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STUDY ON GENETIC VARIABILITY AND HERITABILITY IN CHERRY TOMATO (*Solanum lycopersicum* var*. cerasiforme*) FOR YIELD AND QUALITY TRAITS

Nikhil Thakur[1], Balbir Singh Dogra[1], Jasdeep Kaur[2*] and Rishabh Kumar[1]

[1]Department of Vegetable Science, Dr. Y.S ParmarUniversity of Horticulture and Forestry, Nauni, Solan – 173211, Himachal Pradesh
[2]Department of Vegetable Science, CSK Himachal PradeshKrishi Vishvavidyalaya Palampur- 176061, Himachal Pradesh

ABSTRACT

The work was carried out in the experimental farm of the Department of Vegetable Science, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan (H.P). The experiment was laid out in randomized block design comprising of 23 diverse genotypes of cherry tomato, which were replicated thrice to ascertain the extent of variability, heritability, genetic advance and gain for yield and other horticultural traits among the genotypes. Results revealed significant differences among all the genotypes for all the characters studied. Analysis of coefficient of variation revealed that the magnitude of the phenotypic coefficient of variation was slightly higher than the genotypic coefficient of variation for all the studied traits. Further, high heritability along with high estimates of genetic gain was observed for the number of flowers per cluster, number of fruits per cluster, fruit length (mm), number of locules per fruit, pericarp thickness (mm), shelf life (days) and fruit yield per plot (kg). This indicates the predominance of additive component for these traits and hence direct selection would be more effective in improving these traits.

Keywords: Cherry tomato, Genetic advance, Genotype, Heritability, Variability

Cherry tomato (*Solanum lycopersicum* var*. cerasiforme*) is thought to be the ancestor of all cultivated tomatoes and has chromosome number 2n =24. The wild cherry tomato was first found throughout tropical and sub-tropical America and then propagated in the tropics of Asia and Africa (Gharezi *et al.,* 2012). It is a warm-season crop and requires a long growing period to reap more harvest, reasonably tolerant to heat, drought and grows under a wide range of soil and climatic conditions and it is the most promising crop under protected structure. They are becoming popular in the market and fetch a premium price compared to regular tomatoes (Vidyadhar *et al.,* 2014).

Cherry tomato is a popular table purpose tomato with small fruits with a bright red colour resembling a cherry and having an excellent taste, which is consumed as fresh vegetable as well as raw material for processed products such as juice, ketchup, sauce, canned fruits, puree, paste and unripe green fruits are used for preparation of pickles and chutney (Charlo *et al.,* 2007). In addition cherry tomato is used for preparation of tomolive and tomatine which are having more industrial value (Venkadeswaran *et al.,* 2018).

Cherry tomatoes are indeterminate in growth habit, vigorous with strong branches that are distinctly trailing in habit. The leaves are flat but slightly curled. Botanically, the fruit is a berry and is borne in a cluster. The fruit size ranges from the size of a thumb tip to the size of a golf ball and can range from being spherical to slightly oblong in shape. Flower is perfect and hermaphrodite (Prema *et al.,* 2011). A great genetic variation is available in cherry tomatoes throughout the country with regard to various important horticultural traits like fruit size, shape, colour, growth habit and yield etc. Considering the potential and requirements of this crop, there is a need for improvement and to develop varieties suited to specific agro-ecological conditions and also for specific end uses. A thorough knowledge regarding the amount of genetic variability presented for various characters is essential for initiating the crop improvement program. Thus, exploration was undertaken to ascertain the magnitude and extent of genetic variability in cherry tomato genotypes.

MATERIALS AND METHODS

The present investigation was carried out in the Department of Vegetable Science, College of Horticulture and Forestry, Neri, Hamirpur, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, HP during 2018-2019 and 2019-20. The experimental material comprised of semi-determinate to indeterminate types of genotypes. Twenty three genotypes including check cultivar (Table 1) were grown under open field conditions. The experiment was laid out in Randomized Complete Block Design with

*Corresponding author : jasdeepkaur3024@gmail.com
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three replications of each genotype. The seeds were first sown in the nursery bed and then the seedlings were transferred to the main field at a spacing of 90 x 30 cm, with a plot size of 1.5 x 1.5 m^2 that accommodated 10 plants per plot. The standard cultural practices as recommended in the package of practices for vegetable crops were followed to ensure a healthy crop stand (Anonymous, 2022).

The observations were recorded for days to 50 percent flowering, first flowering node, plant height (cm), stem girth (mm), number of flowers per cluster, number of fruits per cluster, percent of fruit set (%), average fruit weight (gm), fruit length (mm), fruit width (mm), number of locules per fruit, pericarp thickness (mm), shelflife (days), TSS of fruits (^{0}Brix), titratable acidity (%), ascorbic acid (mg/100g), number of seeds per fruit, number of seeds in 1 gm, fruit yield per plot (kg), fruit color and fruit shape from five randomly selected plants in each replication for all characters except for fruit characters for which observations were recorded on ten randomly selected fruits per replication. Observations were recorded as:

Days to 50 per cent flowering

Number of days taken from transplanting to first flower appearance in 50 per cent of the plants was recorded and the average was computed.

First flowering node

Flowering nodes were observed in five randomly selected plants and counting for the number of node from the crown level to first flowering node was done and the mean was worked out.

Plant height

Plant height was measured from the base to the highest tip of the plant at the last picking in five randomly selected plants, the average was worked out and plant height was expressed in centimeters.

Stem girth

At the time of final harvest, a digital Vernier calliper was used to measure the girth of the main stem at ground level in five randomly chosen plants. The average stem girth was calculated and expressed in millimetres.

Number of flowers per cluster

From five tagged plants, five clusters per plant were selected, and the number of flowers in each cluster was counted when they had fully bloomed. The average number of floral clusters was then determined (The clusters selected were tagged for counting the fruits).

Number of fruits per cluster

Five randomly chosen clusters from each of the five tagged plants were counted, and the average was calculated.

Fruit set

The number of flowers per cluster and number of fruits per cluster were selected from the five tagged clusters in each plant and calculated as

$$\text{Percent fruit set} = \frac{\text{No. of fruit per cluster}}{\text{No. of flower per cluster}} \text{ X } 100$$

Average fruit weight

Weight of ten randomly selected fruits in each genotypes was recorded and mean values were averaged and expressed in grams.

Fruit length

The average length of fruit was calculated from the randomly selected ten fruits of each genotype with vernier caliper and mean values were averaged and recorded in millimeters.

Fruit width

The average width of fruit was calculated from the randomly selected ten fruits of each genotype with vernier caliper and values were averaged and recorded in millimeters.

Number of locules per fruit

Ten fruits were collected randomly and sliced radially, numbers of locules were counted and mean value was calculated.

Pericarp thickness

Ten fruits were taken randomly and sliced radially and thickness of pericarp was measured by using digital caliper and expressed in millimeters.

Shelf life

Fruits harvested at ripe stage were kept at room temperature and the number of days was observed till the consumption stage was over and shelf-life in days was recorded.

Total soluble solids (TSS)

A drop of fruit juice from each reference entry was placed on the prism of Erma hand refractrometer and reading was recorded.

Titratable acidity

Ten grams fresh fruit pulp was thoroughly homogenized in an electric blender and volume was

made to 100 ml. The mixture was then filtered through Whatman No.1 filter paper and 20 ml of fresh sample solution was taken. The sample solution was then titrated against 0.1 N NaOH solution using phenolphthalein indicator till it gave light pink coloured end point.

$$\text{Tiratable acidity (\%)} = \frac{\text{Titre reading x normality of NaOH x volume made x equivalent weight x 100}}{\text{Volume of sample taken x weight of sample x 1000}}$$

Ascorbic acid content

Ascorbic acid was estimated by using 2, 6-dichlorophenol-indophenol titration method. Two per cent metaphosphoric acid was added to 20 ml of sample. The volume made up to 100 ml in a volumetric flask and filtered using Whatman No. 4 filter paper. Five ml of this filtrate was taken and titrated against 2, 6-dichlorophenol-indophenol dye. The titration was carried out till a light pink color appeared. The dye was prepared using 50 mg of sodium salt of 2, 6-dichlorophenol-indophenol dye in approximately 150 ml of double distilled water containing 2 mg of sodium bicarbonate. It was slightly warmed and the volume was made up to 200 ml. This dye was used for titration and standardizing ascorbic acid (Ranganna, 1994).

$$\text{Ascorbic acid mg/100g} = \frac{\text{Tire value x Dye factor x volume made up}}{\text{Aliquot of extraction x volume of sample taken}} \times 100$$

Number of seeds per fruit

Seeds from ten randomly collected fruits from each genotype were extracted, dried, counted and average was worked out.

Number of seeds

One gram of seeds were taken from each genotypes, numbers of seeds were counted and mean value was calculated.

Fruit yield per plot

Fruit yield per plot was calculated for each genotype by adding the total fruit weight of overall pickings and expressed in kilograms (kg).

Fruit colour

Five fruits were harvested at maturity and the colour of the fruits were judged using Royal Horticulture Society (RHS) color chart and classified into different colour groups.

Fruit shape

At maturity all fruits of five plants of each variety observed visually with the help of descriptor and grouped into flattened (oblate), slightly flattened, rounded, high rounded, heart shape, cylindrical (long oblong), pyriform and ellipsoid (plum shaped).

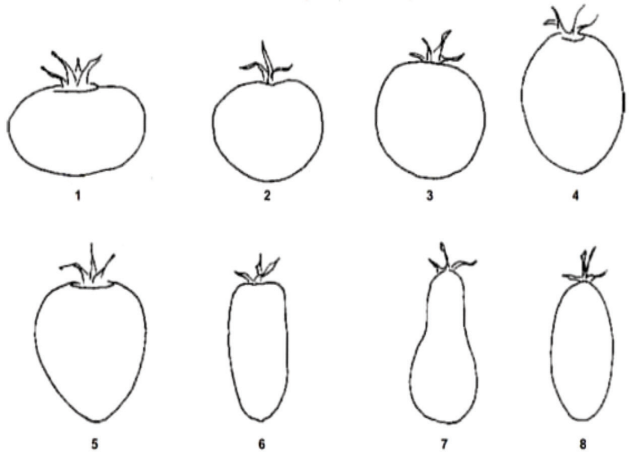

Fig. 1. Fruit shape check with the help of discriptor

The data were subjected to analysis of variance as per procedure described by Gomez and Gomez (1983). The genotypic and phenotypic coefficients of variation were calculated as per formulae given by Burton and De-Vane (1953). The expected genetic advance (GA) resulting from selection of five per cent superior individuals was worked out.

RESULTS AND DISCUSSION

Variability studies

A thorough knowledge regarding the amount of genetic variability existing for different characters is necessary for initiating any crop improvement programme. The scope of improvement of any crop depends upon the magnitude of genetic variability

Table 1. List of cherry tomato genotypes studied along with their sources.

Genotype	Source
LC-CT-01-18, LC-CT-02-18, LC-CT-03-18, LC-CT-04-18, LC-CT-05-18, LC-CT-06-18, LC-CT-07-18, LC-CT-08-18, LC-CT-09-18, LC-CT-10-18, LC-CT-11-18, LC-CT-12-18, LC-CT-13-18, LC-CT-14-18, LC-CT-15-18, LC-CT-01-18, LC-CT-01-18, LC-CT-01-18, LC-CT-01-18, LC-CT-16-18, LC-CT-17-18, LC-CT-18-18, LC-CT-19-18, LC-CT-20-18, LC-CT-21-18	Department of Vegetable Science, COH&F, Neri, Hamirpur Dr. Y.S Parmar University of Horticulture and Forestry, Nauni, Solan (H.P)
Punjab Kesar Cherry, Punjab Red Cherry	Punjab Agriculture University, Ludhiana

Table 2. Different growth and yield attributing components of cherry tomato genotypes.

Genotype	Days to 50% Flowering	First flowering node	Plant height (cm)	Stem girth (mm)	No. of flowers per cluster	No. of fruits per cluster	Percent of fruit set (%)[b]	Average fruit weight (g)	Fruit length (mm)	Fruit width (mm)	Number oflocules	Pericarp Thickness (mm)	Shelf life (days)
LC-CT-01-2018	32.00	8.40	89.80	10.18	15.11	7.16	47.37 (43.47)	12.20	32.71	23.82	3.33	2.77	14.57
LC-CT-02-2018	26.80	6.60	114.87	12.62	16.02	13.05	81.46 (64.47)	7.81	28.78	23.36	3.27	1.87	12.58
LC-CT-03-2018	26.00	6.53	102.53	10.56	15.42	7.25	47.00 (43.26)	12.93	33.89	24.73	2.12	2.57	13.80
LC-CT-04-2018	24.47	5.33	98.06	10.38	7.09	4.45	62.76 (52.37)	2.61	17.27	15.62	2.80	0.95	6.19
LC-CT-05-2018	25.13	6.33	103.66	10.86	6.53	4.27	65.35 (53.92)	7.91	22.24	24.32	2.07	1.46	12.47
LC-CT-06-2018	20.07	4.47	106.86	11.89	8.22	4.45	54.15 (47.36)	2.81	15.63	15.59	3.67	0.73	5.85
LC-CT-07-2018	24.87	5.87	100.66	10.46	6.67	3.50	52.49 (46.41)	9.58	22.90	24.86	2.07	1.94	12.74
LC-CT-08-2018	28.20	7.07	109.20	11.99	7.38	5.62	76.24 (60.81)	2.91	15.36	17.08	3.60	0.81	6.19
LC-CT-09-2018	23.40	5.53	103.46	10.82	5.42	3.29	60.68 (51.15)	19.86	27.99	31.28	3.67	1.19	8.22
LC-CT-10-2018	29.67	7.60	123.40	12.96	6.22	4.56	73.36 (58.91)	17.18	27.85	31.25	2.27	1.84	12.38
LC-CT-11-2018	28.60	7.07	105.20	11.57	7.78	5.79	74.42 (59.64)	3.35	16.55	17.45	2.33	1.81	11.05
LC-CT-12-2018	31.07	7.67	136.27	14.50	8.18	6.57	80.36 (63.67)	8.96	24.49	24.40	2.07	2.38	13.31
LC-CT-13-2018	26.00	6.53	126.46	13.12	13.98	7.14	51.12 (45.63)	6.17	20.62	22.80	2.13	1.63	12.43
LC-CT-14-2018	24.87	5.80	110.47	12.48	7.54	4.40	58.26 (49.74)	2.97	17.08	17.86	2.67	0.91	6.52
LC-CT-15-2018	25.27	6.33	107.46	11.91	5.93	4.65	78.41 (62.29)	5.99	19.44	22.15	2.47	1.00	10.26
LC-CT-16-2018	28.60	7.27	82.60	9.73	4.73	3.87	81.81 (64.86)	5.93	20.48	22.40	2.33	1.03	11.06
LC-CT-17-2018	28.60	7.33	105.93	11.57	5.07	3.27	64.54 (53.43)	18.97	27.43	31.77	2.60	1.77	8.45
LC-CT-18-2018	29.47	7.53	110.46	12.40	14.31	7.78	54.38 (47.50)	12.81	32.98	23.26	2.27	2.09	11.84
LC-CT-19-2018	24.60	5.60	134.73	13.48	10.16	6.40	62.99 (52.51)	14.35	33.37	24.08	2.40	2.16	10.52
LC-CT-20-2018	26.93	6.93	121.60	12.77	6.69	4.98	74.53 (59.66)	2.81	16.03	16.37	2.73	0.84	6.48
LC-CT-21-2018	27.33	6.93	104.60	11.22	5.40	4.29	79.50 (63.65)	10.33	22.68	25.43	2.47	1.10	9.06
Punjab Kesar Cherry	26.67	6.60	104.87	11.24	12.62	7.92	62.76 (52.37)	10.55	31.44	21.83	2.47	2.16	11.49
Punjab Red Cherry	22.20	4.87	124.40	12.19	14.11	9.67	68.54 (55.86)	10.66	28.65	21.80	2.00	2.14	13.49
C.D.(0.05)	0.83	0.41	3.16	1.11	0.68	0.41	2.93	0.96	1.15	1.23	0.26	0.33	0.64

a Data presented in the Table are pooled of 2018-19 and 2019-20
b Figures in the parenthesis are angular transformed values

present in the available germplasm. Greater the variability in the available germplasm better would be the chances of selecting superior genotypes**.** A wide range of genetic variability is available in cherry tomato (Table 2), providing good scope for improvement in yield and other character of cherry tomato through selection. Analysis of variance indicated significant differences among the genotypes for all the characters under study. These differences indicated the presence of variability in the available germplasm and offers opportunity for improvement in yield and quality traits of cherry tomato.

Genetic variability is the basic need for a plant breeder to initiate any breeding programme. Wide range was observed for days to 50 percent flowering (20.07-32.00), which determine the earliness of a variety, first flowering node (4.47-8.40), plant height (82.60-136.27cm), stem girth (9.73- 14.50mm), number of flowers per cluster (4.73-16.02), number of fruits per cluster (3.27-13.05), percent of fruit set (47.00-81.81%), average fruit weight, fruit length and fruit width are the major yield contributing traits, wide variations were observed with respect to these traits (2.61-20.86g, 15.36- 33.89 mm and15.59-31.77mm respectively). Tremendous variations with respect to number of locules per fruit (2.00-5.20), pericarp thickness (0.73-2.77mm), shelf life (5.85-14.57 days), TSS of fruits (3.42-7.01 ^{0}brix), which decides the consumer's preference, titratable acidity (0.33-0.63%), ascorbic acid (11.33-44.43 mg/100g), number of seeds per fruit (29.67- 68.47), number of seeds in

Table 2a. Different quality components of cherry tomato genotypes

Genotype	TSS(^{0}B)	Titratable Acidity(%)	Ascorbic Acid (mg/ 100g)	No. of seed per fruit	No. of Seedin 1 gm	Fruit yieldper plot (kg)	Colour	Shape
LC-CT-01-2018	3.63	0.60	24.03	36.47	443.21	1.77	RED GROUP 43 A	Cylindrical
LC-CT-02-2018	3.97	0.53	17.68	40.80	565.21	2.52	RED GROUP 40 B	Round
LC-CT-03-2018	3.73	0.57	38.08	32.80	594.10	1.52	RED GROUP 44 C	Pear
LC-CT-04-2018	4.06	0.49	26.29	41.67	506.31	1.76	RED GROUP 44 B	Round
LC-CT-05-2018	4.73	0.43	37.63	62.67	537.15	1.77	RED GROUP 40 A	Round
LC-CT-06-2018	5.17	0.35	24.03	41.87	575.33	1.42	ORANGE RED GROUP 35 C	Round
LC-CT-07-2018	3.70	0.58	29.01	37.73	509.88	1.43	RED GROUP 44 C	Round
LC-CT-08-2018	5.03	0.38	27.20	40.47	441.51	0.85	RED GROUP 40 B	Round
LC-CT-09-2018	3.42	0.63	11.33	57.67	392.88	1.25	RED GROUP 43C	Round
LC-CT-10-2018	3.67	0.60	13.17	48.80	427.09	1.09	RED GROUP 40A	Round
LC-CT-11-2018	3.51	0.61	21.78	48.87	449.67	1.38	RED GROUP 43 A	Round
LC-CT-12-2018	6.08	0.34	44.43	45.87	427.56	3.08	RED GROUP 42A	Round
LC-CT-13-2018	4.91	0.38	20.85	65.33	573.32	0.87	RED GROUP 41 A	Round
LC-CT-14-2018	5.29	0.34	30.37	43.07	344.55	1.41	RED GROUP 40 A	Round
LC-CT-15-2018	5.95	0.35	39.89	57.27	517.32	2.50	RED GROUP 40 B	Round
LC-CT-16-2018	4.39	0.46	21.31	68.47	525.32	1.57	RED GROUP 44 A	Round
LC-CT-17-2018	4.19	0.47	17.23	52.20	542.88	2.11	RED GROUP 41 A	Round
LC-CT-18-2018	4.83	0.41	21.31	46.07	542.88	2.13	YELLOW GROUP 9A	Cylindrical
LC-CT-19-2018	4.39	0.46	25.39	49.40	480.81	1.26	RED GROUP 40 A	Round
LC-CT-20-2018	4.70	0.45	28.11	46.80	562.99	1.53	ORANGE RED GROUP 33C	Cylindrical
LC-CT-21-2018	4.13	0.49	14.51	45.13	518.59	1.46	RED GROUP 40 C	Round
Punjab Kesar Cherry	5.85	0.34	26.75	43.87	470.72	2.07	ORANGE GROUP 14 A	Oval
Punjab Red Cherry	7.01	0.33	32.64	29.67	371.33	2.36	RED GROUP 41 C	Round
C.D.(0.05)	0.58	0.02	1.67	1.95	0.86	0.36		

a Data presented in the Table are pooled of 2018-19 and 2019-20

1gm (344.55-594.10) and fruit yield per plot (0.85-3.08 kg). Tremendous variability with respect to various horticultural traits were also reported by (Najeema *et al.,* 2016) and (Shiksha *et al.,* 2018).

All the genotypes under study also showed wide variations for fruit shape and colour (red, yellow and orange). Majority of the genotypes had round shape and red coloured fruits, which are in general preferred by consumers. Fruit colour is an important trait which decides the consumer preference. Wide variation for fruit colour was also been reported by (Chernet *et al*., 2014).

Coefficients of variability

The observations recorded on magnitude of genotypic and phenotypic variability and the genotypic and phenotypic coefficients of variability are presented in Table 3. For all the characters studied, phenotypic coefficients of variability were higher in magnitude than genotypic coefficients of variability, though difference was very less in majority of cases. Thus, stating that these traits were not much influenced by environmental factors. Hence, selection based on phenotypic performance will be reliable. Coefficients of variability varied in magnitude from character to character, either low or moderate or high. Therefore, it indicated that there was greater diversity in the material used in the present study. The wide variations in the characters among all the genotypes are due to effect of genotype and environment. Environmental variations are not fixable.

High phenotypic and genotypic coefficient of variability were recordedfor average fruit weight (58.34 and 58.69), number of flowers per cluster (43.01 and 43.25), number of fruits per cluster (39.59 and 39.82), pericarp thickness (37.58 and 39.55), number of locules per fruit (33.06 and 33.56), ascorbic acid (33.47 and 33.70) and yield per plot (31.88 and 34.33). Moderate magnitude of GCV and PCV were observed for shelf life (26.48 and 26.74), fruit length (26.28 and 26.44), titrable acidity (21.12 and 21.25), number of seeds per fruit (20.87 and 21.48), fruit width (20.43 and 20.69), total soluble solids (18.70 and 20.23) and percentage of fruit set (16.70 and 16.92). The low magnitude of GCV and PCV was observed for the first flowering node (14.58 and 14.98), number of seeds in 1gm (14.07 and 14.24), plant height (11.85 and 11.98), days to 50 per cent flowering (10.52 and 10.69) and stem girth (9.89 and 11.41). These were in accordance with the findings of Tasisa *et al.* (2011), Manna and Paul (2012), Dutta

Table 3. Estimate of range, Phenotypic and Genotypic coefficients of variation, Heritability (%), Genetic advance and genetic gain (%).

Character	Range	Mean Range± SE(d)	Coefficients of variability (%)		Herita-bility(%)	Genetic advance	Genetic gain(%)
			Genotypic	Phenotypic			
Days to 50 percent flowering	20.07-32.00	26.56±0.41	10.52	10.69	96.85	5.66	21.32
First flowering node	4.47-8.40	6.53±0.21	14.58	14.98	93.51	1.90	29.04
Plant height (cm)	82.60-136.27	109.89 ±1.56	11.85	11.98	97.89	26.54	24.15
Stem girth (mm)	9.73-14.50	11.80±0.55	9.89	11.41	75.07	2.08	17.65
Number of flowers per cluster	4.73-16.02	9.22±0.34	43.01	43.25	98.92	8.12	88.12
Number of fruits per cluster	3.27-13.05	5.84±0.20	39.59	39.82	98.85	4.74	81.09
Percent of fruit set (%)	47.00-81.81	65.66±1.45	16.70	16.92	97.44	22.30	33.96
Average fruit weight (gm)	2.61-20.86	9.15±0.48	58.34	58.69	98.79	10.95	19.44
Fruit length(mm)	15.36-33.89	24.17±0.57	26.28	26.44	98.82	13.01	53.82
Fruit width(mm)	15.59-31.77	22.76±0.61	20.43	20.69	97.51	9.46	41.56
Number of locules per fruit	2.00-5.20	2.77±0.13	33.06	33.56	97.05	1.86	67.09
Pericarp thickness(mm)	0.73-2.77	1.62±0.16	37.58	39.55	90.27	1.19	73.55
Shelf life (days)	5.85-14.57	10.48±0.32	26.48	26.74	98.07	5.66	54.02
TSS of fruits(^{0}Brix)	3.42-7.01	4.56±0.29	18.70	20.23	85.45	1.62	35.61
Titratable Acidity (%)	0.33-0.63	0.46±0.01	21.12	21.25	98.85	0.20	43.27
Ascorbic acid (mg/100g)	11.33-44.43	25.78±0.83	33.47	33.70	98.65	17.66	68.48
Number of seeds per fruit	29.67-68.47	47.08±1.95	20.87	21.48	94.41	19.67	41.78
Number of seeds in 1(g)	344.55-594.10	492.20±0.41	14.07	14.24	97.66	141.00	28.65
Fruit yield per plot(kg)	0.85-3.08	1.70±0.18	31.88	34.33	86.26	1.04	60.96

et al. (2018) and Shiksha *et al.* (2018) which contradict present studies and this may be due to difference in experimental material used.

Heritability and genetic gain

A broad sense heritability estimate provides information on relative magnitude of genetic and environmental variation in germplasm pool. The heritability estimate varied from 75.07 per cent in stem girth to 98.92 per cent in number of fruits per cluster (Table 3). The heritability for the characters under study are categorized as high (>80%), moderate (50-80%) and low (< 50%) as previously done by Warshamana (2005).

High heritability was recorded for the characters *viz.*, number of flowers per cluster (98.92%), number of fruits per cluster (98.85%), titratable acidity (98.85%), fruit length (98.82%), average fruit weight (98.79%), ascorbic acid (98.65%), shelf life (98.07%), plant height (97.89%), number of seed in 1gm (97.66%), fruit width (97.51%), percentage of fruit set (97.44%), number of locules per fruit (97.05%), days to 50% flowering (96.85%), number of seeds per fruit (94.41%), first flowering node (93.51%), pericarp thickness (90.72%), fruit yield per plot (90.70%) and total soluble solid (85.45%). Moderate heritability was recorded for stem girth (75.07%). High heritability along with high estimates of genetic gain was observed for number of flowers per cluster, number of fruits per cluster, fruit length (mm) number of locules per fruit, pericarp thickness (mm), shelf life (days) and fruit yield per plot (kg). These were in accordance with the findings of Shankar *et al.* (2013), Ligade *et al.* (2017) and Panchbhaiya *et al.* (2018).

High heritability along with high genetic gain was recorded in the number of flowers per cluster (98.92% and 88.12%), number of fruits per cluster (98.85% and 81.09%) fruit length (98.82% and 53.82%) number of locules per fruit (97.05% and 67.09), pericarp thickness (90.72% and 73.55), shelf life (98.07% and 54.02%) and fruit yield per plot (90.70% and 60.96%). These characters indicate the presence of additive gene effect and selection based on the phenotypic performance could be very effective in improvement of these characters and which can also be retained in the subsequent generation.

Genetic advance and genetic gain

Genetic gain (expressed as per cent of population mean) was low to high in nature and ranged from 17.65-119.44), per cent for different characters under study (Table 3). It was found high for average fruit weight (119.44%), number of flowers per cluster (88.12%), number of fruits per cluster (81.09%), pericarp thickness (73.55%), ascorbic acid (68.48%), number of locules per fruit (67.09%), fruit yield per plot (60.96%), shelf life (54.02%) and fruit length (53.82%). Moderate genetic gain was observed for titratable acidity (43.27 %), number of seeds per fruit (41.79%), fruit width (41.56%), total soluble solids (35.61%), percentage of fruit set (33.96%), first flowering node (29.04%) and number of seed in 1gm (28.65%). Whereas, it was recorded low for plant height (24.15%), days to 50% flowering (21.32%) and stem girth (17.65%) which point towards the existence of non additive gene action. These results contradict with the findings of Shiksha and Sharma (2018).

High heritability along with high genetic gain for number of flower per cluster, number of fruits per cluster, percentage of fruit set, fruit length, fruit width, number of locules per fruit, predominant additive genetic control for these traits. Therefore, selection based on the phenotypic performance will be very effective for improvement of these characters. High heritability with moderate genetic gain days to 50% flowering, first flowering node and plant height indicated additive genetic control for these traits hence, selection will be less effective in these traits but can be taken up. Similar results were also reported by Ligade *et al.* (2017) and Panchbhaiya *et al.* (2018).

Authors' contribution

Conceptualization of research work and designing of experiments (NT,JK); Execution of field/lab experiments and data collection (NT); Analysis of data and interpretation (NT); Preparation of manuscript (NT,BSD,JK,RK).

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