

Original Research Article

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Evaluation of Tomato (*Solanum lycopersicum* L.) Hybrids during Rainy Season in Coastal Plain of Odisha, India

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ABSTRACT

Tomato grown during the main season (winter) causes a glut of produce in the market and its sale price is also very low. But the crop grown in rainy season has a better demand and is much remunerative for the farmer. Therefore, the present experiment was undertaken to develop and identify tomato hybrids well adapted to the rainy season. The experiment was conducted at the All India Co-ordinated Research Project on Vegetable Crops, Orissa University of Agriculture and Technology, Bhubaneswar. Forty five F₁ hybrids were developed by crossing 10 divergent parental lines in half diallel fashion during 2016-17 (winter). The 45 F₁ hybrids along with the 10 parents were evaluated in Randomised Block Design with three replications during the rainy season of 2017. Analysis of variance revealed significant differences among the hybrids for all the characters. The parent BT 317 proved to be the best with respect to characters like fruit yield per plant, average fruit weight, plant height, fruits per plant, fruit girth, fruit pericarp thickness, no. of clusters per plant and no. of locules per fruit. The hybrids BT 217 x BT 215-3-3-1 and TOBW-3 x BT 215-3-3-1 proved to be best with regard to fruit yield/plant (943.64 g and 651.24 g respectively), average fruit weight (37.00 g and 35.20 g in order), fruit length (5.96 cm and 6.10 cm), fruit girth (5.86 cm and 5.70cm), fruits per plant (27.18). BT 106 x BT317 was promising for earliness i.e. days to first flowering (64.00 days). The hybrid BT 305-2-4-2 x BT 215-3-3-1 was the best for fruit pericarp thickness (0.64 cm). In respect of plant height, the hybrid BT317x BT 429-1-1 was found to be promising (110.40 cm). Fruit length of BT 215-3-3-1 was the maximum.

Keywords

Tomato, Off-season, Evaluation, Rainy season, Hybrid

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Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most popular and widely grown vegetables in the world. It belongs to the family Solanaceae. It originated in a wild form in the Peru-Ecuador Bolivia region of the Andes in

South America. It is a major source of vitamins and minerals particularly vitamin C (31.0 mg), vitamin A (321 IU), protein (1.98 g), moisture (93.1 g), minerals (0.6 g), fibre (0.7 g), sulphur (24 mg), chlorine (38 mg) and calcium (20 mg) on per 100 g fresh weight basis. India is the second largest tomato

producing country in the world after China and contributes about 11.5% of the total global tomato production. Andhra Pradesh, Karnataka, Madhya Pradesh, Telengana and Odisha are the five major tomato growing states of the country. (Horticultural statistic at a glance, 2017) In tomato, anthesis and dehiscence occur between 7 to 8 am and 9 to 11 am respectively. Pollen fertility is maximum on the day of anthesis and stigma is fully receptive at 16 hours before anthesis to the day of anthesis (Sindhu *et al.*, 1980).

Genetic variability is defined as the occurrence of a high degree of variation differences among individuals due to differences in their genetic composition and environment in which they are based (Falconer & Mackey, 1996). The basic requirement for genetic improvement of a crop is to utilise the available or created genetic variability. Wild tomatoes have a large genetic diversity, especially within the self-incompatible species like, *L. chilense* and *L. peruvianum* (Rick 1998). The genetic variations present in the wild species have been investigated intensively for the specific traits and is being exploited in tomato breeding (Larry and Joanne, 2007). Utilisation of desirable genes conferring resistance to biotic and abiotic stresses available in different wild and cultivated gene pools could be possible through hybrid breeding programme. The basic force behind such a miracle achievement in relation to production and productivity of this crop was of development of F₁ hybrids suitable for different agro-climatic conditions. The tomato hybrids got quick popularity due to occurrence of heterosis for fruit yield characteristics.

The agro-climatic conditions of coastal Odisha are known for variability, uncertainty and extremity. This region is 'hot spot' of almost all the biotic and abiotic stresses, like early and late onset of monsoon, flush rains,

cyclone, erratic and unevenly distributed rainfall, bacterial wilt, fruit rot etc. With these collages cultivation of conventional varieties of tomato is prone to be uneconomical enterprise. Hybrids have been found to be more suitable for ensuring good yield even under such extreme agro ecological situations.

Tomato grown during the main season (winter) causes a glut of produce in the market and its sale price is also very low. But the crop grown in rainy season has a better demand and is much remunerative for the farmer.

With a view to combating these problems, evaluation of hybrids in rainy season in coastal plain zone of Odisha is indispensable for boosting the production and price of tomatoes in the state. Therefore, an experiment was planned to develop and evaluate the available hybrids of tomato during rainy season.

Materials and Methods

A set of 10 x 10 half diallel crosses of tomato excluding reciprocals (45 F₁ hybrids) were evaluated along with their 10 parents (BT 2, BT 106, BT 317, BT 22-4-1, BT 306-1-2, BT 413-1-2, BT 429-1-1, BT 305-2-4-2, TOBW-3, BT 215-3-3-1) in a randomized block design with three replications at the experimental farm of All India Coordinated Research Project on Vegetable Crops, OUAT, Bhubaneswar. Seeds were sown in nursery bed on 20.06.2017 and seedlings were transplanted on 20.07.2017. Plant to plant spacing was 40 cm and row to row spacing was 50 cm. Eighteen plants were accommodated in each plot having 1.8m x 2.4m plot size. Recommended cultural practices were followed to raise a good crop. Observations were recorded on 5 randomly taken plants of parents and F₁s for the characters viz., plant height, days to 1st flowering, number of clusters per plant,

number of fruits per plant, fruit length, fruit girth, fruit pericarp thickness, number of locules per fruit, average fruit weight and fruit yield per plant. Statistical analysis was performed in accordance with the procedure mentioned by Pansey and Sukhatme (1967).

Results and Discussion

The mean performances of parents and F₁ hybrids for all quantitative and qualitative characters studied have been presented in Table 1. Like the parents, all the 45 F₁ hybrids exhibited variation for the characters studied.

Days to first flowering

The mean values of the parents are presented in Table 1. It was observed that the days to first flowering ranged from 69.33 days in BT 317 (P₃) to 81.00 days in BT 413-1-2 (P₆). In case of hybrids, the mean values ranged from 64.00 days in (2x3) BT 106 x BT 317 to 82.33 days in (6 x 9) BT 413-1-2 x TOBW-3 for days to first flowering. Lowest mean value that is earliness was observed in (2x3) BT 106 x BT 317 i.e. 64.00 days which is the best hybrid for this character. Variability in days to first flowering has also been reported by Ali *et al.*, (2012), Shankar *et al.*, (2013) and Said *et al.*, (2014).

Number of clusters per plant

The number of clusters per plant is an important yield determining trait. Higher number of flowering clusters may lead to greater number of fruits per plant in favourable conditions. The genotype BT 317 (P₃) showed highest value for the character number of clusters/plant (28.23). Again, minimum value for the above mentioned character (14.00) was recorded in BT 413-1-2 (P₆). However, in hybrids the range was 16.13 in (1 x 6) BT 2 x BT 413-1-2 to 31.37 in (4 x 7) BT 22-4-1 x BT 429-1-1 for number of

clusters/plant. The best hybrid showing highest mean value was (4x7) BT 317 X BT 215-3-3-1 (31.37) followed by (3X10) BT 317XBT 215-3-3-1 (30.90). The results of present investigation could also be compared with findings of Sekhar *et al.*, (2009), Alam *et al.*, (2010), and Singh *et al.*, (2014).

Number of fruits / plant

The difference among the hybrids with respect to number of fruits per plant was highly significant which varied from 10.96 (BT 413-1-2 (P₆) to 25.73 BT 317 (P₃) for parents and 13.26 in (4x6) BT 22-4-1 x BT 413-1-2 to 27.18 in case of (3 x 10) BT 317 x BT 215-3-3-1 for hybrids.

Maximum number of fruits per plant were observed in (3 x 10) BT 317 x BT 215-3-3-1 (27.18) followed by (4x7) BT 317 X BT 215-3-3-1 (26.12) which were significantly higher than that in all the other hybrids tested in present investigation. The results of present study were in accordance with those reported by Sekhar *et al.*, (2009), Saleem *et al.*, (2013) and Singh *et al.*, (2014).

Plant height

Plant height ranged from 106.53 cm in BT 317 (P₃) to 71.80 cm in BT 413-1-2 (P₆). For hybrids the range was 75.93 cm in 1 x 6 (BT 2 x BT 413-1-2) to 112.81 cm in (1 x 10), BT 2 x BT 215-3-3-1 for plant height and cross (3x7) BT 317 X BT429-1-1 (110.40 cm) showed significantly highest value for this character. Variability in plant at flowering and fruiting has also been obtained by Ali *et al.*, (2012), Shankar *et al.*, (2013), Singh *et al.*, (2013), Saleem *et al.*, (2013).

Fruit length (cm)

Significant difference for fruit length was noted among the hybrids evaluated.

Table.1 Mean performance of parents and hybrids in *kharif* tomato

Sl. No.	Parents/ F ₁ Hybrids	Days to first flowering (Days after sowing)	No. of clusters/plant	No of fruits/plant	Plant height (cm)	Fruit length (cm)	Fruit girth (cm)	Fruit pericarp thickness (cm)	No of locules/fruit	Average fruit wt.(g)	Fruit yield /plant
1	BT 2 (P1)	77.00	17.87	15.93	77.09	3.51	2.96	0.38	3.43	22.55	296.15
2	BT106 (P2)	72.00	24.27	20.49	87.10	3.53	3.03	0.43	2.37	24.57	336.90
3	BT 317 (P3)	69.33	28.23	25.73	106.53	4.88	4.06	0.60	2.17	30.50	718.78
4	BT 22-4-1(P4)	74.00	25.93	23.30	86.44	3.59	3.13	0.45	2.63	22.57	382.41
5	BT 306-1-2 (P5)	76.00	24.03	17.67	101.01	3.91	3.36	0.36	3.87	25.00	249.54
6	BT 413-1-2 (P6)	81.00	14.00	10.96	71.80	3.12	2.65	0.36	3.53	19.17	116.84
7	BT429-1-1 (P7)	75.67	25.07	21.03	96.05	3.24	3.00	0.36	2.63	23.93	307.74
8	BT 305-2-4-2 (P8)	73.67	25.37	20.78	98.08	4.00	3.84	0.49	3.47	26.10	329.52
9	TOBW -3 (P9)	80.67	23.50	19.05	86.84	4.53	4.00	0.58	2.67	29.00	426.55
10	BT 215-3-3-1 (P10)	73.33	21.40	18.88	100.98	4.90	3.52	0.54	2.62	28.77	370.61
F1											
1	P1 XP 2	69.67	26.53	18.17	91.20	4.45	3.36	0.42	2.83	32.27	437.79
2	P1 XP 3	67.67	26.57	19.63	107.30	4.16	3.72	0.53	2.07	32.30	405.40
3	P1 X P4	71.33	24.93	21.24	89.30	3.25	3.19	0.43	2.73	24.17	372.13
4	P1 XP 5	65.33	25.77	15.95	103.87	4.41	3.54	0.43	2.30	19.27	355.52
5	P1 XP 6	74.67	16.13	13.54	75.93	4.17	4.05	0.47	3.09	21.10	210.29
6	P1 X P7	68.67	20.00	17.37	101.30	3.37	3.09	0.40	2.53	28.77	323.07
7	P1 X P8	65.00	27.80	18.27	107.43	3.08	3.42	0.47	2.87	29.40	388.07
8	P1 X P9	70.33	24.44	21.67	90.20	3.92	3.61	0.53	2.63	18.40	380.55
9	P1X P10	70.33	22.33	19.06	112.81	4.10	3.26	0.58	2.60	25.30	376.87
10	P2 X P3	64.00	27.83	22.33	97.80	5.52	4.20	0.56	2.30	23.77	431.37
11	P2 X P4	69.67	28.07	21.55	89.38	3.51	3.03	0.47	2.70	27.03	409.81
12	P2 X P5	71.67	19.30	14.87	102.91	3.83	3.48	0.45	2.17	28.03	365.30
13	P2 X P6	70.67	19.30	13.55	91.48	4.09	3.84	0.34	2.30	21.93	308.73
14	P2 XP 7	71.00	22.30	19.92	99.95	4.00	3.76	0.45	2.20	26.50	413.03

15	P2 X P8	74.67	28.00	21.55	97.38	4.06	3.83	0.27	2.73	24.13	385.26
16	P2 X P9	75.67	27.27	21.02	90.10	5.51	4.35	0.35	2.27	33.33	536.95
17	P2X P10	76.00	23.33	16.99	95.61	5.04	3.95	0.52	2.73	32.30	437.47
18	P3 X P4	67.67	24.60	19.44	107.72	3.64	3.30	0.52	2.20	29.80	383.40
19	P3 X P5	69.00	27.33	21.55	108.34	3.51	3.19	0.47	2.27	26.70	363.50
20	P3 X P6	68.33	22.03	16.39	100.48	3.49	4.05	0.48	2.70	21.73	229.58
21	P3 X P7	73.00	25.43	21.85	110.40	3.85	3.31	0.42	2.50	25.43	404.49
22	P3 X P8	71.00	27.17	22.60	108.06	3.41	4.02	0.53	2.77	30.17	419.66
23	P3 X P9	77.33	26.03	23.37	101.00	5.46	4.23	0.57	2.15	23.93	431.15
24	P3 X P10	73.00	30.90	27.18	106.47	5.96	5.86	0.60	2.40	37.00	943.64
25	P4 X P5	69.00	25.53	22.75	87.63	4.93	5.01	0.43	2.15	26.16	518.67
26	P4 X P6	77.67	20.53	13.26	70.19	4.30	3.51	0.58	3.59	21.68	289.22
27	P4 X P7	72.00	31.37	26.13	106.83	4.98	4.64	0.53	2.47	28.00	610.87
28	P4X P8	71.67	26.40	22.77	97.52	4.26	5.17	0.55	2.67	22.80	450.89
29	P4 X P9	77.00	24.73	22.30	88.23	4.29	3.58	0.51	2.64	24.89	395.57
30	P4 X P10	77.00	24.33	22.68	95.73	3.90	2.88	0.47	2.38	26.43	391.74
31	P5 X P6	70.67	22.33	13.36	99.27	3.58	2.72	0.33	2.87	22.14	236.24
32	P5 X P7	72.00	23.47	15.42	97.42	4.61	2.89	0.41	2.73	24.23	361.12
33	P5 X P8	71.67	28.20	22.47	102.42	3.57	3.23	0.45	3.33	26.50	413.59
34	P5 X P9	80.00	27.27	19.08	107.42	4.56	3.94	0.44	4.20	31.20	399.54
35	P5 X P10	74.33	22.07	19.97	104.59	4.62	3.97	0.52	2.87	32.17	405.13
36	P6 X P7	74.33	23.17	14.13	88.19	4.29	2.91	0.34	2.63	23.47	303.83
37	P6 X P8	74.33	20.10	16.75	79.67	4.44	2.79	0.43	2.87	25.00	390.39
38	P6 X P9	82.33	19.53	16.75	83.64	4.16	3.73	0.56	5.09	23.93	391.86
39	P6 X P10	75.33	23.60	20.71	79.13	4.23	3.28	0.51	3.07	22.68	397.65
40	P7 X P8	68.00	23.13	19.25	98.62	4.68	2.84	0.52	2.37	23.80	407.24
41	P7 X P9	79.33	22.97	22.48	96.91	5.41	3.63	0.46	3.73	30.02	497.71
42	P7 X P10	71.00	25.63	21.77	102.05	4.57	3.59	0.45	2.76	26.07	447.41
43	P8 X P9	75.00	28.63	23.30	99.10	4.58	3.03	0.45	2.83	27.87	416.96
44	P8 X P10	70.67	23.60	23.45	97.87	4.89	4.60	0.64	3.03	33.00	483.02
45	P9 X P10	75.67	28.10	22.67	101.23	6.10	5.70	0.61	2.90	35.20	651.24
	SE	1.6224	1.0391	0.8902	1.8974	0.1158	0.1152	0.0236	18.7180	0.7303	17.3746
	SE(d)	2.2944	1.4695	1.2590	2.6833	0.1676	0.1629	0.0333	26.4712	1.0328	24.5714
	CD 5%	4.4970	2.8801	2.4676	5.2592	0.3285	0.3193	0.0653	51.8836	2.0242	48.1599
	CD 1%	5.9195	3.7912	3.2482	6.9228	0.4324	0.4202	0.0860	0.7823	2.6645	63.3941

The mean value for the fruit length in different parents and hybrids exhibited a range of 3.12 cm BT 413-1-2 (P₆) to 4.90 cm. BT 215-3-3-1 (P₁₀) and 3.08 cm in (1 x 8) BT 2 x BT 305-2-4-2 to 6.10 cm in (9 x 10) TOBW-3 x BT 215-3-3-1 respectively. Significantly highest value for this trait was observed in cross (9x10) TOBW-3 X BT 215-3-3-1(6.10cm) which was followed by (3 x 10) BT 317 x BT 215-3-3-1 (5.96). Variability in fruit length of tomato hybrids has also been reported by Ali *et al.*, (2012), Saleem *et al.*, (2013), Shankar *et al.*, (2013) and Said *et al.*, (2014).

Fruit girth (cm)

Fruit girth ranged from 2.65 cm in BT 413-1-2 (P₆), 4.06 cm in BT 317 (P₃) for parents. In case of hybrids the range of Fruit girth varied from 2.72 cm in (5 x 6) BT 306-1-2 x BT 413-1-2 to 5.86 cm in (3 x 10) BT 217 x BT 215-3-3-1. Significantly highest value for this trait was observed in cross (3 x 10) BT 217 x BT 215-3-3-1 (5.86 cm) followed by (9x10) TOBW-3 X BT 215-3-3-1(5.70cm). There were significant variations in fruit girth across the parents and hybrids. The findings are in accordance with Ali *et al.*, (2012) and Shankar *et al.*, (2013).

Fruit pericarp thickness (cm)

The perusal of results on pericarp thickness indicated significant variations among the parents and hybrids for this character. Mean value for parents ranges from 0.31 cm in BT 4.3-1-2 (P₆) to 0.60 cm in BT 317 (P₃) and for hybrids 0.27 cm in (2 x 8) BT 106 x BT 305-2-4-2 to 0.64 cm in (8 x 10) BT 305-2-4-2 x BT 215-3-3-1. Significantly highest value for this trait was observed in cross (8 x 10) BT 305-2-4-2 x BT 215-3-3-1 (0.64 cm) followed by (9x10) TOBW-3 X BT 215-3-3-1(0.61cm). Almost similar findings on variability in fruit pericarp thickness of tomato hybrids have

also been observed by Sekhar *et al.*, (2009), Shankar *et al.*, (2013) and Singh *et al.*, (2014).

Number of locules / fruit

The analysed data on number of locules per fruit indicated that there were significant differences among the parents and hybrids. The mean for parents and hybrids ranged from 2.17 in P₃ (BT 317) to 3.87 in BT 306-1-2 (P₅) and 2.07 in (1 x 3) BT 2 x BT 317 to 5.09 in (6 x 9) BT 413-1-2 x TOBW-3 respectively. Similar results on variability in number of locules / fruit has been obtained by Kurian *et al.*, (2001), Sekhar *et al.*, (2009) and Shankar *et al.*, (2013).

Average fruit weight

There was a highly significant difference among 10 parents and 45 hybrids with respect to average fruit weight. The fruit weight ranged between 19.17 gm in BT 413-1-2 (P₆) and 30.50 g in BT 317 (P₃) for parents and 18.40 g in (1 x 9) BT 2 x TOBW-3 to 37.00 g in (3 x 10) BT 317 x BT 215 -3-3-1 for hybrids. Significantly highest value for this trait was observed in cross (3 x 10) BT 217 x BT 215-3-3-1 (37.00 g) followed by (9x10) TOBW-3 X BT 215-3-3-1(35.20 g) Corresponding to the above results variability in average fruit weight and inverse association with number of fruit per plant have also been reported by Sekhar *et al.*, (2009), Singh *et al.*, (2013), Cheema *et al.*, (2013) and Said *et al.*, (2014).

Fruit yield per plant

The fruit yield is supposed to be ultimate economic trait in tomato as well as other fruit vegetables. Fruit yield per plant is accurate assessment of potentiality of a particular hybrid at individual plant level. The data on fruit yield per plant exhibited a wide

variability among the hybrids evaluated. The highest (718.78 g) fruit yield per plant was recorded in BT 317 (P₃) followed by TOBW-3 (426.55 g) (P₉), lowest yield of 116.84 g was recorded in BT 413-1-2 (P₆). However, in case of hybrids fruit yield per plant was ranged from 219.29 g in (1 x 6) BT 2 x BT 413-1-2 to 943.64 g/plant in (3 x 10) BT 317 x BT 215-3-3-1. Significantly highest value for this trait was observed in cross (3 x 10) BT 217 x BT 215-3-3-1 (943.64 g) followed by (9x10) TOBW-3 X BT 215-3-3-1(651.24 g) and (4x7) BT 22-4-1 X BT 429-1-1 (610.87). Variability in fruit yield per plant in tomato hybrids have also been reported by Sharma *et al.*, (2013), Saleem *et al.*, (2013) and Shankar *et al.*, (2013).

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