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## Studies on general and specific combining ability variances and their effects in tomato (*Solanum lycopersicum*)

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**Abstract**

The present study was carried out during *Rabi* seasons of 2016-17 and 2017-18 at Main Experiment Station of Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) India. The experimental materials of the study comprised of 54 treatments of tomato [40 F<sub>1</sub>'s and 14 parental lines (10 lines *viz.*, NDT-1, NDT-2, NDT-3, NDT-4, NDT-5, NDT-6, NDT-7, NDT-8, Azad T-6, Arka Saurabh and 4 testers *viz.*, Pusa Ruby, Punjab Chhuhara, Arka Vikash and Arka Meghali]. The 14 parents were involved in a crossing programme to develop a line × tester set (10 lines + 4 testers + 40 F<sub>1</sub>'s). The experimental materials (40 F<sub>1</sub>'s and 14 parental lines) were evaluated in Randomized Complete Block Design (RBD) with three replication having each experimental unit with spacing of 60cm × 50cm with plot size of 1.2m × 3.0m. The observations were recorded on fifteen characters, *viz.*, days to 50% flowering, days to first fruit set, days to first fruit harvest, plant height (cm), number of primary branches per plant, number of fruits per cluster, number of fruits per plant, average fruit weight (g), fruit length (cm), fruit girth (cm), number of locules per fruit, pericarp thickness (mm), total soluble solids (TSS), ascorbic acid (mg/100g fresh fruit) and total fruit yield per plant (kg). The analysis of variance for combining ability revealed that there were significant line × tester for all the traits in Y<sub>1</sub>, Y<sub>2</sub> and over pooled, except number of primary branches per plant and pericarp thickness in both year. The parent NDT-2 and NDT-3 had good general combining ability for number of fruits per plant and total fruit yield per plant in both years (Y<sub>1</sub>, Y<sub>2</sub>) and pooled. Two crosses *viz.*, NDT-5 × Pb. Chhuhara and NDT-6 × Pusa Ruby showed significant and positive sca effects for fruit yield per plant in both the year and pooled. The relative contribution of lines × testers component were higher than the lines and testers for all the characters in both the years, except plant height, number of primary branches per plant, number fruits per plant, ascorbic acid and total fruit yield per plant in both years and pooled, testers were higher than the lines for all the characters except plant height. Estimates of sca variance were higher than gca variances for most of the traits except plant height and ascorbic acid in both years and pooled. The value of sca variances were found significant and positive for all the characters except number of primary branches per plant and pericarp thickness in both years, total soluble solids in pooled. Likewise, positive and significant gca variances were also exhibited by almost all the characters except days to 50% flowering, days to first fruit set, fruit length and total soluble solids in both the years and pooled.

**Keywords:** General and specific combining ability variances and their effects in tomato (*Solanum lycopersicum* L.)

**Introduction**

Tomato is originated from Peru Ecuador and Bolivia region of Andes of South America (Rick, 1969) [9]. India ranks third in terms of production after China and USA. In India, total area under tomato cultivation is 0.808 million hectares with production of 19.69 million tonnes and its productivity is 24.4 tonnes per hectare; In India the leading tomato growing states are, Karnataka, West Bengal, Maharashtra, Uttar Pradesh, Haryana, Punjab, Gujarat and Bihar. (Anonymous, 2017) [1]. It is a day neutral warm season crop and grows under wide range of soil and climatic conditions. Though tomato is a self-pollinated crop, the unusual high heterosis observed in it, has been attributed to the fact that, originally tomato was a highly out crossing genus which has later evolved into a self-pollinated one (Rick, 1965) [8] and edible part is botanically known as berry (Kalloo *et al.*, 2001) [5]. It is globally cultivated for its fleshy fruits and known as protective food. Under Indian condition, the fruits mainly consumed either as raw or in the preparation of sambar, chatni, pickles etc. Tomato is also rich in medicinal value.

The pulp and juice are digestible, mild aperients, a promoter of gastric secretion and blood purifier. It is reported to have antiseptic properties against intestinal infestations. In the present days, it is gaining more medicinal importance because of the antioxidant property of ascorbic acid and lycopene content. Thus, today it is one of the important raw materials for multimillion food industries. Due to its nutritional values it is also called as "Poor man's apple". In many countries it is considered as "poor man's orange" because of its attractive appearance and nutritive value (Singh *et al.*, 2004). It acts as an antioxidant and scavenger of free radicals, which is often associated with carcinogenesis. Thus, lycopene has great beneficial effects on human health (Khachik *et al.*, 1995) [6].

### Materials and Methods

The present study was carried out during *Rabi* seasons of 2016-17 and 2017-18 at Main Experiment Station of Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) India. The experimental materials of the study comprised of 54 treatments of tomato [40  $F_1$ 's and 14 parental lines (10 lines *viz.*, NDT-1, NDT-2, NDT-3, NDT-4, NDT-5, NDT-6, NDT-7, NDT-8, Azad T-6, Arka Saurabh and 4 testers *viz.*, Pusa Ruby, Punjab Chuhara, Arka Vikash and Arka Meghali]. The 14 parents were involved in a crossing programme to develop a line  $\times$  tester set (10 lines + 4 testers + 40  $F_1$ 's). The experimental materials (40  $F_1$ 's and 14 parental lines) were evaluated in Randomized Complete Block Design (RBD) with three replication having each experimental unit with spacing of 60 cm  $\times$  50 cm with plot size of 1.2 m  $\times$  3.0 m. The observations were recorded on eighteen characters, *viz.*, days to 50% flowering, days to first fruit set, days to first fruit harvest, plant height (cm), number of primary branches per plant, number of fruits per cluster, number of fruits per plant, fruit weight per plant (kg), average fruit weight (g), fruit length (cm), fruit girth (cm), number of locules per fruit, pericarp thickness (mm), total soluble solids (TSS), ascorbic acid (mg/100g fresh fruit) total fruit yield per plant (kg). The analysis of variance was carried out as suggested by Panse and Sukhatme (1967).

### Result and Discussion

Analysis of variances for combining ability in both the years ( $Y_1$  and  $Y_2$ ) is presented in Table 1. Analysis of variances for combining ability revealed that the partitioning of variances due to lines  $\times$  testers showed highly significant for days to 50% flowering, days to first fruit set, plant height, number of fruits per plant, average fruit weight, fruit length, number of locules per fruit, total soluble solids, ascorbic acid in both years and total fruit yield per plant in  $Y_1$  whereas, significant for days to first fruit harvest, number of fruits per cluster, fruit girth in both years and total fruit yield per plant in  $Y_2$ , except number of primary branches per plant and pericarp thickness in both years. Variances due to lines were highly significant for plant height followed by ascorbic acid, number of fruits per plant, number of primary branches per plant and total fruit yield per plant in  $Y_1$  and plant height followed by ascorbic acid, number of fruits per plant, number of primary branches per plant and total fruit yield per plant in  $Y_2$ , whereas, variances due to testers was also highly significant for plant height in both the years.

Analysis of variances for combining ability in pooled is presented in Table 2. Analysis of variances for combining ability revealed that the partitioning of variances due to environments showed highly significant for all the characters.

Analysis of variances for combining ability revealed that the partitioning of variances due to lines  $\times$  testers showed highly significant for all the characters. Variances due to lines were highly significant for plant height followed by ascorbic acid, number of fruits per plant, number of primary branches per plant and total fruit yield per plant whereas, variances due to testers was also highly significant for plant height. Similar finding was also reported by Pandey (2006) [7], Dharmatti *et al.* (1999) [2], Singh *et al.* (2006 a) and Saidi *et al.* (2008) [10].

General combining ability study helps in making the choice of the parents and also helps in the isolation of suitable germplasm for further improvement. General combining ability is primarily a function of additive and additive  $\times$  additive gene action.

For illustrating genetic worth of parents for hybridization programme, the general combining ability (gca) effects of 14 parents (10 lines and 4 testers) for fifteen characters in  $Y_1$ ,  $Y_2$  and pooled had been presented in Table 3

The significant and positive gca effects for fruit yield per plant were exhibited by fourteen parent. Among the parents NDT-2, NDT-3 were found good general combiners in both the years and pooled. On the basis of gca effects and mean performance; parents NDT-4 and NDT-1 were found good general combiner for days to 50% flowering in both the years and pooled; parents NDT-4 was found good general combiner for days to first fruit set in both the years and pooled; parents NDT-4 and NDT-1 were found good general combiner for days to first fruit harvest in both the years and pooled; parents NDT-5, Azad T-6, NDT-4 and NDT-1 were found as the top four good general combiners for plant height at last picking stage in both the years and pooled; parents Azad T-6 was found good general combiner for number of primary branches per plant; parents, NDT-8 was found good general combiners in both the years and pooled for number of fruits per cluster; parents, NDT-3, NDT-1, NDT-2, Arka Saurabh and NDT-5 were found good general combiners in both the years and pooled for number of fruits per plant; based on result both the years and pooled; NDT-1, Azad T-6, Arka Saurabh, NDT-7 and NDT-2 were found as the top good general combiners for average fruit weight; none of the parents was found as the good general combiners for fruit length over both the years and pooled; parents Arka Saurabh was found as good general combiners for fruit length over both the years and pooled; parents Azad T-6 and NDT-6 were found as the top two good general combiners for fruit length in both the years and pooled; parents NDT-8 were found as good general combiners for pericarp thickness in both the years and pooled; NDT-2 and Arka Saurabh were found as top two good general combiners for total soluble solids in both the years and pooled and parents NDT-5, Azad T-6 and NDT-4 were found good general combiners in both the years and pooled for ascorbic acid. Significant gca values indicated the importance of additive and additive  $\times$  additive gene effect as earlier reported by Griffing (1956) [3]. In view of this, these parents offered the best possibilities for the development of improved lines of tomato through hybridization programme. It is, therefore, recommended that to improve yield one should breed for superior combining ability for the component traits with an ultimate objective to improve the pace of its genetic improvement. On the basis of mean performance and gca effects it had been found that there is perfect relationship between *per se* performance and gca effect of the parents.

The above two parents (NDT-2 and NDT-3) in both the years and pooled showed positive and significant gca effects for fruit yield per plant and other important traits as mentioned in

above paragraphs may serve as valuable parents for hybridization programme or multiple crossing programme for obtaining high yielding variety or transgressive segregants for developing varieties of tomato.

The sca effects represent non-additive gene action which is non-fixable. Specific combining ability effects help in the identification of superior cross combinations for development of promising varieties/hybrids. The crosses showing high sca effects involving parents with high gca effects may give rise desirable segregates in future generation. The specific combining ability effects of the forty crosses for fifteen traits

in both the years and over pooled have been presented in Table 4. Perusal of Table 4 revealed that significant positive and negative sca effects were observed for all the characters. However, none of the crosses showed significant sca effect for all the traits. Further, sca effects were found to vary in nature and magnitude for all the characters with the change of seasons. This varying magnitude of sca effects over seasons may be due to environmental effects and genotypes, respectively. Hussun *et al.* (2014) [4] also reported similar results.

**Table 1:** Analysis of variance for combining ability following line  $\times$  tester mating design for 15 characters in tomato (Y<sub>1</sub>=2016-17 and Y<sub>2</sub>=2017-18)

Source of Variation	Years	d.f.	Days to 50% flowering	Days to first fruit set	Days to first fruit harvest	Plant height (cm)	Number of primary branches per plant	Number of fruits per cluster	Number of fruits per plant	Average fruit weight (g)
Replications	Y <sub>1</sub>	2	0.42	2.89	2.49	7.74	0.43	0.08	0.04	0.63
	Y <sub>2</sub>	2	0.10	2.89	2.49	22.26	0.44	0.07	0.04	0.95
Lines	Y <sub>1</sub>	9	7.97	7.55	9.35	5832.09**	1.25**	1.32*	316.70**	325.21
	Y <sub>2</sub>	9	9.89	7.55	9.35	5821.39**	1.25**	1.25	316.70**	326.89*
Testers	Y <sub>1</sub>	3	3.68	2.27	4.21	9345.01**	0.13	1.13	19.05	33.13
	Y <sub>2</sub>	3	3.92	2.27	4.21	10036.59**	0.13	1.11	19.05	32.56
Lines $\times$ Testers	Y <sub>1</sub>	27	8.58**	7.13**	6.24*	180.03**	0.33	0.57*	28.50**	144.92**
	Y <sub>2</sub>	27	7.21**	7.13**	6.24*	199.56**	0.33	0.58*	28.50**	144.82**
Error	Y <sub>1</sub>	78	2.35	2.86	3.56	11.92	0.22	0.30	2.54	3.90
	Y <sub>2</sub>	78	2.43	2.86	3.56	12.50	0.21	0.31	2.54	3.96

Source of Variation	Years	d.f.	Fruit length (cm)	Fruit girth (cm)	Number of locules per fruit	Pericarp thickness (mm)	Total soluble solid (TSS)	Ascorbic acid (mg/100 g fresh fruit)	Total fruit yield per plant (kg)
Replications	Y <sub>1</sub>	2	0.01	1.58	0.06	0.39	0.11	0.32	0.19
	Y <sub>2</sub>	2	0.01	1.54	0.06	0.22	0.11	16.74	0.17
Lines	Y <sub>1</sub>	9	0.73	3.77	2.16	0.70*	0.84	1163.36**	0.95**
	Y <sub>2</sub>	9	0.73	4.12	2.16	0.70*	0.84	1128.72**	0.98**
Testers	Y <sub>1</sub>	3	0.41	1.34	0.45	0.47	0.20	98.41	0.19
	Y <sub>2</sub>	3	0.41	1.22	0.45	0.47	0.20	88.88	0.24
Lines $\times$ Testers	Y <sub>1</sub>	27	0.85**	2.46*	1.04**	0.25	0.94**	53.92**	0.21**
	Y <sub>2</sub>	27	0.85**	2.49*	1.04**	0.25	0.94**	73.95**	0.18*
Error	Y <sub>1</sub>	78	0.33	1.36	0.36	0.20	0.30	5.47	0.10
	Y <sub>2</sub>	78	0.33	1.38	0.36	0.18	0.30	7.51	0.10

\*, \*\* Significant at 5 per cent and 1 per cent probability levels, respectively.

**Table 2:** Analysis of variance (mean squares) for combining ability following line  $\times$  tester mating design for 15 characters in tomato (Pooled)

Source of Variation	d.f.	Days to 50% flowering	Days to first fruit set	Days to first fruit harvest	Plant height (cm)	Number of primary branches per plant	Number of fruits per cluster	Number of fruits per plant	Average fruit weight (g)
Replications	2	0.44	5.79	4.98	3.55	0.87	0.15	0.08	1.57
Environmets	1	617.89**	93.75**	95.26**	250.51**	13.25**	14.60**	95.26**	92.75**
Rep $\times$ Env.	2	0.07	0.00	0.00	26.46	0.00	0.01	0.00	0.02
Lines	9	17.52	15.10	18.71	11646.74**	2.51**	2.56	633.39**	652.08*
Testers	3	7.53	4.55	8.42	19371.80**	0.26	2.23	38.10	65.68
Lines $\times$ Testers	27	15.54**	14.26**	12.47**	370.06**	0.66**	1.14**	56.99**	289.73**
Error	156	2.39	2.86	3.56	12.21	0.22	0.31	2.54	3.93

Source of Variation	d.f.	Fruit length (cm)	Fruit girth (cm)	Number of locules per fruit	Pericarp thickness (mm)	Total soluble solid (TSS)	Ascorbic acid (mg/100 g fresh fruit)	Total fruit yield per plant (kg)
Replications	2	0.01	3.10	0.12	0.58	0.21	7.52	0.36*
Environmets	1	17.50**	85.44**	7.78**	10.09**	9.13**	297.97**	8.09**
Rep $\times$ Env.	2	0.00	0.02	0.00	0.03	0.00	9.54	0.00
Lines	9	1.46	7.87	4.32	1.40*	1.69	2281.23**	1.93**
Testers	3	0.81	2.55	0.89	0.94	0.40	169.64	0.43
Lines $\times$ Testers	27	1.70**	4.94**	2.08**	0.50**	1.88**	113.39**	0.39**
Error	156	0.33	1.37	0.36	0.19	0.30	6.49	0.10

\*, \*\* Significant at 5 per cent and 1 per cent probability levels, respectively.

**Table 3:** Estimates of general combining ability effects of parents (lines and testers) for 15 characters in tomato over two years (Y<sub>1</sub>, Y<sub>2</sub>) and pooled

Traits Lines	Days to 50% flowering			Days to first fruit set			Days to first fruit harvest			Plant height (cm)		
	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled
NDT-1	-1.09*	-1.32**	-1.21**	-1.01	-1.01	-1.01**	-1.22*	-1.22*	-1.22**	3.70**	5.41**	4.55**
NDT-2	0.66	0.75	0.70*	0.64	0.64	0.64	0.51	0.51	0.51	-20.53**	-21.31**	-20.92**
NDT-3	1.29**	1.54**	1.41**	0.97	0.97	0.97**	1.38*	1.38*	1.38**	-16.43**	-14.71**	-15.57**
NDT-4	-1.48**	-1.48**	-1.48**	-1.55**	-1.55**	-1.55**	-1.55**	-1.55**	-1.55**	24.87**	24.50**	24.69**
NDT-5	-0.10	-0.34	-0.22	-0.24	-0.24	-0.24	-0.32	-0.32	-0.32	34.53**	34.58**	34.55**
NDT-6	0.41	0.40	0.40	0.51	0.51	0.51	0.61	0.61	0.61	-14.08**	-13.62**	-13.85**
NDT-7	0.10	-0.23	-0.07	-0.34	-0.34	-0.34	-0.25	-0.25	-0.25	-8.07**	-9.61**	-8.84**
NDT-8	0.42	0.37	0.40	0.38	0.38	0.38	0.57	0.57	0.57	-19.96**	-20.74**	-20.35**
Azad T-6	-0.33	0.10	-0.12	0.09	0.09	0.09	-0.05	-0.05	-0.05	31.11**	30.57**	30.84**
Arka Saurabh	0.12	0.24	0.18	0.55	0.55	0.55	0.31	0.31	0.31	-15.12**	-15.07**	-15.10**
SE (gi) lines	0.47	0.47	0.31	0.52	0.52	0.34	0.54	0.54	0.38	0.97	1.00	0.71
SE(gi – gj)	0.66	0.66	0.45	0.74	0.74	0.49	0.76	0.76	0.54	1.38	1.42	1.01
Testers												
Pusa Ruby	0.38	0.33	0.35	0.33	0.33	0.33	0.40	0.40	0.40	26.39**	27.38**	26.89**
Punjab Chhuhara	-0.41	-0.48	-0.44*	-0.32	-0.32	-0.32	-0.38	-0.38	-0.38	-10.70**	-10.81**	-10.75**
Arka Vikas	0.19	0.23	0.21	0.08	0.08	0.08	0.23	0.23	0.23	-7.48**	-8.46**	-7.97**
Arka Meghali	-0.16	-0.08	-0.12	-0.09	-0.09	-0.09	-0.25	-0.25	-0.25	-8.22**	-8.10**	-8.16**
SE (gi) testers	0.30	0.30	0.20	0.33	0.33	0.22	0.34	0.34	0.24	0.62	0.63	0.45
SE (gi-gj)	0.42	0.42	0.28	0.47	0.47	0.31	0.48	0.48	0.34	0.87	0.90	0.64

\*, \*\* Significant at 5 per cent and 1 per cent probability levels, respectively.

Traits Lines	Number of primary branches per plant			Number of fruits per cluster			Number of fruits per plant			Average fruit weight (g)		
	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled
NDT-1	0.08	0.08	0.08	0.26	0.28	0.27*	4.99**	4.99**	4.99**	7.34**	7.36**	7.35**
NDT-2	-0.04	-0.04	-0.04	0.24	0.25	0.24*	4.62**	4.62**	4.62**	1.90**	1.92**	1.91**
NDT-3	-0.21	-0.21	-0.21*	-0.55**	-0.54**	-0.55**	7.59**	7.59**	7.59**	-3.07**	-3.05**	-3.06**
NDT-4	-0.24	-0.24	-0.24*	0.18	0.20	0.19	-0.58	-0.58	-0.58	-6.93**	-6.92**	-6.93**
NDT-5	0.00	0.00	0.00	-0.15	-0.13	-0.14	0.87*	0.87*	0.87**	-8.09**	-8.07**	-8.08**
NDT-6	0.18	0.18	0.18	-0.28	-0.27	-0.27*	-5.88**	-5.88**	-5.88**	-3.71**	-3.86**	-3.79**
NDT-7	0.11	0.11	0.11	-0.19	-0.26	-0.22	-1.96**	-1.96**	-1.96**	3.02**	3.03**	3.02**
NDT-8	0.13	0.13	0.13	0.57**	0.51**	0.54**	-4.59**	-4.59**	-4.59**	0.70	0.72	0.71
Azad T-6	0.61**	0.61**	0.61**	-0.20	-0.19	-0.19	-8.02**	-8.02**	-8.02**	5.12**	5.14**	5.13**
Arka Saurabh	-0.63**	-0.63**	-0.63**	0.13	0.14	0.14	2.96**	2.96**	2.96**	3.72**	3.74**	3.73**
SE (gi) lines	0.14	0.15	0.10	0.16	0.16	0.11	0.44	0.44	0.33	0.56	0.55	0.41
SE(gi – gj)	0.20	0.20	0.13	0.22	0.23	0.16	0.62	0.62	0.46	0.78	0.78	0.57
Testers												
Pusa Ruby	-0.05	-0.05	-0.05	0.12	0.14	0.13	-0.06	-0.06	-0.06	-0.77*	-0.75*	-0.76**
Punjab Chhuhara	0.07	0.07	0.07	-0.16	-0.15	-0.16*	0.23	0.23	0.23	-0.95**	-0.94**	-0.94**
Arka Vikas	0.04	0.04	0.04	0.21*	0.19	0.20**	-1.04**	-1.04**	-1.04**	0.45	0.40	0.43
Arka Meghali	-0.06	-0.06	-0.06	-0.17	-0.18	-0.17*	0.87**	0.87**	0.87**	1.27**	1.29**	1.28**
SE (gi) testers	0.09	0.09	0.06	0.10	0.10	0.07	0.28	0.28	0.21	0.35	0.35	0.26
SE(gi – gj)	0.13	0.13	0.09	0.14	0.14	0.10	0.39	0.39	0.29	0.49	0.49	0.36

\*, \*\* Significant at 5 per cent and 1 per cent probability levels, respectively.

Traits Lines	Fruit length (cm)			Fruit girth (cm)			Number of locules per fruit			Pericarp thickness (mm)		
	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled
NDT-1	0.19	0.19	0.19	-0.02	0.00	-0.01	0.19	0.19	0.19	-0.46**	-0.46**	-0.46**
NDT-2	-0.10	-0.10	-0.10	-0.50	-0.49	-0.50*	0.24	0.24	0.24*	0.28	0.28	0.28**
NDT-3	-0.18	-0.18	-0.18	-0.49	-0.47	-0.48*	-0.99**	-0.99**	-0.99**	-0.09	-0.09	-0.09
NDT-4	0.24	0.24	0.24*	0.46	0.48	0.47	0.18	0.18	0.18	-0.18	-0.18	-0.18*
NDT-5	-0.54**	-0.54**	-0.54**	-0.30	-0.29	-0.29	-0.42*	-0.42*	-0.42**	0.11	0.11	0.11
NDT-6	-0.09	-0.09	-0.09	-0.69*	-0.84*	-0.77**	0.36*	0.36*	0.36**	0.14	0.14	0.14
NDT-7	0.15	0.15	0.15	0.46	0.47	0.46	-0.06	-0.06	-0.06	-0.01	-0.01	-0.01
NDT-8	-0.04	-0.04	-0.04	0.31	0.33	0.32	-0.11	-0.11	-0.11	0.36*	0.36*	0.36**
Azad T-6	0.11	0.11	0.11	-0.30	-0.28	-0.29	0.39*	0.39*	0.39**	0.05	0.05	0.05
Arka Saurabh	0.26	0.26	0.26*	1.08**	1.09**	1.08**	0.20	0.20	0.20	-0.19	-0.19	-0.19*
SE (gi) lines	0.16	0.16	0.12	0.35	0.35	0.24	0.17	0.17	0.12	0.14	0.14	0.09
SE(gi – gj)	0.23	0.23	0.17	0.49	0.49	0.34	0.25	0.25	0.17	0.20	0.20	0.13
Testers												
Pusa Ruby	-0.12	-0.12	-0.12	-0.31	-0.29	-0.30*	-0.07	-0.07	-0.07	-0.17	-0.17	-0.17**

Punjab Chhuhara	0.06	0.06	0.06	0.15	0.13	0.14	0.05	0.05	0.05	0.05	0.05	0.05
Arka Vikas	0.13	0.13	0.13	0.11	0.13	0.12	-0.13	-0.13	-0.13	0.12	0.12	0.12*
Arka Meghali	-0.07	-0.07	-0.07	0.05	0.03	0.04	0.14	0.14	0.14	0.00	0.00	0.00
SE (gi) testers	0.10	0.10	0.07	0.22	0.22	0.15	0.11	0.11	0.08	0.09	0.09	0.06
SE (gi-gj)	0.15	0.15	0.10	0.31	0.31	0.21	0.16	0.16	0.11	0.13	0.13	0.08

\*, \*\* Significant at 5 per cent and 1 per cent probability levels, respectively.

Traits Lines	Total soluble solid (TSS)			Ascorbic acid (mg/100 g fresh fruit)			Total fruit yield per plant (kg)		
	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled
NDT-1	-0.24	-0.24	-0.24*	-8.27**	-5.38**	-6.83**	0.19*	0.16	0.18**
NDT-2	0.45**	0.45**	0.45**	-3.03**	-3.79**	-3.41**	0.39**	0.39**	0.39**
NDT-3	0.28	0.28	0.28*	-2.76**	-3.62**	-3.19**	0.33**	0.33**	0.33**
NDT-4	-0.20	-0.20	-0.20	3.75**	2.69**	3.22**	0.04	0.04	0.04
NDT-5	-0.17	-0.17	-0.17	18.10**	18.50**	18.30**	-0.46**	-0.46**	-0.46**
NDT-6	-0.15	-0.15	-0.15	-6.45**	-7.46**	-6.95**	-0.26**	-0.26**	-0.26**
NDT-7	-0.14	-0.14	-0.14	-10.36**	-10.21**	-10.29**	-0.35**	-0.37**	-0.36**
NDT-8	-0.27	-0.27	-0.27*	1.03	-0.40	0.31	0.04	0.07	0.05
Azad T-6	0.13	0.13	0.13	15.48**	15.64**	15.56**	-0.03	-0.05	-0.04
Arka Saurabh	0.31*	0.31*	0.31**	-7.48**	-5.98**	-6.73**	0.11	0.14	0.13*
SE (gi) lines	0.15	0.15	0.11	0.70	0.76	0.52	0.08	0.09	0.07
SE(gi – gj)	0.22	0.22	0.16	0.99	1.07	0.74	0.12	0.12	0.09
Testers									
Pusa Ruby	-0.11	-0.11	-0.11	-2.19**	-0.85	-1.52**	0.01	0.01	0.01
Punjab Chhuhara	-0.01	-0.01	-0.01	-0.39	-1.08*	-0.74*	-0.09	-0.11*	-0.10*
Arka Vikas	0.05	0.05	0.05	0.41	-0.64	-0.11	0.10*	0.11	0.11*
Arka Meghali	0.07	0.07	0.07	2.17**	2.57**	2.37**	-0.03	0.00	-0.02
SE (gi) testers	0.09	0.10	0.07	0.44	0.48	0.33	0.05	0.05	0.04
SE (gi-gj)	0.14	0.14	0.10	0.63	0.68	0.47	0.07	0.08	0.30

\*, \*\* Significant at 5 per cent and 1 per cent probability levels, respectively.

**Table 4:** Estimates of specific combining ability (sca) effects of crosses for 15 characters in tomato over two years (Y<sub>1</sub>, Y<sub>2</sub>) and pooled

Traits Crosses	Days to 50% flowering			Days to first fruit set			Days to first fruit harvest			Plant height (cm)		
	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled
NDT-1 × Pusa Ruby	-0.32	-0.65	-0.49	-0.30	-0.30	-0.30	-0.04	-0.04	-0.04	-3.26	-6.75**	-5.01**
NDT-1 × Pb. Chhuhara	-0.21	0.10	-0.05	-0.10	-0.10	-0.10	-0.14	-0.14	-0.14	-3.04	-5.43**	-4.24**
NDT-1 × Arka Vikas	2.05*	1.91*	1.98**	1.90	1.90	1.90**	1.54	1.54	1.54*	1.06	-0.46	0.30
NDT-1 × Arka Meghali	-1.52	-1.35	-1.44*	-1.50	-1.50	-1.50*	-1.36	-1.36	-1.36	5.25**	12.63**	8.94**
NDT-2 × Pusa Ruby	0.22	-0.15	0.04	-1.11	-1.11	-1.11	-0.94	-0.94	-0.94	-1.90	-2.89	-2.40
NDT-2 × Pb. Chhuhara	-1.12	-1.14	-1.13	-1.23	-1.23	-1.23	-0.79	-0.79	-0.79	-5.78**	-5.66**	-5.72**
NDT-2 × Arka Vikas	0.45	0.32	0.38	0.60	0.60	0.60	0.48	0.48	0.48	0.31	1.29	0.80
NDT-2 × Arka Meghali	0.45	0.96	0.71	1.74	1.74	1.74*	1.26	1.26	1.26	7.37**	7.26**	7.32**
NDT-3 × Pusa Ruby	-0.05	-0.25	-0.15	0.70	0.70	0.70	0.39	0.39	0.39	-6.35**	0.17	-3.09*
NDT-3 × Pb. Chhuhara	1.42	1.23	1.32*	1.60	1.60	1.60*	1.10	1.10	1.10	5.08*	2.70	3.89**
NDT-3 × Arka Vikas	0.58	0.29	0.44	-0.38	-0.38	-0.38	0.50	0.50	0.50	4.37*	2.85	3.61*
NDT-3 × Arka Meghali	-1.95*	-1.28	-1.62*	-1.93	-1.93	-1.93**	-2.00	-2.00	-2.00*	-3.11	-5.72**	-4.41**
NDT-4 × Pusa Ruby	-0.27	-0.22	-0.24	-0.17	-0.17	-0.17	-0.44	-0.44	-0.44	-7.17**	-8.57**	-7.87**
NDT-4 × Pb. Chhuhara	1.52	0.92	1.22	0.85	0.85	0.85	0.91	0.91	0.91	9.78**	11.15**	10.47**
NDT-4 × Arka Vikas	2.48**	2.44*	2.46**	2.33*	2.33*	2.33**	2.34*	2.34*	2.34**	4.45*	5.02*	4.74**
NDT-4 × Arka Meghali	-3.73**	-3.14**	-3.44**	-3.00**	-3.00**	-3.00**	-2.82*	-2.82*	-2.82**	-7.06**	-7.59**	-7.33**
NDT-5 × Pusa Ruby	-0.18	0.12	-0.03	-0.14	-0.14	-0.14	0.01	0.01	0.01	-14.59**	-13.07**	-13.83**
NDT-5 × Pb. Chhuhara	-1.41	-1.09	-1.25*	-1.08	-1.08	-1.08	-1.07	-1.07	-1.07	10.20**	9.48**	9.84**
NDT-5 × Arka Vikas	1.06	1.27	1.17	1.53	1.53	1.53*	1.22	1.22	1.22	2.98	3.13	3.05*
NDT-5 × Arka Meghali	0.52	-0.30	0.11	-0.31	-0.31	-0.31	-0.16	-0.16	-0.16	1.41	0.46	0.94
NDT-6 × Pusa Ruby	0.84	0.90	0.87	0.80	0.80	0.80	0.55	0.55	0.55	-0.95	-3.19	-2.07
NDT-6 × Pb. Chhuhara	-2.30*	-2.55**	-2.43**	-1.77	-1.77	-1.77*	-1.69	-1.69	-1.69*	0.15	4.01*	2.08
NDT-6 × Arka Vikas	-0.63	-0.37	-0.50	-0.90	-0.90	-0.90	-0.68	-0.68	-0.68	-4.14*	-4.41*	-4.27**
NDT-6 × Arka Meghali	2.09*	2.02*	2.05**	1.87	1.87	1.87**	1.82	1.82	1.82*	4.95*	3.58	4.27**

Traits Crosses	Days to 50% flowering			Days to first fruit set			Days to first fruit harvest			Plant height (cm)		
	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled
NDT-7 × Pusa Ruby	0.30	0.68	0.49	0.02	0.02	0.02	0.00	0.00	-0.01	12.91**	12.67**	12.79**
NDT-7 × Pb. Chhuhara	-0.13	0.27	0.07	0.47	0.47	0.47	0.09	0.09	0.09	-7.27**	-6.41**	-6.84**
NDT-7 × Arka Vikas	-1.97*	-2.34*	-2.15**	-1.66	-1.66	-1.66*	-1.79	-1.79	-1.79*	-3.55	-3.82	-3.68*
NDT-7 × Arka Meghali	1.80	1.39	1.59*	1.17	1.17	1.17	1.70	1.70	1.70*	-2.08	-2.45	-2.27
NDT-8 × Pusa Ruby	0.14	0.25	0.19	0.15	0.15	0.15	0.29	0.29	0.29	13.32**	12.34**	12.83**

NDT-8 × Pb. Chuhara	-0.85	-0.72	-0.79	-1.27	-1.27	-1.27	-0.72	-0.72	-0.72	-5.25**	-5.13*	-5.19**
NDT-8 × Arka Vikas	-0.65	-0.53	-0.59	-0.42	-0.42	-0.42	-0.44	-0.44	-0.44	-6.81**	-5.82**	-6.31**
NDT-8 × Arka Meghali	1.36	1.01	1.18	1.54	1.54	1.54*	0.87	0.87	0.87	-1.27	-1.38	-1.33
Azad T-6 × Pusa Ruby	0.33	-0.06	0.13	0.39	0.39	0.39	0.56	0.56	0.56	-3.81	-4.04*	-3.93**
Azad T-6 × Pb. Chuhara	2.37*	2.34*	2.35**	1.87	1.87	1.87**	1.93	1.93	1.93*	0.81	0.68	0.75
Azad T-6 × Arka Vikas	-2.68**	-2.16*	-2.42**	-2.12*	-2.12*	-2.12**	-2.11	-2.11	-2.11**	-1.57	-0.84	-1.21
Azad T-6 × Arka Meghali	-0.01	-0.12	-0.07	-0.14	-0.14	-0.14	-0.39	-0.39	-0.39	4.57*	4.20*	4.38**
Arka Saurabh × Pusa Ruby	-1.02	-0.63	-0.82	-0.33	-0.33	-0.33	-0.37	-0.37	-0.37	11.81**	13.33**	12.57**
Arka Saurabh × Pb. Chuhara	0.70	0.66	0.68	0.66	0.66	0.66	0.37	0.37	0.37	-4.68*	-5.39**	-5.04**
Arka Saurabh × Arka Vikas	-0.68	-0.84	-0.76	-0.88	-0.88	-0.88	-1.06	-1.06	-1.06	2.90	3.05	2.98*
Arka Saurabh × Arka Meghali	1.00	0.81	0.91	0.55	0.55	0.55	1.06	1.06	1.06	-10.04**	-10.99**	-10.51**
SE (Sij)	0.94	0.94	0.63	1.05	1.05	0.69	1.08	1.08	0.77	1.95	2.00	1.43
SE (Sij-Sik)	2.20	2.20	1.48	2.46	2.46	1.62	2.53	2.53	1.81	4.57	4.70	3.35

\*, \*\* Significant at 5 per cent and 1 per cent probability levels, respectively.

Traits Crosses	Number of primary branches per plant			Number of fruits per cluster			Number of fruits per plant			Average fruit weight (g)		
	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled
NDT-1 × Pusa Ruby	0.16	0.16	0.16	-0.60	-0.62	-0.61**	-0.78	-0.78	-0.78	-12.58**	-12.59**	-12.59**
NDT-1 × Pb. Chuhara	0.38	0.38	0.38*	0.62	0.60	0.61**	0.99	0.99	0.99	-5.36**	-5.37**	-5.36**
NDT-1 × Arka Vikas	-0.09	-0.09	-0.09	0.19	0.21	0.20	-0.89	-0.89	-0.89	6.52**	6.57**	6.55**
NDT-1 × Arka Meghali	-0.45	-0.45	-0.45*	-0.21	-0.19	-0.20	0.69	0.69	0.69	11.41**	11.39**	11.40**
NDT-2 × Pusa Ruby	0.38	0.38	0.38*	0.36	0.34	0.35	-0.04	-0.04	-0.04	6.58**	6.56**	6.57**
NDT-2 × Pb. Chuhara	-0.14	-0.14	-0.14	0.08	0.07	0.08	-4.97**	-4.97**	-4.97**	8.73**	8.72**	8.73**
NDT-2 × Arka Vikas	-0.17	-0.17	-0.17	-0.49	-0.47	-0.48*	5.96**	5.96**	5.96**	-3.49**	-3.44**	-3.47**
NDT-2 × Arka Meghali	-0.07	-0.07	-0.07	0.05	0.06	0.05	-0.96	-0.96	-0.96	-11.82**	-11.84**	-11.83**
NDT-3 × Pusa Ruby	0.32	0.32	0.32	0.62	0.60	0.61**	0.94	0.94	0.94	-2.02	-2.04	-2.03*
NDT-3 × Pb. Chuhara	0.00	0.00	0.00	-0.13	-0.14	-0.13	-0.28	-0.28	-0.28	2.95**	2.93**	2.94**
NDT-3 × Arka Vikas	-0.05	-0.05	-0.05	-0.47	-0.45	-0.46*	0.92	0.92	0.92	6.34**	6.39**	6.36**
NDT-3 × Arka Meghali	-0.27	-0.27	-0.27	-0.02	-0.01	-0.02	-1.58	-1.58	-1.58*	-7.26**	-7.28**	-7.27**
NDT-4 × Pusa Ruby	-0.22	-0.22	-0.22	-0.35	-0.37	-0.36	1.86*	1.86*	1.86**	-2.04	-2.06	-2.05*
NDT-4 × Pb. Chuhara	-0.34	-0.34	-0.34	-0.06	-0.08	-0.07	0.58	0.58	0.58	0.50	0.48	0.49
NDT-4 × Arka Vikas	0.63*	0.63*	0.63**	0.27	0.29	0.28	-1.34	-1.34	-1.34*	0.74	0.79	0.77
NDT-4 × Arka Meghali	-0.07	-0.07	-0.07	0.14	0.16	0.15	-1.10	-1.10	-1.10	0.80	0.78	0.79
NDT-5 × Pusa Ruby	-0.16	-0.16	-0.16	-0.09	-0.11	-0.10	1.15	1.15	1.15	0.12	0.11	0.12
NDT-5 × Pb. Chuhara	0.37	0.37	0.37	0.53	0.51	0.52*	-0.84	-0.84	-0.84	0.89	0.88	0.88
NDT-5 × Arka Vikas	-0.01	-0.01	-0.01	0.03	0.05	0.04	0.22	0.22	0.22	-0.15	-0.10	-0.12
NDT-5 × Arka Meghali	-0.20	-0.20	-0.20	-0.47	-0.45	-0.46*	-0.53	-0.53	-0.53	-0.87	-0.89	-0.88
NDT-6 × Pusa Ruby	-0.10	-0.10	-0.10	0.37	0.36	0.37	0.09	0.09	0.09	-0.28	-0.13	-0.21
NDT-6 × Pb. Chuhara	-0.42	-0.42	-0.42*	-0.44	-0.45	-0.45	5.20**	5.20**	5.20**	-1.17	-1.02	-1.09
NDT-6 × Arka Vikas	0.11	0.11	0.11	0.26	0.28	0.27	-2.91**	-2.91**	-2.91**	0.85	0.40	0.62
NDT-6 × Arka Meghali	0.41	0.41	0.41*	-0.20	-0.18	-0.19	-2.38**	-2.38**	-2.38**	0.60	0.75	0.68

Traits Crosses	Number of primary branches per plant			Number of fruits per cluster			Number of fruits per plant			Average fruit weight (g)		
	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled
NDT-7 × Pusa Ruby	-0.33	-0.33	-0.33	-0.72*	-0.65*	-0.69**	1.53	1.53	1.53*	-4.42**	-4.44**	-4.43**
NDT-7 × Pb. Chuhara	0.06	0.06	0.06	0.14	0.21	0.17	-0.51	-0.51	-0.51	-1.82	-1.83	-1.82*
NDT-7 × Arka Vikas	-0.12	-0.12	-0.12	0.57	0.67*	0.62**	-5.62**	-5.62**	-5.62**	1.22	1.27	1.24
NDT-7 × Arka Meghali	0.39	0.39	0.39*	0.01	-0.22	-0.11	4.61**	4.61**	4.61**	5.02**	5.01**	5.01**
NDT-8 × Pusa Ruby	0.08	0.08	0.08	0.02	0.08	0.05	0.87	0.87	0.87	-1.93	-1.95	-1.94*
NDT-8 × Pb. Chuhara	0.09	0.09	0.09	0.08	0.15	0.11	1.57	1.57	1.57*	0.50	0.48	0.49
NDT-8 × Arka Vikas	0.18	0.18	0.18	0.16	-0.08	0.04	2.59**	2.59**	2.59**	-3.16**	-3.11**	-3.14**
NDT-8 × Arka Meghali	-0.35	-0.35	-0.35	-0.25	-0.15	-0.20	-5.03**	-5.03**	-5.03**	4.59**	4.58**	4.59**
Azad T-6 × Pusa Ruby	-0.03	-0.03	-0.03	0.16	0.15	0.15	-1.50	-1.50	-1.50*	-1.09	-1.11	-1.10
Azad T-6 × Pb. Chuhara	-0.35	-0.35	-0.35	-0.52	-0.54	-0.53*	0.02	0.02	0.02	-2.40*	-2.42*	-2.41**
Azad T-6 × Arka Vikas	-0.10	-0.10	-0.10	-0.40	-0.38	-0.39	-0.55	-0.55	-0.55	-2.09	-2.04	-2.06*
Azad T-6 × Arka Meghali	0.48	0.48	0.48*	0.75*	0.77*	0.76**	2.03*	2.03*	2.03**	5.58**	5.56**	5.57**
Arka Saurabh × Pusa Ruby	-0.09	-0.09	-0.09	0.23	0.22	0.22	-4.11**	-4.11**	-4.11**	17.66**	17.64**	17.65**
Arka Saurabh × Pb. Chuhara	0.35	0.35	0.35	-0.31	-0.33	-0.32	-1.75*	-1.75*	-1.75**	-2.83*	-2.84*	-2.84**
Arka Saurabh × Arka Vikas	-0.38	-0.38	-0.38*	-0.12	-0.10	-0.11	1.63	1.63	1.63*	-6.78**	-6.73**	-6.75**
Arka Saurabh × Arka Meghali	0.12	0.12	0.12	0.19	0.21	0.20	4.24**	4.24**	4.24**	-8.06**	-8.07**	-8.06**
SE (Sij)	0.29	0.29	0.19	0.32	0.32	0.23	0.87	0.87	0.65	1.10	1.10	0.81
SE (Sij-Sik)	0.68	0.68	0.45	0.74	0.75	0.53	2.04	2.04	1.53	2.57	2.59	1.90

\*, \*\* Significant at 5 per cent and 1 per cent probability levels, respectively.

Traits Crosses	Fruit length (cm)			Fruit girth (cm)			Number of locules per fruit			Pericarp thickness (mm)		
	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled
NDT-1 × Pusa Ruby	-0.63	-0.63	-0.63**	-0.70	-0.72	-0.71	-0.14	-0.14	-0.14	0.04	0.04	0.04
NDT-1 × Pb. Chhuhara	0.25	0.25	0.25	0.32	0.34	0.33	-0.09	-0.09	-0.09	0.17	0.17	0.17
NDT-1 × Arka Vikas	0.08	0.08	0.08	0.08	0.07	0.08	0.12	0.12	0.12	-0.11	-0.11	-0.11
NDT-1 × Arka Meghali	0.30	0.30	0.30	0.29	0.31	0.30	0.12	0.12	0.12	-0.10	-0.10	-0.10
NDT-2 × Pusa Ruby	0.35	0.35	0.35	-0.29	-0.31	-0.30	0.14	0.14	0.14	-0.01	-0.01	-0.01
NDT-2 × Pb. Chhuhara	0.17	0.17	0.17	0.69	0.71	0.70	-0.51	-0.51	-0.51*	-0.02	-0.02	-0.02
NDT-2 × Arka Vikas	-0.78*	-0.78*	-0.78**	-0.35	-0.36	-0.36	0.70*	0.70*	0.70**	0.19	0.19	0.19
NDT-2 × Arka Meghali	0.27	0.27	0.27	-0.05	-0.04	-0.04	-0.33	-0.33	-0.33	-0.15	-0.15	-0.15
NDT-3 × Pusa Ruby	-0.17	-0.17	-0.17	0.01	0.00	0.01	-1.35**	-1.35**	-1.35**	0.36	0.36	0.36*
NDT-3 × Pb. Chhuhara	0.53	0.53	0.53*	-0.39	-0.38	-0.39	0.22	0.22	0.22	-0.09	-0.09	-0.09
NDT-3 × Arka Vikas	-0.08	-0.08	-0.08	-0.01	-0.03	-0.02	0.13	0.13	0.13	0.04	0.04	0.04
NDT-3 × Arka Meghali	-0.29	-0.29	-0.29	0.39	0.41	0.40	1.00**	1.00*	1.00**	-0.30	-0.30	-0.30
NDT-4 × Pusa Ruby	0.76**	0.76*	0.76**	1.31	1.29	1.30**	0.40	0.40	0.40	-0.15	-0.15	-0.15
NDT-4 × Pb. Chhuhara	0.02	0.02	0.02	0.78	0.80	0.79	0.42	0.42	0.42	-0.38	-0.38	-0.38*
NDT-4 × Arka Vikas	-0.03	-0.03	-0.03	-0.75	-0.77	-0.76	-0.30	-0.30	-0.30	0.48	0.48	0.48**
NDT-4 × Arka Meghali	-0.74*	-0.74*	-0.74**	-1.34	-1.32	-1.33**	-0.51	-0.51	-0.51*	0.05	0.05	0.05
NDT-5 × Pusa Ruby	-0.57	-0.57	-0.57*	-1.57*	-1.59*	-1.58**	-0.03	-0.03	-0.03	0.05	0.05	0.05
NDT-5 × Pb. Chhuhara	-0.32	-0.32	-0.32	-1.05	-1.04	-1.04*	0.02	0.02	0.02	-0.12	-0.12	-0.12
NDT-5 × Arka Vikas	-0.02	-0.02	-0.02	0.71	0.69	0.70	-0.17	-0.17	-0.17	-0.03	-0.03	-0.03
NDT-5 × Arka Meghali	0.91**	0.91**	0.91**	1.92**	1.93**	1.92**	0.19	0.19	0.19	0.10	0.10	0.10
NDT-6 × Pusa Ruby	-0.47	-0.47	-0.47*	0.22	0.37	0.29	1.10**	1.10**	1.10**	-0.23	-0.23	-0.23
NDT-6 × Pb. Chhuhara	-0.24	-0.24	-0.24	-0.06	-0.21	-0.13	0.44	0.44	0.44	0.05	0.05	0.05
NDT-6 × Arka Vikas	0.79*	0.79*	0.79**	0.07	0.22	0.15	-0.65	-0.65	-0.65**	-0.32	-0.32	-0.32
NDT-6 × Arka Meghali	-0.07	-0.07	-0.07	-0.23	-0.38	-0.31	-0.89*	-0.89*	-0.89**	0.50	0.50	0.50**

Traits Crosses	Total soluble solid (TSS)			Ascorbic acid (mg/100 g fresh fruit)			Total fruit yield per plant (kg)		
	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled
NDT-1 × Pusa Ruby	-0.03	-0.03	-0.03	5.15**	-0.42	2.36*	-0.04	0.00	-0.02
NDT-1 × Pb. Chhuhara	-0.22	-0.22	-0.22	-4.44**	-2.06	-3.25**	0.18	0.09	0.13
NDT-1 × Arka Vikas	0.56	0.56	0.56*	-4.25**	-8.10**	-6.17**	-0.12	-0.08	-0.10
NDT-1 × Arka Meghali	-0.31	-0.31	-0.31	3.55*	10.59**	7.07**	-0.02	0.00	-0.01
NDT-2 × Pusa Ruby	0.17	0.17	0.17	9.79**	7.87**	8.83**	-0.01	-0.01	-0.01
NDT-2 × Pb. Chhuhara	-0.51	-0.51	-0.51*	-0.29	0.81	0.26	-0.19	-0.17	-0.18
NDT-2 × Arka Vikas	0.21	0.21	0.21	-4.48**	-3.01*	-3.75**	0.01	0.01	0.01
NDT-2 × Arka Meghali	0.14	0.14	0.14	-5.02**	-5.67**	-5.34**	0.19	0.17	0.18
NDT-3 × Pusa Ruby	0.29	0.29	0.29	-1.61	-3.10*	-2.35*	-0.16	-0.16	-0.16
NDT-3 × Pb. Chhuhara	-0.40	-0.40	-0.40	-0.40	0.13	-0.13	0.12	0.14	0.13
NDT-3 × Arka Vikas	-0.04	-0.04	-0.04	2.79*	3.59*	3.19**	0.24	0.24	0.24
NDT-3 × Arka Meghali	0.15	0.15	0.15	-0.78	-0.62	-0.70	-0.20	-0.22	-0.21
NDT-4 × Pusa Ruby	0.06	0.06	0.06	0.28	-1.19	-0.45	-0.11	-0.11	-0.11
NDT-4 × Pb. Chhuhara	-0.04	-0.04	-0.04	0.00	0.71	0.35	-0.01	0.02	0.01
NDT-4 × Arka Vikas	0.20	0.20	0.20	1.26	2.36	1.81	0.30	0.30	0.30*
NDT-4 × Arka Meghali	-0.22	-0.22	-0.22	-1.54	-1.89	-1.72	-0.19	-0.21	-0.20
NDT-5 × Pusa Ruby	-0.68*	-0.68*	-0.68**	-7.68**	-2.78	-5.23**	-0.30	-0.30	-0.30*
NDT-5 × Pb. Chhuhara	0.71*	0.71*	0.71**	4.74**	3.01*	3.88**	0.41*	0.43*	0.42**
NDT-5 × Arka Vikas	-0.39	-0.39	-0.39	1.55	0.18	0.86	-0.40*	-0.40*	-0.40**
NDT-5 × Arka Meghali	0.36	0.36	0.36	1.40	-0.42	0.49	0.29	0.27	0.28*
NDT-6 × Pusa Ruby	-0.21	-0.21	-0.21	2.86*	1.51	2.18*	0.41*	0.42*	0.42**
NDT-6 × Pb. Chhuhara	0.44	0.44	0.44	0.73	1.41	1.07	-0.57**	-0.55**	-0.56**
NDT-6 × Arka Vikas	0.47	0.47	0.47*	-1.74	-0.69	-1.22	0.07	0.06	0.06
NDT-6 × Arka Meghali	-0.70*	-0.70*	-0.70**	-1.84	-2.24	-2.04	0.09	0.07	0.08

Traits Crosses	Total soluble solid (TSS)			Ascorbic acid (mg/100 g fresh fruit)			Total fruit yield per plant (kg)		
	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled	Y <sub>1</sub>	Y <sub>2</sub>	Pooled
NDT-7 × Pusa Ruby	-0.17	-0.17	-0.17	2.66	4.82**	3.74**	-0.21	-0.18	-0.20
NDT-7 × Pb. Chhuhara	1.08**	1.08**	1.08**	-0.69	-1.17	-0.93	-0.21	-0.16	-0.19
NDT-7 × Arka Vikas	-0.37	-0.37	-0.37	0.06	-0.06	0.00	0.10	0.13	0.12
NDT-7 × Arka Meghali	-0.54	-0.54	-0.54*	-2.03	-3.59*	-2.81**	0.32	0.22	0.27*
NDT-8 × Pusa Ruby	0.53	0.53	0.53*	-8.39**	-9.32**	-8.86**	0.06	0.03	0.04

NDT-8 × Pb. Chhuhara	-0.76*	-0.76*	-0.76**	-0.67	-3.90*	-2.29*	0.18	0.11	0.15
NDT-8 × Arka Vikas	0.43	0.43	0.43	2.19	5.33**	3.76**	-0.02	-0.06	-0.04
NDT-8 × Arka Meghali	-0.20	-0.20	-0.20	6.87**	7.89**	7.38**	-0.21	-0.08	-0.15
Azad T-6 × Pusa Ruby	-0.22	-0.22	-0.22	-2.55	-4.06**	-3.30**	0.12	0.11	0.12
Azad T-6 × Pb. Chhuhara	0.13	0.13	0.13	0.38	2.23	1.31	-0.02	-0.02	-0.02
Azad T-6 × Arka Vikas	-0.16	-0.16	-0.16	0.90	2.12	1.51	0.02	0.04	0.03
Azad T-6 × Arka Meghali	0.24	0.24	0.24	1.27	-0.30	0.49	-0.13	-0.13	-0.13
Arka Saurabh × Pusa Ruby	0.26	0.26	0.26	-0.51	6.65**	3.07**	0.23	0.21	0.22
Arka Saurabh × Pb. Chhuhara	-0.43	-0.43	-0.43	0.64	-1.17	-0.26	0.11	0.11	0.11
Arka Saurabh × Arka Vikas	-0.91**	-0.91**	-0.91**	1.73	-1.72	0.00	-0.20	-0.23	-0.22
Arka Saurabh × Arka Meghali	1.08**	1.08**	1.08**	-1.87	-3.76*	-2.81**	-0.14	-0.09	-0.11
SE (Sij)	0.31	0.31	0.22	1.40	1.51	1.04	0.16	0.17	0.13
SE (Sij-Sik)	0.72	0.72	0.53	3.28	3.54	2.44	0.38	0.40	0.30

\*, \*\* Significant at 5 per cent and 1 per cent probability levels, respectively.

Out of forty crosses studied some crosses showed significant and positive sca effects for fruit yield per plant as well as some other yield components in both the years and in pooled. For total fruit yield per plant, two cross combinations among forty crosses showed significant and positive sca effects for this trait in  $Y_1$ . Amongst these, the notable crosses were NDT-5 × Pb. Chhuhara and NDT-6 × Pusa Ruby. On the other hand two cross combinations showed negative and significant sca effects for this traits.

In case of  $Y_2$ , two cross combinations showed positive and significant sca effects. The best positive and significant cross combinations were NDT-5 × Pb. Chhuhara and NDT-6 × Pusa Ruby. Two cross combinations showed negative sca effects for total fruit yield per plant.

In case of pooled, five cross combinations showed positive and significant sca effects. The best positive and significant cross combinations were NDT-5 × Pb. Chhuhara and NDT-6 × Pusa Ruby, NDT-4 × Arka Vikas, NDT-5 × Arka Meghali and NDT-7 × Arka Meghali. Three cross combinations showed negative sca effects for total fruit yield per plant.

The cross NDT-5 × Pb. Chhuhara and NDT-6 × Pusa Ruby (0.42) was found most promising as it had highly significant sca effects for fruit yield per plant along with average fruit weight during both the years and pooled; likewise cross NDT-5 × Pb. Chhuhara along with plant height, total soluble solids and ascorbic acid in both the years and pooled except plant height, and ascorbic acid in  $Y_2$ ; NDT-6 × Pusa Ruby along with number of locules per fruit during both the years and pooled.

The two crosses in both years and pooled mentioned above may be considered for utilization in breeding programme for yield enhancement.

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