	0.33

Three hybrids, EC 620494 x ArkaVikas (58.80 g), EC 620494 x Pusa Ruby (57.41g) and EC 620408 x ArkaMeghali (50.74 g) recorded higher fruit weight compared to best check Arka Rakshak (48.45 g). Gul *et al.*, (2010), Ravindra Kumar *et al.*, (2012) and Sujeet and Ramanjini Gowda (2016) are also reported the similar results. The fruit yield per plant was high in ArkaVikas (1.82 kg). Among hybrids, this character was ranged from 0.95 Kg in EC 654289 × ArkaVikas to 3.13 Kg in EC 620494 × Arka Vikas with an average mean 1.95 Kg. Two hybrids EC 620494 x Arka Vikas(3.13 Kg) and EC 620494 x Pusa Ruby (3.10 Kg) were recorded high fruit yield per plant compared to best check US 440 (2.84 Kg). The present findings are in accordance with the results of Basavaraj *et al.,* (2016) and Sujeetkumar and Ramanjini Gowda (2016). In hybrids, yield per hectare was ranged from 31.30 tons EC 654289 × Arka Vikas to 111.05 tons in EC 620494 × Pusa Ruby. Two hybrids, EC 620494 x Pusa Ruby (111.05) and EC 620408 x ArkaMeghali (108.31 tons) exhibited superior performance compared to best check US 440 (101.63 tons.) for this character. Similar result is also reported by Sunil *et al.*, (2013).

TSS ranged from 4.30 in LA 3667 x Pusa Ruby to 7.33 in EC 654289 x ArkaMeghali, with a mean 5.79. Among 21 hybrids, 13 hybrids showed significantly superior TSS (°Brix) compared to best check US 440 (5.59). The mean values of hybrids for TSS were presented in Table 1b. Present findings are in accordance with the reports of Shankar *et al.,* (2014) and Basavaraj *et al.,* (2016). pH in negative direction was desirable. In hybrids, it was ranged from 3.41 in LA 3667 × ArkaMeghali to 4.22 in EC 631407 × ArkaMeghali with a mean 4.03. All the twenty one hybrids have less pH value compared to quality check Punjab Chhuhara (4.25). Basavaraj *et al.,* (2016) recorded similar results for this character. Ascorbic acid content is nutritionally an important constituent. Small fruited genotypes are generally richer in ascorbic acid content among hybrids, this character was varied from 20.79 mg/100g in EC 620408 × ArkaMeghali to 27.02 mg/100g in EC 620639 × Pusa Ruby with a mean 24.23 mg/100g. The results are in agreement the results of Shankar *et al.*, (2014) and Basavaraj *et al.,* (2016). All hybrids registered higher ascorbic acid content compared to check US 440 (20.09 mg/100g). For, lycopene (mg/100g) five hybrids *viz.,* EC 654289 x ArkaMeghali (9.27), EC 620408 x ArkaVikas (8.15), EC 631410 x ArkaMeghali (8.11), EC 620494 x ArkaMeghali (7.71) and LA 3667 x ArkaVikas (7.28) were showed significant and superior values for lycopene compared best check US 440 (6.59). The present results are getting support from the findings of Shankar *et al.,* (2014) and Basavaraj *et al.,* (2016).

From the present findings, it can be summarized that based on mean worth, top five hybrids for fruit yield per plant were *viz.*, EC 620494 x ArkaVikas (3.13 kg), EC 620494 x Pusa Ruby (3.10kg), EC 620408 x ArkaMeghali (2.67 kg), EC 631410 x Arka Vikas 92.41 kg) and EC 631410 x ArkaVikas (2.35 kg). Hence, these should be utilized for future breeding programmes for desirable trait improvement.

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