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Variability Studies in Tomato Genotypes for Growth, Yield and Quality Traits

Chandan Gunaga, Kavita Kandpal, P. Venkatesha Murthy and A. P. Mallikarjuna Gowda
Department of Horticulture, College of Agriculture, UAS, GKVK, Bengaluru - 560 065
e-Mail : chandan04mg@gmail.com

Authors Contribution

Chandan Gunaga :
Conceptualization, carried out experiment, data analysis and draft preparation

Kavita Kandpal &
P. Venkatesha Murthy :
Conceptualization, draft correction, supervision and technical assisstance

A. P. Mallikarjuna Gowda :
Conceptualization and designing of experiment

Corresponding Author :
Chandan Gunaga

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Abstract

Genetic variability analysis provides a guideline for the assessment of relative breeding potential of the parents which could be utilized either to exploit heterosis in F_1 hybrids or the accumulation of fixable genes to evolve a variety. Present study focussed on the assessment of yield potential and variability study in 48 genotypes of tomato. Genotypes under study showed greater potential with respect to growth parameters. Observations on phenological parameters revealed higher number of flowers in wild types compared to cultivated genotypes. Early flowering and early harvest were exhibited by wild types in comparison with cultivated genotypes. Compared to local checks, most of *Solanum lycopersicum* genotypes showed similar yield while some have exhibited higher yield. Genotypic and phenotypic coefficients of variability were high for plant height, number of branches, number of leaves, number of flower clusters, total number of fruits, polar circumference of fruit, transverse circumference of fruit, fruit weight, yield per plant and estimated yield per hectare. Heritability was high for all the 18 investigated traits. Genetic advance as per cent of mean was found high for all the characters except for total harvest duration.

Keywords : Tomato, Genotypes, Evaluation, Variability studies

The cultivated tomato, *Solanumly copersicum* L., is one of the world's most consumed vegetables due to its status as a basic ingredient in a large variety of raw, cooked or processed foods. Tomato is grown worldwide both as a local use crop or as an export crop and is second most remunerable vegetable after potato (Ashwini and Nagaraju, 2022). According to FAO STAT (Anonymous, 2022), the world's top five greatest producers of tomato were China, India, United States, Turkey and Egypt.

Decades of breeding have resulted in a significant loss to the genetic diversity in the crop plants. Genetic variability analysis is fundamental for the assessment of relative breeding potential of the parents which could be utilized either to exploit heterosis in F_1 hybrids or the accumulation of fixable genes to evolve a new variety. Genetic variability forms the basis for any breeding programme that may be resistance breeding or breeding for high yield. Correlation between performance of a genotype and attributing characters give insight for the selection of superior ones. Systematic studies and evaluation of genotypes are of great importance for present and future improvement of a crop (Tejaswini *et al*., 2022). Morphological characterization is the initial phase in the description and classification of genotype collections.

Wide genetic diversity of *Solanum* spp has been reported in India. Quantification of diversity is vital to identify trait specific genotypes within the available germplasm. Repository of genes can be exploited and employed in tomato improvement programme.

Keeping the above facts in view, the present study intends to assess variability among genotypes of tomato collected from different parts of India for growth, yield and quality parameters.

Material and Methods

In present study, 48 genotypes of tomato belonging to four different species were evaluated at the Vegetable Block of Horticulture Department, UAS, GKVK, Bengaluru during 2022-23. Among them, one belonged to *Solanum peruvianum* and *Solanum pimpinellifolium* each, two belonged to *Solanum ceraciforme* an drest of the genotypes belonged to *S. lycopersicum.* Arka Rakshak and Arka Abhed were used as local checks for yield. Details of the genetic material used in the study are furnished in Table 1.

Seedlings were raised in nursery for 28 days before transplanting. Transplanting was done onto raised beds prepared in field with plastic mulching. Spacing of 90×60 cm was followed while planting in randomized complete block design (RCBD) with three replications. Observations were recorded for 18 parameters. Analysis was done for significance of variance, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, genetic advanceand path analysis.

Table 1

Details of tomato genotypes used for the evaluation study

Name of the Genotype	Species
WIR-3957	*S. peruvianum*
WIR-13708	*S. ceraciforme*
WIR-13706	*S. ceraciforme*
EC-520074	*S. pimpinellifolium*
C-269	*S. lycopersicum*
C-224	*S. lycopersicum*
C-253	*S. lycopersicum*
S-219	*S. lycopersicum*
C-59	*S. lycopersicum*
S-187	*S. lycopersicum*
S-217	*S. lycopersicum*
C-195	*S. lycopersicum*
C-162	*S. lycopersicum*
S-160	*S. lycopersicum*
C-89	*S. lycopersicum*
S-83	*S. lycopersicum*
S-72	*S. lycopersicum*
C-147	*S. lycopersicum*
C-132	*S. lycopersicum*
C-137	*S. lycopersicum*
S-136	*S. lycopersicum*
S-129	*S. lycopersicum*
S-143	*S. lycopersicum*
S-141	*S. lycopersicum*
C-56	*S. lycopersicum*
C-57	*S. lycopersicum*
D-28	*S. lycopersicum*
S-33	*S. lycopersicum*
M-23	*S. lycopersicum*
S-25	*S. lycopersicum*
D-218	*S. lycopersicum*
M-202	*S. lycopersicum*
C-194	*S. lycopersicum*
S-191	*S. lycopersicum*
S-186	*S. lycopersicum*
S-189	*S. lycopersicum*
M-188	*S. lycopersicum*
D-220	*S. lycopersicum*
M-208	*S. lycopersicum*
L-193	*S. lycopersicum*
S-190	*S. lycopersicum*
S-54	*S. lycopersicum*
S-48	*S. lycopersicum*
S-41	*S. lycopersicum*
C-21	*S. lycopersicum*
S-60	*S. lycopersicum*
S-76	*S. lycopersicum*
S-67	*S. lycopersicum*
Arka Rakshak	*S. lycopersicum*
Arka Abhed	*S. lycopersicum*

Continued....

Table 1 Continued....

Results and Discussion

Mean Performance of Genotypes for Growth Parameters

Mean performance of genotypes for growth parameters is presented in Table 2. All the 48 geno types used in the study belonged to indeterminate type. Plant height of the genotypes at last harvest varied from 417.50 cm (C-269) to 158.75 cm (S-186). Forty five out of 48 genotypes under study showed taller plant habit than the local check varieties. WIR-3957 (365 cm), WIR-13708 (375 cm) and EC-520074 (377.5 cm) were some of the taller genotypes with statistically on par heights. Among the genotypes used in the study, number of branches varied from 50 (D-218) to 11.5 (S-186). Thirty out of 48 genotypes showed on par results with either of the checks. EC-520074 (*S. pimpinellifolium*) produced highest number of leaves (625.45). S-25 with 75.65 leaves was designated as genotype with lowest number of leaves. WIR-3957, WIR-13708, C-269, C-224, C-132 and S-143 produced more than 400 leaves per plant.

Table 2

Mean performance of genotypes for growth parameters

Genotypes	Plant height (cm)	Number of branches	Number of leaves
WIR-3957	365.00	21.00	400.50
WIR-13708	375.00	26.25	425.36
WIR-13706	297.50	20.50	125.47
EC-520074	377.50	33.00	625.45
C-269	417.50	39.25	525.00
C-224	317.50	31.75	430.35
C-253	240.00	20.50	162.65
S-219	265.00	18.00	176.62
C-59	265.00	21.00	165.24
S-187	283.75	18.00	140.35
S-217	272.50	20.50	165.55
C-195	286.25	18.00	125.63
C-162	285.00	28.25	130.25
S-160	297.50	19.00	140.66
C-89	340.00	18.50	128.65
S-83	257.50	18.00	150.65
S-72	291.25	18.25	160.32
C-147	260.00	18.00	156.55
C-132	292.50	20.50	465.65
C-137	291.25	19.50	166.00
S-136	267.50	20.00	138.33
S-129	196.25	16.50	125.36
S-143	325.00	18.50	500.25
S-141	321.25	20.50	140.22
C-56	282.50	20.00	130.35
C-57	323.75	20.00	237.69
D-28	293.75	20.00	130.24
S-33	270.00	12.75	120.18
M-23	293.75	18.00	200.47
S-25	216.25	15.00	75.65
D-218	297.50	50.00	300.74
M-202	261.25	22.25	300.25
C-194	307.50	21.00	130.47
S-191	180.00	13.75	85.24
S-186	158.75	11.50	86.35
S-189	277.50	27.00	250.24
M-188	297.50	23.75	135.68
D-220	318.75	31.25	300.47
M-208	311.25	31.75	380.75
L-193	291.25	21.75	85.65
S-190	260.00	18.00	136.16
S-54	295.00	16.00	100.24
S-48	207.50	14.50	320.24
S-41	225.00	14.00	90.25
C-21	303.75	19.50	300.24
S-60	216.25	19.50	120.35
S-76	192.50	12.50	100.35
S-67	168.75	12.50	110.25
ArkaAbhed	143.75	27.50	125.25
ArkaRakshak	191.25	18.00	86.50
F test	*	*	*
C.D.	22.5	2.44	43.54
SE(m)	8.04	0.87	15.49
C.V.(%)	5.84	8.28	13.01

* Significant at 5% probability level

Genotypes under study showed greater potential with respect to characters like plant height, number of branches and number of leaves as proven by the results of evaluation for growth parameters. Their performance over local checks like Arka Abhed and Arka Raksak made them useful participants in crop improvement programme. Tomato being highly self-pollinated crop makes it easy to employ these traits in hybrid production.

Mean Performance of Genotypes for Phenological Parameters

Phenological parameters are plant characters that are related to flowering behaviour. Observations on these traits is presented in Table 3. Among the genotypes used in the study, S-187 (157.5) produced highest number of flower clusters. S-217 with 150 flower clusters was statistically on par with highest value. Lowest number of flower clusters was produced by S-48 (11.75). EC-520074, S-141 and C-194 produced more than 100 flower clusters.WIR-13708 (*S. ceraciforme*) produced earliest flower with 31 days after transplanting. WIR-3957, C-269, C-224 and C-

Table 3

Mean performance of genotypes for phenological parameters

Genotypes	Number of flower clusters	Days to first flowering	Days to 50% flowering
WIR-3957	70.00	33.75	35.00
WIR-13708	92.50	31.00	32.00
WIR-13706	67.50	43.00	45.00
EC-520074	115.00	36.50	38.00
C-269	41.50	32.25	33.00
C-224	72.50	33.50	34.00
C-253	62.50	34.00	34.00
S-219	28.25	34.00	34.00
C-59	56.25	36.00	36.00
S-187	157.50	36.25	37.00
S-217	150.00	37.00	37.00
C-195	97.50	38.50	39.00
C-162	78.75	42.25	43.00
S-160	60.00	39.00	40.00
C-89	46.25	45.75	48.00
S-83	71.25	36.00	36.00
S-72	71.25	38.50	39.00
C-147	51.25	39.00	40.00
C-132	76.25	36.50	38.00
C-137	91.25	44.50	45.00
S-136	70.00	40.50	41.00
S-129	33.75	43.50	44.00
S-143	98.75	47.75	48.00
S-141	136.75	35.75	36.00
C-56	73.75	33.00	34.00
C-57	67.50	46.50	48.00
D-28	58.75	45.25	46.00
S-33	34.00	51.25	52.00
M-23	37.50	36.50	37.00
S-25	21.25	47.00	48.00
D-218	43.00	46.00	46.00
M-202	68.75	47.75	48.00
C-194	106.25	47.25	48.00
S-191	27.50	47.75	48.00
S-186	17.50	39.00	40.00
S-189	32.75	51.25	52.00
M-188	68.75	54.50	55.00
D-220	25.00	43.00	44.00
M-208	71.25	36.50	37.00
L-193	95.00	45.75	46.00
S-190	35.00	41.00	42.00
S-54	48.75	45.00	46.00
S-48	11.75	45.50	46.00
S-41	28.75	50.50	51.00
C-21	72.50	42.75	43.00
S-60	43.75	48.25	49.00
S-76	18.25	49.50	50.00
S-67	25.00	51.75	53.00
ArkaAbhed	44.75	35.00	36.00
ArkaRakshak	83.75	39.00	40.00
F test	*	*	*
C. D.	15.24	2.32	2.02
SE(m)	5.45	0.83	0.72
C.V. (%)	17.25	3.98	2.97

Continued....

Table 3 Continued....

* Significant at 5% probability level

56 also produced early flowering with statistically on par data with the lowest. Latest flowering was seen in M-188 (54.5 days). WIR-13708 (*S. ceraciforme*) exhibited least number of days for 50 per cent flowering. C-269, C-224, C-253, S-219 and C-56 were also statistically on par with WIR-13708 for least number of days for 50 per cent flowering. M-188 with 55 days produced delayed 50 per cent flowering.

Observations on phenological parameters of genotypes reported higher number of flowers in wild types compared to cultivated genotypes, which was contributed by the presence of a greater number of flower bearing branches in wild types. Compared to local checks, the *S. lycopersicum* genotypes produced a greater number of flower clusters, which can be considered as a beneficial trait. In case of early flowering, again the wild types showed earlier flowering than cultivated genotypes. Most of the *S. lycopersicum* genotypes used in the study showed later or on-par commence of flowering with local checks.

Mean Performance of Genotypes for Harvest Parameters

Harvest parameters include days to first harvest, total harvest duration, number of fruits per cluster and number of fruits per plant (Table 4). Days to first harvest is an indication of earliness of the genotype. Among the genotypes studied, S-160 produced harvestable fruits at the earliest with 50.3 days after transplanting. WIR-13708, C-269, C-162 and C-56 showed statistically on par data with least value. M-188 showed latest harvest with 75.40 days after transplanting. In the present study longest harvest duration was observed in WIR-3957 with 99.74 days. M-23 with 98.75 days was statistically on par with WIR-3957. Least harvest duration was observed in D-218 (66.37 days). A greater number of fruits per cluster was observed in C-269 with 8.30 fruits per cluster. D-218 (8 fruits/cluster) showed statistically on par value with C-269.

TABLE 4

Mean performance of genotypes for harvest parameters

Genotypes	Days to first harvest	Total harvest duration (days)	Number of fruits/cluster	Number of fruits/plant
WIR-3957	55.26	99.74	5.30	290.00
WIR-13708	52.50	92.50	4.35	310.00
WIR-13706	65.63	89.37	4.35	210.00
EC-520074	58.54	91.46	7.84	745.00
C-269	52.39	92.61	8.34	272.00
C-224	52.75	82.25	6.64	115.00
C-253	54.30	95.70	6.65	315.00
S-219	54.60	90.40	5.71	81.25
C-59	56.50	86.50	4.36	155.00
S-187	56.85	96.15	5.82	82.38
S-217	57.60	96.40	6.34	59.34
C-195	58.45	86.55	5.65	75.60
C-162	52.50	87.50	4.71	85.00
S-160	50.30	89.70	4.98	95.00
C-89	58.40	76.60	5.34	97.00
S-83	56.36	83.64	4.35	125.00
S-72	58.65	76.35	5.20	76.00

Continued....

TABLE 4 Continued....

Genotypes	Days to first harvest	Total harvest duration (days)	Number of fruits/cluster	Number of fruits/plant
C-147	60.80	69.20	4.60	175.75
C-132	58.65	84.35	5.40	210.00
C-137	65.55	68.45	4.80	78.00
S-136	60.80	92.20	5.20	104.00
S-129	62.40	87.60	5.70	132.38
S-143	68.45	76.55	4.20	93.00
S-141	55.25	89.75	4.30	175.00
C-56	52.70	82.30	4.50	78.63
C-57	68.42	85.58	5.20	190.00
D-28	65.55	87.45	5.40	120.00
S-33	71.45	73.55	5.10	78.00
M-23	55.25	98.75	4.80	120.00
S-25	68.35	85.65	4.90	64.13
D-218	68.63	66.37	8.00	284.00
M-202	66.33	83.67	4.70	126.24
C-194	66.85	78.15	5.60	135.65
S-191	66.25	78.75	5.40	88.50
S-186	60.47	92.53	5.50	86.50
S-189	72.80	77.20	5.70	126.68
M-188	75.40	74.60	4.20	86.35
D-220	62.34	82.66	5.10	75.90
M-208	68.17	71.83	4.30	96.35
L-193	56.36	78.64	5.30	68.37
S-190	65.17	79.83	5.40	78.00
S-54	62.59	77.41	4.60	145.36
S-48	66.37	83.63	4.80	76.40
S-41	66.48	83.52	4.90	80.88
C-21	70.50	84.50	5.30	124.36
S-60	62.68	72.32	5.70	78.66
S-76	68.37	85.63	5.20	84.90
S-67	70.33	74.67	5.40	75.00
ArkaAbhed	65.40	84.60	5.00	78.63
ArkaRakshak	60.40	89.60	5.65	83.86
F test	*	*	*	*
C.D.	2.06	2.62	0.30	64.53
SE(m)	0.73	0.93	0.11	22.96
C.V. (%)	2.06	1.92	3.44	11.82

* Significant at 5% probability level

Lowest number of fruits per cluster (4.20) was observed in S-143 and M-188. Genotype EC-520074 (*S. pimpinellifolium*) with 745 fruits showed highest number of fruits per plant. Among *S. lycopersicum* genotypes, C-253 with 315 fruits/plant was the highest. S-217 produced lowest number of fruits per plant with 59.34 fruits.

Early harvest was exhibited by wild types in comparison with cultivated genotypes. This trait was contributed by early flowering. While using wild types in breeding programme, breeder can target for transfer of earliness as proven by current study. Except for few, most of the cultivated genotypes showed on par commence of harvest with local checks. In case of number of fruits per plant, wild types showed the highest value. Compared with local checks the cultivated genotypes showed similar number of fruits per plant.

Mean Performance of Genotypes for Yield Parameters

Yield parameters include fruit weight, yield per plant and estimated yield per hectare (Table 5). Average weight of the fruit in the present study ranged from

Table 5

Mean performance of genotypes for yield parameters

Genotypes	Average fruit weight (g)	Yield per plant (kg)	Estimated yield per hectare (t)
WIR-3957	10.50	2.98	31.79
WIR-13708	20.35	6.31	69.39
WIR-13706	16.37	3.12	34.32
EC-520074	0.65	0.48	5.33
C-269	1.23	0.33	3.68
C-224	80.50	9.26	101.83
C-253	70.25	4.37	48.05
S-219	33.25	2.70	29.72
C-59	43.60	6.76	74.34
S-187	55.35	4.56	50.16
S-217	65.55	3.89	42.79
C-195	80.00	6.05	66.53
C-162	75.00	6.38	70.13
S-160	83.00	7.89	86.74
C-89	80.00	7.76	85.36
S-83	79.31	4.50	49.50
S-72	76.31	5.78	63.54
C-147	15.24	2.64	29.00
C-132	17.35	3.57	39.27
C-137	95.31	7.41	81.51
S-136	35.68	3.64	40.04
S-129	33.41	4.37	48.05
S-143	55.27	5.12	56.27
S-141	35.61	6.13	67.38
C-56	115.23	9.04	99.47
C-57	33.49	6.27	68.97
D-28	57.39	6.84	75.24
S-33	100.38	7.80	85.80
M-23	18.47	2.16	23.76
S-25	27.63	1.73	19.05
D-218	0.50	0.14	1.56
M-202	53.66	6.69	73.60
C-194	35.13	4.75	52.23
S-191	82.41	7.26	79.83
S-186	50.69	4.33	47.58
S-189	45.28	5.70	62.70
M-188	90.34	7.77	85.49
D-220	55.00	4.17	45.92
M-208	65.33	6.26	68.89
L-193	96.67	6.56	72.19
S-190	102.00	7.96	87.52
S-54	45.26	6.54	71.95
S-48	77.48	5.88	64.71
S-41	55.91	4.45	48.93
C-21	35.23	4.35	47.88
S-60	98.65	7.76	85.36
S-76	54.77	4.58	50.43
S-67	65.00	4.88	53.63
ArkaAbhed	95.68	7.52	82.76
ArkaRakshak	75.36	6.32	69.52
F test	*	*	*
C.D.	9.75	0.71	7.81
SE(m)	3.47	0.25	2.78
C.V. (%)	10.76	8.30	8.30

Continued....

Table 5 Continued....

* Significant at 5% probability level

115.23 g to 0.50 g. Highest fruit weight was recorded in C-56. Further, S-190 and S-33 exhibited fruit weight of more than 100 g. Lowest fruit weight was observed in D-218. Lowest value was also statistically on par with C-269 and EC-520074. Among the investigated genotypes, highest yield per plant was recorded in C-224 (9.26 kg). Other genotypes *viz*., S-60, S-190, M-188, S-191, S-33, C-137, C-56, C-89 and S-160 also showed higher yields of more than 7 kg per plant. Lowest yield was reported in C-269 with 0.33 kg. The highest yielding genotype per hectare was C-224 with the yield of 101.83 tons. This value was on par with C-56 (99.47 t). Lowest yield per hectare was recorded in C-269.

The wild types with smaller fruits recorded least yield due to lower fruit weight. But wild types showed higher number of fruits per plant contributed by higher number of flowers. Compared to local checks, most of *S. lycopersicum* genotypes showed similar yield per hectare while some have exhibited higher yield.

Mean Performance of Genotypes for Fruit Parameters

Present study focused on fruit parameters like polar fruit circumference, transverse fruit circumference, shape index, TSS and shelf life (Table 6). S-190 with 21.34 cm was regarded as the genotype with longest polar fruit circumference. This value was statistically on par with S-33 with 20.00 cm. Lowest polar fruit circumference was recorded in D-218 with 4.00 cm. S-33 with 20.90 cm had the highest transverse fruit circumference. This value was statistically on par with L-193, S-190 and S-60. Lowest transverse fruit circumference was recorded in D-218 with 4.00 cm. Among the genotypes used in the study, S-48 with 1.27 exhibited the highest value. 22 genotypes showed shape index value of more than 1. The genotype, S-217 with 0.67 was the lowest. Genotype EC-520074 with 7.50 ^{o} brix had the highest TSS. Likewise, L-193, M-208, WIR-13708, WIR-13706 and C-269 recorded higher TSS of more than 6 ^{o} brix. Genotype

Table 6

Mean performance of genotypes for fruit parameters

Genotypes	Polar fruit circumference (cm)	Transverse fruit circumference (cm)	Shape index	TSS (°brix)	Shelf life (days)
WIR-3957	8.65	9.65	0.90	5.20	12.00
WIR-13708	11.72	13.65	0.86	6.20	10.00
WIR-13706	8.55	7.65	1.12	6.50	13.00
EC-520074	4.50	4.30	1.05	7.50	15.00
C-269	4.36	4.55	0.96	6.50	12.00
C-224	17.86	19.35	0.92	4.00	10.00
C-253	16.35	15.45	1.06	3.00	12.00
S-219	12.98	15.24	0.85	5.00	12.00
C-59	14.20	15.29	0.93	5.00	13.00
S-187	14.50	15.30	0.95	4.50	13.00
S-217	11.63	17.41	0.67	4.20	10.00
C-195	17.70	17.00	1.04	4.30	12.00
C-162	17.32	16.58	1.04	4.80	10.00
S-160	18.40	17.70	1.04	4.00	12.00
C-89	19.74	17.81	1.11	4.50	11.00
S-83	16.95	17.22	0.98	4.30	12.00
S-72	14.63	18.25	0.80	3.40	10.00

Continued....

TABLE 6 Continued....

Genotypes	Polar fruit circumference (cm)	Transverse fruit circumference (cm)	Shape index	TSS (°brix)	Shelf life (days)
C-147	11.50	14.35	0.80	4.00	9.00
C-132	12.35	11.24	1.10	4.00	12.00
C-137	18.55	17.35	1.07	3.80	10.00
S-136	13.24	12.58	1.05	3.80	11.00
S-129	13.50	14.53	0.93	4.20	13.00
S-143	15.50	16.74	0.93	5.40	8.00
S-141	14.65	14.33	1.02	4.20	9.00
C-56	19.34	19.25	1.00	4.80	9.00
C-57	14.67	14.80	0.99	5.00	12.00
D-28	15.50	16.70	0.93	4.20	12.00
S-33	20.00	20.90	0.96	3.80	9.00
M-23	10.22	13.25	0.77	5.50	13.00
S-25	12.00	13.20	0.91	4.50	14.00
D-218	4.00	4.00	1.00	4.80	9.00
M-202	15.24	16.50	0.92	5.00	9.00
C-194	12.80	13.20	0.97	4.40	12.00
S-191	18.00	16.50	1.09	5.50	13.00
S-186	14.85	15.47	0.96	5.80	14.00
S-189	13.36	15.64	0.85	4.50	13.00
M-188	18.33	17.50	1.05	5.10	12.00
D-220	16.50	15.50	1.06	4.00	10.00
M-208	17.24	17.54	0.98	6.00	10.00
L-193	19.50	20.00	0.98	6.00	11.00
S-190	21.34	20.10	1.06	4.00	14.00
S-54	14.50	14.00	1.04	4.50	11.00
S-48	19.74	15.50	1.27	5.00	13.00
S-41	16.00	14.23	1.12	4.80	12.00
C-21	13.30	13.60	0.98	4.60	14.00
S-60	19.65	20.10	0.98	4.50	12.00
S-76	16.50	15.60	1.06	5.00	13.00
S-67	17.40	17.00	1.02	4.80	12.00
ArkaAbhed	17.35	18.35	0.95	4.50	12.00
ArkaRakshak	15.34	16.36	0.94	4.00	12.00
F test	*	*	*	*	*
C.D.	1.30	1.23	0.03	0.28	0.53
SE(m)	0.46	0.44	0.01	0.10	0.19
C.V. (%)	5.39	4.99	2.11	3.62	2.82

* Significant at 5% probability level

with lowest TSS was C-253 with 3 °brix. In the present study EC-520074 exhibited longest shelf life with 15 days. WIR-13706, C-59, S-187, S-129, M-23, S-25, S-191, S-186, S-189, S-190, S-48, C-21 and S-76 showed better storability with longer shelf life. Shortest shelf life was recorded in S-143 with 8 days.

In general, it has been proven that yield is ultimately and primarily governed by average fruit weight and total number of fruits. In the present study, the fruit yield per plant differed significantly among genotypes which might be attributed to varied plant height, number of flowers per cluster, number of fruits per plant and fruit weight. Significantly highest fruit yield per plant (9.26 kg) was recorded in C-224 compared to other genotypes. Highest yield of C-224 was mainly due to a greater number of fruits per plant as well as a greater number of flowers and fruits per cluster in addition to comparatively a greater number of branches and plant height. Deepa and Thakur (2008) also obtained highest yield of 1347g per plant in AI-9 of tomato. The results reported by Shivanand (2008) and Renuka *et al.* (2014) in tomato and cherry tomato, respectively showed that the highest yield was due to highest number of fruits per plant supporting the present findings.

Genotypic and Phenotypic Coefficient of Variation

As observed in the study (Table 7), high GCV and PCV estimates were observed for the traits *viz*., plant height (20.66% and 21.61%), number of branches per plant (33.43% and 34.57%), number of leaves per plant (64.62% and 65.91%), number of flower clusters (54.30%, 56.45%), total number of fruits per plant (58.69%, 59.86%), polar circumference of fruit (26.78%, 27.31%), transverse circumference of fruit (24.78%, 25.28%), average fruit weight (53.45%, 54.52%), yield per plant (41.18%, 42.01%) and estimated yield per hectare (41.23%, 42.06%). Medium GCV and PCV were observed in days to first flowering (14.51%, 15.03%), days to 50 per cent

TABLE 7

Variability parameters for yield and yield contributing characters among 48 genotypes of tomato

Characters	Range		Mean	CV (%)	GCV (%)	PCV (%)	h_{bs}^2 (%)	GA	GAM (%)
	Max	Min							
Plant height (cm)	417.50	143.75	275.6	5.84	20.66	21.61	91.40	112.13	40.69
Number of branches	50.00	11.50	21.05	8.28	33.43	34.57	93.47	14.01	66.57
Number of leaves	625.45	75.65	206.23	13.01	64.62	65.91	96.10	269.11	130.49
Days to first flowering	54.50	31.00	41.57	3.98	14.51	15.03	93.22	12.00	28.86
Days to 50% flowering	55.00	32.00	41.78	2.98	14.78	15.07	96.10	12.47	29.84
Number of flower clusters	157.50	11.75	63.01	17.25	54.30	56.45	92.52	67.79	107.59
Days to first harvest	75.40	50.30	61.74	2.06	10.20	10.41	96.10	12.72	20.60
Number of fruits per cluster	8.34	4.20	5.32	3.44	17.04	17.38	96.10	1.83	34.41
Number of fruits per plant	745.00	59.34	336.54	11.82	58.69	59.86	96.10	398.84	118.51
Polar fruit circumference (cm)	21.34	4.00	14.84	5.40	26.78	27.31	96.10	8.02	54.06
Transverse fruit circumference (cm)	20.90	4.00	15.17	4.99	24.78	25.28	96.11	7.59	50.04
Shape index	1.27	0.67	0.98	0.98	10.48	10.69	96.09	0.21	21.15
Fruit weight (g)	115.23	0.50	55.84	10.76	53.45	54.52	96.10	60.27	107.94
Total harvest duration (days)	99.74	66.37	83.90	1.92	9.55	9.74	96.10	16.17	19.28
TSS (°brix)	7.50	3.00	4.74	3.62	17.97	18.33	96.10	1.72	36.29
Shelf life (days)	15.00	8.00	11.56	2.82	14.01	14.30	96.10	3.27	28.30
Yield per plant (kg)	9.26	0.14	5.27	8.30	41.18	42.01	96.10	4.39	83.17
Estimated yield per hectare (t)	101.83	1.56	57.99	8.30	41.23	42.06	96.10	48.29	83.27

flowering (14.78%, 15.07%), days to first harvest (10.20%, 10.41%), number of fruits per cluster (17.04%, 17.38%), shape index (10.48%, 10.69%), TSS (17.97%, 18.33%) and shelf life (14.01%, 14.30%). Low GCV and PCV was observed in total harvest duration (9.55% and 9.74 %). Such kind of variability was also observed by Islam *et al*. (2012). Similar works were also conducted by Patel *et al*. (2001), Muniappan *et al*. (2010), Ahmad *et al.* (2013) and Deshmukh *et al*. (2014).

The expression of characters was governed by genotypic effect as well as environmental effect. Phenotypic expression of characters such as plant height, number of branches, number of leaves was attributed to nature of genotype. Variation between genotypic and phenotypic expressions of characters was discussed to be governed by the effect of environment.

Heritability and Genetic Advance

High heritability as well as genetic advance were reported for plant height, number of branches, number of leaves, days to first flowering, days to 50 per cent flowering, number of flower clusters, days to first harvest, number of fruits per cluster, number of fruits per plant, polar fruit circumference, transverse fruit circumference, shape index, fruit weight, TSS, shelf life, yield per plant and estimated yield per hectare. Experimental findings of Negi *et al*. (2000) revealed that most of the traits showed high estimates of heritability (>70 per cent). High genetic advance coupled with high heritability was exhibited by number of fruits per plant, fruit yield per plant and average fruit weight suggesting predominance of additive gene action. Days to 50 per cent flowering and picking had high heritability and low genetic advance. Prasad *et al*. (2004) observed moderate genetic advance and heritability for plant height, days to first flowering and days to first fruit set. The heritability estimates were high (above 87 per cent) for all the characters according to the study of Singh and Kumar (2005). Similar results were also obtained by Golani *et al*. (2007).

Tomato is a highly self-pollinated crop. Due to homozygous condition, any new genotype that performs well for yield and yield attributing characters can be directly released as a variety. Present study revealed many such genotypes like C-224, S-160, C-89, C-56, S-60 and S-190 which showed higher yield than the local check Arka Abhed. High GCV and PCV recorded for most of the characters studied revealed the presence of variability among the population used in the study which is a desirable outcome to design crop improvement programmes. Recording of high heritability and genetic advance were also useful in view of using present material in future breeding programme. High heritability and genetic advance made sure that selection for these traits can be planned in progenies produced using present genotypes.

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