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Genetic Evaluation of Tomato (*Solanum lycopersicum* L.) Germplasm for Yield and Quality Traits

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A B S T R A C T

Genetic evaluation of twenty five diverse genotypes tomato was conducted for yield and quality traits at the experimental farm of RHR&TS, Jachh, Kangra, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during the year 2018. These genotypes were comprised of eleven varieties, ten exotic lines and three local collections along with one standard check Solan Lalima. Experiment was conducted in Randomized Complete Block Design with three replications to ascertain extent of variability, heritability, genetic advance and gain for yield and other horticultural traits. Analysis of variance revealed significant differences among all the genotypes for all the characters under study. The estimates of PCV and GCV were high for marketable fruit yield per plant, number of locules per fruit, average fruit weight, harvest duration, shelf life and number of fruits per cluster. High heritability estimates were observed for all the traits among all genotypes while high estimates of genetic gain were observed for marketable fruit yield per plant, average fruit weight, harvest duration, shelf life, number of fruits per cluster, number of locules per fruit, number of fruits per plant, fruit breadth, pericarp thickness, number of fruit cluster per plant, fruit length and plant height. On the basis of overall performance, EC-802557, LC-2 and Arka Alok were found superior for marketable fruit yield and other important horticultural traits. They could be the promising parents for utilization in further breeding programmes.

Introduction

Tomato is a very popular warm season vegetable crop grown worldwide because it has wider adaptation along with high yield potential and is suitable for fresh use as well as in processed form. It ranks second only after potato (Bose *et al.*, 2002). It is designated as "Protective food" because of its nutritive value and presence of several

antioxidants *viz.* carotenoids, particularly lycopene, ascorbic acid, vitamin E and phenol compounds, particularly flavonoids. Lycopene is reported to possess dietetic properties as it reduces the risk of heart attacks and various types of cancers (Clinton, 2005). In India, it is cultivated over an area of nearly 814 thousand ha with annual production of 20,515 thousand MT [Anonymous, 2018-19 (a)]. Madhya Pradesh, Andhra Pradesh, Karnataka, Odisha are the major producing states of tomato in India. It has the share of nearly 8.3% of total vegetable area and 10.3% of total vegetable production in India. Though, tomato is one of the major vegetables exported from India, per capita consumption in India is abysmally low. In the year 2014-15, an estimated 0.22 MT of tomato worth 44, 461.34 Lakh were exported from India.

Himachal Pradesh is a major off-season tomato growing state covering an area of 9.93 thousand hectare with an annual production of 4.13 lakh metric tonnes and productivity of 41.7 metric tonnes per hectares. Considering the importance of this crop, there is an urgent need for development of new high yielding varieties/hybrids of tomato with good quality attributes. A complete knowledge pertaining to the amount of genetic variability existing for different traits is considered a prerequisite to start any crop improvement programme. The phenotypic expression of a particular trait is mainly influenced by the genetic makeup of the plant and the environment, in which it is growing. Further, the genetic variance of any quantitative trait is comprised of additive and non-additive variance. Therefore, it become pertinent that observed phenotypic variability is sub-divided into its heritable and non-heritable components with the help of suitable parameters *viz.* coefficients of variation, heritability and genetic advance. Further, genetic advance can be used to predict the efficiency of selection. Therefore, the present investigation was undertaken with the objective to estimate the extent of genetic variability for yield and quality traits in different genotypes of tomato

Materials and Methods

The experimental trial was carried out during 2018 at Regional Horticultural Research and Training Station, Dr YS Parmar University of Horticulture and Forestry, Jachh (Nurpur), District-Kangra, Himachal Pradesh. This site is situated on Pathankot-Mandi National Highway (NH-22) at an altitude of 428 m above mean sea level, lying between $32^0 16' 54.02''$ N latitude and $75^0 51' 4.38''$ E longitude under sub-mountain and low hill sub- tropical agro-climatic zone of Himachal Pradesh, India. The mean annual rainfall received by this area was 1500 mm. The soil structure of the experimental farm was sandy loam to clay loam with the pH ranging from 6.8-7.0. The complete lists of genotypes along with their source of collection have been presented in Table 1.

The seed sowing of all the genotypes were carried out during March, 2018 in raised nursery bed. Recommended cultural practices were followed for raising the healthy nursery. The experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications during April, 2018. The experiment was laid out in layout are given below Randomized Complete Block Design (RCBD) with three replications. After raising healthy nursery it was transplanted in the plots of 1.8 m x 1.8 m at a spacing of 60 cm x 45 cm. Observations were recorded for various growth and fruit yield characteristics like days to first fruit harvesting (number), plant height (cm), fruit length (cm), fruit breadth (cm), average fruit weight (g), number of fruit clusters per plant, number of fruits per cluster, number of fruits per plant, number of locules per fruit, harvest duration (days), marketable fruit yield per plant (kg) & per

hectare (q) and fruit quality characteristics like shelf life (days), pericarp thickness (mm), total soluble solids (^{o}Brix), For each observed character, the statistical analysis was performed by using MS-Excel, OPSTAT and SPAR 1.0 packages. Analysis of variance (ANOVA) was done by the method recommended by Gomez and Gomez (1983) for Randomized Complete Block Design.

All the characters which showed significant differences among genotypes were further subjected to analysis for the following parameters like coefficients of variability (phenotypic and genotypic), heritability, genetic advance and genetic gain. Variability at genotypic (GCV) and phenotypic (PCV) levels were estimated as per the method suggested by Burton and De- Vane (1953).

Heritability in broad sense was estimated as per the formulae suggested by Allard (1960). The expected genetic advance (GA) resulting from selection of five percent superior individuals was calculated as per Allard (1960). Genetic gain expressed as per cent ratio of genetic advance and population mean was calculated by the method given by Johnson *et al.,* (1955). The genetic advance as per cent over mean was calculated as mentioned by Johnson *et al.,* 1955.

Results and Discussion

Variability studies

Mean performance of genotypes

A highly significant difference was observed among the genotypes for all the traits studied which indicated the existence of enough variability in the germplasm under study. The mean performance of twenty-five genotypes along with parameters of variability for different horticultural traits are described and discussed below:

Days to first fruit harvesting (number)

Its value ranged from (62.00 – 81.33 days) with a grand mean of 69.69 days (Table 2). Thirteen genotypes including check were earlier in days to first fruit harvesting than the total population mean. Minimum number of days to first fruit harvesting was recorded in LC-2 (62.00 days) and maximum number of days to first fruit harvesting was recorded in Pusa Rohini (81.33 days). Considerable variability regarding this trait was found in accordance with the findings of Rai *et al.,* (2016) and Patel *et al.,* (2013).

Plant height (cm)

Wide variation observed among all the genotypes for plant height. The overall mean value for the trait was 71.57 cm (Table 2). It varied from 55.73 to 98.87 cm. Ten genotypes including check had more plant height than the population mean (71.57 cm). Maximum plant height was recorded in Pusa Ruby (98.87 cm) whereas minimum plant height was recorded in Arka Alok (55.73 cm). Considerable variation for this trait was also observed by Meena *et al.,* (2018) and Singh *et al.,* (2017a).

Fruit length (cm)

A significant variation was observed among all the genotypes under study for fruit length. It ranged from 3.53 to 5.89 cm (Table 2). Sixteen genotypes including standard check (Solan Lalima) produced longer fruits than population mean (4.97 cm). EC- 802562 (5.89 cm) reported the maximum fruit length and was found statistically at par with 5 genotypes *viz.* EC-802563 (5.87 cm), EC-802561 (5.63 cm), EC-802557 (5.57 cm), Punjab Chhuhara (5.61 cm) and Arka Vikas (5.63cm) whereas, minimum fruit length was observed in EC-802555 (3.53 cm) and was found statistically at par with Pant T-3 (3.79 cm) and Pusa Ruby

(3.58 cm). Among all the genotypes under study, seven genotypes had larger fruit length than standard check Solan Lalima (5.43 cm). Meena *et al.,* (2018) and Prajapati *et al.,* 2015 reported a wide variations for fruit length.

Fruit breadth (cm)

Fruit breadth ranged from 2.64 to 5.96 cm (Table 2) and varied significantly among all the genotypes under study as shown in Table 1. Sixteen genotypes including standard check had higher fruit breadth than population mean (4.99 cm). Highest breadth was observed in Arka Alok (5.96 cm) and was statistically at par with 3 genotypes *viz.* LC-2 (5.75 cm), EC-802557 (5.70 cm) and EC-802562 (5.65 cm). Minimum fruit breadth was recorded in LC-3 (2.64 cm). Twelve genotypes under study had greater fruit breadth than standard check Solan Lalima (5.23 cm). Similar findings were also reported by Meena *et al.,* (2018), Prajapati *et al.,* 2015.

Average fruit weight (g)

Average fruit weight ranged from 25.37 to 76.65 g (Table 2) and varied significantly among all the genotypes under study. Highest average fruit weight was observed in EC-802562 (76.65 g) and was statistically at par with Arka Alok (75.62 g) and EC-802563 (74.91 g). Minimum average fruit weight was recorded in LC-3 (25.37 g) and was statistically at par with EC-802555 (30.08 g).

Seven genotypes viz., EC- 802563 (74.91 g), EC-802562 (76.65 g), EC-802561 (70.44 g), EC-802557 (70.17 g), Arka Vikas (68.85g), Arka Alok (75.62 g) and LC-2 967.35 g) gave higher fruit weight than the standard check cultivar Solan Lalima (65.32 g). It is one of the major yields contributing character. Wide genetic variation with respect to this character was also reported by Meena *et al.,* (2018), Prajapati *et al.,* 2015 and Patel *et al.,* (2013).

Number of fruit clusters per plant

The number of fruit cluster per plant varied from 3.60 to 7.20 (Table 3) and varied significantly among all the genotypes under study (Table 2). Eleven genotypes had more number of fruits per cluster than population mean. EC-802563 (7.20) reported the maximum number of fruits per cluster and was found statistically at par with EC-802562 (6.87) while Pusa Uphar (3.60) reported the minimum number of fruit cluster per plant. Twenty-one genotypes produced more number of fruit cluster per plant than the standard check cultivar Solan Lalima (5.10). Results of the present study were in line with the findings of Meena *et al.,* (2018) and Reddy *et al.,* (2013a).

Number of fruits per cluster

The number of fruits per cluster varied from 2.31 to 5.65 with the overall mean 3.76 (Table 2) and varied significantly among all the genotypes under study. Twelve genotypes including standard check had more number of fruits per cluster than population mean. Maximum number of fruits per cluster was observed in Pusa Uphar (5.65) while EC-802563 (2.31) reported the minimum number of fruits per cluster and was found statistically at par with EC-802559 (2.58). Results of the present study were in line with the findings of Meena *et al.,* (2018), Rai *et al.,* (2016), Prajapati *et al.,* (2015) and Shankar *et al.,* (2013).

Number of fruits per plant

The number of fruits per plant ranged from 15.53 to 30.60 and varied significantly among all the genotypes under study (Table 2). Including standard check twelve genotypes produced more number of fruits per plant than the population means (20.93). Maximum number of fruits per plant was observed in

genotype EC-802555 (30.60) while LC- 1 (15.53) recorded in minimum number of fruits per plant and was statistically at par with LC-3 (17.07), EC-802558 (17.57), EC-802559 (17.02), EC-802561 (15.84) and EC- 802563 (16.62). Eleven genotypes among study produced more number of fruits per plant than the standard check (Solan Lalima, 22.58).

Results of the present study were in line with the findings of Meena *et al.,* (2018), Singh *et al.,* (2017a), Rai *et al.,* (2016), Patel *et al.,* (2013) and Reddy *et al.,* (2013a).

Number of locules per fruit

Number of locules ranged from 2.33 to 5.67 (Table 3) and varied significantly among all the genotypes under study. EC-802555 (2.33) recorded the minimum number of locules per fruit whereas maximum number of locules per fruit was observed in Arka Abha (5.67).

Eighteen genotypes had reduced number of locules per fruit than the check cultivar Solan Lalima (4.33). Similar results have also been obtained by Meena *et al.,* (2018) and Singh *et al.,* (2017a).

Harvest duration (days)

Harvest duration ranged from 21.33 to 46.67 days with the overall mean of 31.08 days (Table 3) and varied significantly among all the genotypes under study. Eleven genotypes including standard check had the longer harvest duration than population mean among all the genotypes under study.

Genotype EC-802555 (46.67 days) recorded the maximum harvest duration whereas, EC-802563 (21.25 days) reported the minimum harvest duration which was found statistically at par with EC-802561 (23.00 days). Similar results were also reported by Rai *et al.,* (2016) for this attribute.

Shelf life (days)

Statistical analysis revealed that genotypes showed significant variations for shelf life. It ranged from 14.00 to 31.33 days (Table 3). Overall mean for the character was 22.13 days. Ten genotypes were found to have longer shelf life than population mean.

Maximum shelf life was recorded in genotype EC-802562 (31.33 days) which was found statistically at equivalence with EC-802557 (30.33 days), whereas, minimum shelf life was observed in LC-3 (14.00 days) which was found statistically at par with Pant T-3 (16.00 days). Results of the present study were in accordance with the findings of Reddy *et al.,* (2013a).

Pericarp thickness (mm)

Pericarp thickness ranged from 4.24 to 7.85 mm with the mean value 6.46 mm and varied significantly among all the genotypes under study. Fourteen genotypes including standard check had higher pericarp thickness than population mean. Maximum pericarp thickness was recorded in EC-802562 (31.33 days) which was statistically at par with EC-802557 (7.78 mm) and EC-802554 (7.37 mm). Minimum pericarp thickness was observed in LC-3 (4.24 mm). Results of the present study were in line with the findings of Singh *et al.,* (2017a), Rai *et al.,* (2016), Prajapati *et al.,* (2015) and Patel *et al.,* (2013).

Total soluble solids (°Brix)

Total soluble solids ranged from 3.65- 5.10 ^{o}B and varied significantly among all the genotypes under study. LC-2 (5.10 ^{o}B) reported with maximum value for total soluble solids which was statistically at par with Pusa Rohini (4.83 ^{o}B), Arka Abha (5.00 ^{o}B) and minimum value was recorded in Pusa Ruby (3.65 ^{o}B).

Table.1 List of different genotypes of tomato and their source of collection

Sr. No.	Genotype	Source
1	EC-802554	AVRDC, Taiwan
2	EC-802555	AVRDC, Taiwan
3	EC-802556	AVRDC, Taiwan
4	EC-802557	AVRDC, Taiwan
5	EC-802558	AVRDC, Taiwan
6	EC-802559	AVRDC, Taiwan
7	EC-802560	AVRDC, Taiwan
8	EC-802561	AVRDC, Taiwan
9	EC-802562	AVRDC, Taiwan
10	EC-802563	AVRDC, Taiwan
11	Pusa Ruby	IARI, New Delhi
12	Pusa Uphar	IARI, New Delhi
13	Pusa Sadabahr	IARI, New Delhi
14	Pusa-120	IARI, New Delhi
15	Pusa Sheetal	IARI, New Delhi
16	Pusa Rohini	IARI, New Delhi
17	Arka Alok	IIHR, Banglore
18	Arka Abha	IIHR, Banglore
19	Arka Vikas	IIHR, Banglore
20	Punjab Chhuhara	PAU, Ludhiana
21	Pant T-3	GBPUAT, Pantnagar
22	LC-1	Bilaspur
23	LC-2	Solan
24	LC-3	Jachh
25	Solan Lalima (Check)	UHF, Nauni

Table.2 Mean performance of tomato genotypes for different horticultural traits.

Genotypes	Days to first fruit harvesting	Plant height (cm)	Fruit length (cm)	Fruit breadth (cm)	Average fruit weight (g)	Number of fruit clusters per plant	Number of fruits per cluster	Number of fruits per plant
EC-802554	66.00	63.25	5.17	5.33	63.39	5.37	4.03	21.64
EC-802555	65.33	76.87	3.53	3.40	30.08	6.07	5.05	30.60
EC-802556	66.33	64.63	5.16	5.25	62.34	6.40	3.72	23.80
EC-802557	75.00	69.90	5.57	5.70	70.17	6.43	3.73	24.00
EC-802558	71.00	68.67	5.24	5.29	63.77	5.93	2.96	17.57
EC-802559	73.00	66.08	5.20	4.70	56.18	6.60	2.58	17.02
EC-802560	74.00	69.28	5.09	4.67	54.69	5.67	3.18	18.01
EC-802561	71.67	74.07	5.63	5.44	70.44	5.40	2.93	15.84
EC-802562	63.33	67.60	5.89	5.65	76.65	6.87	2.92	20.03
EC-802563	72.33	77.83	5.87	5.55	74.91	7.20	2.31	16.62
Pusa Ruby	64.00	98.87	3.58	4.97	40.90	5.57	4.48	24.90
Pusa Uphar	68.00	65.93	4.90	5.33	60.07	3.60	5.65	20.27
Pusa Sadabhar	64.33	63.14	4.84	5.01	55.82	5.40	3.80	20.53
Pusa-120	76.33	72.27	4.06	5.10	47.70	5.47	3.64	19.83
Pusa Sheetal	64.67	61.13	4.42	5.12	52.08	5.43	3.63	19.70
Pusa Rohini	81.33	65.90	5.23	4.80	57.74	5.70	4.29	24.43
Arka Alok	68.67	55.73	5.52	5.96	75.62	5.17	4.06	21.00
Arka Abha	74.67	75.27	5.20	5.26	62.97	5.60	4.07	22.60
Arka Vikas	74.33	70.40	5.63	5.32	68.85	5.37	3.78	20.27
Punjab Chhuhara	62.33	67.63	5.61	4.23	59.40	5.53	4.27	23.60
Pant T-3	73.67	73.00	3.79	4.66	40.61	5.70	3.84	21.90
LC-1	73.67	71.63	4.33	4.39	43.76	4.47	3.48	15.53
LC-2	62.00	87.96	5.09	5.75	67.35	6.50	3.67	23.87
LC-3	69.00	75.31	4.18	2.64	25.37	4.73	3.60	17.07
Solan Lalima (Check)	67.33	86.95	5.43	5.23	65.32	5.10	4.43	22.58
Mean	**69.69**	**71.57**	**4.97**	**4.99**	**57.85**	**5.65**	**3.76**	20.93
Range	**62.00 - 81.33**	**55.73 – 98.87**	**3.53 – 5.89**	**2.64 – 5.96**	**25.37 – 76.65**	**3.60 – 7.20**	**2.31 – 5.65**	15.53 – 30.60
± SE(m)	**0.932**	**1.385**	**0.123**	**0.107**	**1.946**	**0.153**	**0.162**	0.740
CV (%)	**2.317**	**3.351**	**4.293**	**3.721**	**5.826**	**4.691**	**7.466**	6.126
C.D. (0.05)	2.659	3.950	0.351	0.306	5.550	0.437	0.463	2.111

Table.3 Mean performance of tomato genotypes for various horticultural traits.

Genotypes	Number of locules per Fruit	Harvest duration (days)	Shelf life (days)	Pericarp thickness (mm)	Total soluble solids (°Brix)	Buckeye rot incidence (%)*	Marketable fruit yield per plant (kg)	Marketable fruit yield per hectare (q)
EC-802554	3.00	38.00	24.33	7.37	4.77	23.61 (23.61)	1.37	406.42
EC-802555	2.33	46.67	28.00	7.18	4.87	26.42 (26.43)	0.92	272.40
EC-802556	3.67	41.33	25.00	6.41	4.67	24.10 (24.11)	1.48	438.68
EC-802557	4.33	34.00	30.33	7.78	5.03	23.81 (23.82)	1.68	498.90
EC-802558	4.33	26.00	22.00	6.67	4.43	28.30 (28.31)	1.12	332.19
EC-802559	3.67	27.00	19.33	5.86	4.70	29.62 (29.63)	0.96	283.68
EC-802560	2.67	29.67	20.67	6.26	4.80	26.45 (26.46)	0.98	291.26
EC-802561	3.33	23.00	22.00	6.67	4.37	28.13 (28.14)	1.12	330.21
EC-802562	3.00	35.00	31.33	7.85	4.43	26.91 (26.92)	1.54	454.84
EC-802563	3.67	21.33	22.67	6.87	4.80	28.51 (28.53)	1.25	369.07
Pusa Ruby	3.00	39.33	21.67	6.57	3.65	27.27 (27.28)	1.02	301.76
Pusa Uphar	3.00	30.00	24.00	7.27	3.77	27.22 (27.23)	1.21	360.18
Pusa Sadabhar	3.33	23.33	22.67	6.87	4.10	27.50 (27.51)	1.15	339.93
Pusa-120	3.00	26.00	20.33	6.16	4.53	24.44 (24.45)	0.95	279.87
Pusa Sheetal	3.00	29.33	21.67	6.56	4.37	24.09 (24.10)	1.02	303.32
Pusa Rohini	3.00	42.00	21.33	6.46	4.83	23.88 (23.89)	1.41	417.98
Arka Alok	3.67	21.33	20.33	6.16	4.47	27.06 (27.07)	1.59	470.77
Arka Abha	5.67	25.00	19.00	5.76	5.00	24.05 (24.06)	1.42	421.79
Arka Vikas	5.00	31.67	16.33	4.95	3.93	22.32 (22.33)	1.39	412.87
Punjab Chhuhara	4.67	32.33	23.00	7.42	4.77	24.20 (24.21)	1.40	415.09
Pant T-3	3.33	27.67	16.00	4.85	4.80	30.03 (30.04)	0.89	263.38
LC-1	3.33	27.67	16.33	4.95	3.90	33.41 (33.42)	0.68	201.02
LC-2	4.33	36.33	29.00	7.63	5.10	20.05 (20.06)	1.61	476.27
LC-3	3.33	24.00	14.00	4.24	4.07	33.04 (33.05)	0.44	128.83
Solan Lalima (Check)	4.33	39.00	22.00	6.67	4.73	24.18 (24.19)	1.47	436.42
Mean	**3.60**	**31.08**	**22.13**	**6.46**	**4.52**	**26.34 (26.35)**	**1.20**	356.29
Range	**2.33 – 5.67**	**21.33 – 46.67**	**14.00 – 31.33**	**4.24 – 7.85**	**3.65-5.10**	**20.06 – 33.41**	**0.44 – 1.68**	128.83 – 498.90
± SE(m)	**0.303**	**0.888**	**0.711**	**0.210**	**0.144**	**0.796**	**0.050**	14.91
CV (%)	**14.596**	**4.950**	**5.565**	**5.626**	**5.517**	**5.230**	**7.237**	7.25
C.D. (0.05)	0.865	2.534	2.028	0.598	0.410	2.269	0.143	42.52

* Figures in the parenthesis are Arc-Sine transformed values

Table.4 Estimates of phenotypic and genotypic coefficients of variation, heritability, genetic advance and genetic gain for various characters in tomato

Characters	Range	Mean± SE(d)	Coefficients of Variability (%)		Heritability (%)	Genetic advance	Genetic gain (%)
			Genotypic	Phenotypic			
Days to first fruit harvesting (number)	62.00 - 81.33	69.69± 1.32	7.18	7.54	90.57	9.81	14.08
Plant height (cm)	55.73 - 98.87	71.57± 1.96	12.75	13.19	93.54	18.18	25.41
Fruit length (cm)	3.53 - 5.89	4.97± 0.17	13.88	14.53	91.27	1.36	27.32
Fruit breadth (cm)	2.64 - 5.96	4.99± 0.15	14.55	15.02	93.87	1.45	29.04
Average fruit weight (g)	25.37 – 76.65	57.85± 2.75	23.22	23.94	94.08	26.83	46.39
Number of fruit clusters per plant	3.60 – 7.20	5.65± 0.22	13.40	14.19	89.07	1.47	26.04
Number of fruits per cluster	2.31 – 5.65	3.76± 0.23	19.07	20.48	86.71	1.38	36.59
Number of fruits per plant	15.53 – 30.60	20.93± 1.05	16.23	17.35	87.53	6.55	31.29
Number of locules per fruit	2.33 – 5.67	3.60± 0.43	20.19	24.91	65.68	1.21	33.71
Harvest duration (days)	21.33 – 46.67	31.08± 1.26	22.57	23.10	95.41	14.11	45.41
Shelf life (days)	14.00 – 31.33	22.13± 1.01	19.29	20.08	92.32	8.45	38.19
Pericarp thickness (mm)	4.24 – 7.85	6.46± 0.30	14.33	15.40	86.65	1.78	27.48
Total soluble solids (°Brix)	3.65 – 5.10	4.52± 0.20	8.47	10.11	70.20	0.66	14.61
Buckeye rot incidence (%)	20.06 – 33.41	26.34± 1.12	11.58	12.71	83.06	5.73	21.75
Marketable fruit yield per plant (kg)	0.44 – 1.68	1.20± 0.07	25.41	26.42	92.50	0.61	50.35

Ten genotypes recorded maximum value for total soluble solids than the standard check cultivar Solan Lalima (4.73 ^{o}B). Results of the present study were in line with the findings of Meena *et al.,* (2018), Singh *et al.,* (2017a), Rai *et al.,* (2016), Patel *et al.,* (2013), Meena *et al.,* (2015) and Reddy *et al.,* (2013a).

Buckeye rot incidence (%)

In the mid hills zones of Himachal Pradesh, buckeye rot of tomato is one of the most destructive disease. The incidence ranged from 20.05 to 33.41 % (Table 3) and varied significantly among all the genotypes under study. Buckeye rot incidence was minimum in LC-2 (20.05 %) which was statistically at par with Arka Vikas (22.32 %). The values were rated as moderately susceptible as per the scale given by Dodan *et al.,* (1995). The buckeye rot incidence was comparatively less (20.05-24.10 %) in eight genotypes than the standard check cultivar Solan Lalima (24.18 %), whereas, maximum incidence of disease was observed in LC-1 (33.41%). Similar findings were also reported by Kumar *et al.,* (2006).

Marketable fruit yield per plant (kg) and per hectare (q)

Fruit yield (kg/plant and q/ha ranged from 0.44 – 1.68 kg/plant and128.83– 498.90q/ha **(**Table 3) and varied significantly among all the genotypes under study (Appendix-I). General average for this attribute was 1.20kg/plant and 356.29 q/ha. EC-802557 (1.68 kg/plant and 498.90 q/ha) reported the maximum fruit yield and minimum fruit yield was recorded in LC-3 (0.44 kg/plant and 128.83 q/ha). Five genotypes recorded higher yield (kg/plant and q/ha) than the standard check cultivar Solan Lalima (1.47 kg/plant and 436.42 q/ha). Similar observations were made by Meena *et al.,* (2018), Singh *et al.,* (2017a) and Patel *et al.,* (2013).

Parameters of Variability

To assess the prevailing variation in the studied genotypes of tomato, the estimates of variability were worked out for various characters after analyzing the data recorded for different horticultural characters and which are presented in Table 4. It was observed that the major variation was because of the effect of genotype and environment.

Coefficients of variability

For all the characters studied, phenotypic coefficients of variation were higher in magnitude than the corresponding genotypic coefficients of variation, though the difference was less in majority of cases thus, indicating that environmental factors have played less influence on the expression of these characters.

Phenotypic and genotypic coefficients of variation

The perusal of data (Table 4) revealed marked extent of variation for all the characters studied. It ranged from 7.54% - 26.42% at phenotypic level and 7.18% - 25.41% at genotypic level.

The phenotypic and genotypic coefficients of variability were high for average fruit weight (23.94% and 23.22%), number of locules per fruit (24.91% and 20.19%), harvest duration (23.10% and 22.57%) and marketable fruit yield per plant (26.42% and 25.41%). Similar findings have been reported by Rai *et al.,* (2016), Bhandari *et al.,* (2017) and Meena *et al.,* (2018).

Moderate coefficients of variability both at phenotypic and genotypic level were observed for plant height (13.19% and 12.75%), fruit length (14.53% and 13.88%), fruit breadth

(15.02% and 14.55%), number of fruit clusters per plant (14.19% and 13.40%), number of fruits per plant (17.35% and 16.23%), pericarp thickness (15.40% and 14.33%) and buckeye rot incidence (12.71% and 11.58%).

Similar findings were reported by Bhandari *et al.,* (2017) and Meena *et al.,* (2018). Low coefficients of variability was observed for days to first fruit harvesting (7.54% and 7.18%) as also confirmed from the findings of Reddy *et al.,* (2018).

High coefficients of variability at phenotypic level along with moderate coefficients of variability at genotypic level were recorded for number of fruits per cluster (20.48% and 19.07%) and shelf life (20.08% and 19.29%).

Moderate coefficient of variability at phenotypic level along with low coefficient of variability at genotypic level was recorded for total soluble solids (10.11% and 8.47%) as also confirmed from the findings of Meena *et al.,* (2018)

Heritability

Heritability in broad sense is a measure of the proportions of phenotypic variance resulting due to genetic factors. Heritability (broad sense) estimates ranged from 65.68- 95.41% (Table 4).

High heritability was recorded for harvest duration (95.41%), average fruit weight (94.08%), fruit breadth (93.87%), plant height (93.54%), marketable fruit yield per plant (92.50%), shelf life (92.32%), fruit length (91.27%), days to first fruit harvesting (90.57%), pericarp thickness (86.65%), buckeye rot incidence (83.06%), total soluble solids (70.20%) and number of locules per fruit (65.68%) which were in accordance with the findings of Rai *et al.,* (2016) for marketable fruit yield per plant, harvest duration, days to first fruit harvesting, total soluble solids, number of locules per fruit, pericarp thickness, plant height, average fruit weight. Similarly Reddy *et al.,* (2018) reported for number of fruits per plant, total soluble solids, number of fruit clusters per plant and marketable fruit yield per plant.

Genetic advance and genetic gain

The genetic gain ranged from 14.08 to 50.35% (Table 4) and was moderate to high in nature. High genetic gain was recorded for marketable fruit yield per plant (50.35%), average fruit weight (46.39%), harvest duration (49.41%), shelf life (38.19%), number of fruits/cluster (36.59%), number of locules/fruit (33.71%), number of fruits/plant (31.29%), fruit breadth (29.04%), pericarp thickness (27.48%), fruit length (27.32%), number of fruit clusters/plant (26.04%), plant height (25.41%) and buckeye rot incidence (21.75%), while it was moderate for total soluble solids (14.61%) and days to first fruit harvesting (14.08%) which were in accordance with the findings of Reddy *et al.,* (2018), Shankar *et al.,* (2013) and Prajapati *et al.,* (2015).

On the basis of overall performance, out of 25 genotypes, EC-802557, LC-2 and Arka Alok were found superior for marketable fruit yield and other important characters. The estimates of PCV and GCV were high for marketable fruit yield/plant, number of locules/fruit, average fruit weight, harvest duration, shelf life and number of fruits/cluster.

High heritability was observed for all the characters among all genotypes. Genetic advance was observed high for marketable fruit yield per plant, average fruit weight, harvest duration, shelf life, number of fruits/cluster, number of locules/fruit, number of fruits/plant, fruit breadth, pericarp thickness, number of fruit cluster/plant, fruit length and plant height.

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