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Assessment of Genetic Variability, Heritability and Genetic Advance in Tomato

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A B S T R A C T

Tomato is an important plant grown in tropics as a perennial plant and in other areas mostly as annual plant. Tomato plant grows upto an height of 9 feet. The flowers are small, yellow and have five lobes on corolla. The fruit colour is green when unripe and red when it is fully ripe. Fruit is low in calorie and rich in vitamins and minerals. Genetic variability, heritability and genetic advance were assessed in thirty five genotypes of tomato at Departmental Research Farm of Vegetable Science, UHF, Solan, HP during *kharif* season, 2016. The experiment was laid out in RCBD with three replications. Analysis of variance revealed highly significant differences among genotypes for all the characters under study. The PCV (Phenotypic coefficient of variation) and GCV (Genotypic coefficient of variation) were higher for fruits per cluster (49.66 % and 49.50 %), fruits per plant (46.28 % and 46.11 %), yield per plant (38.13 % and 38.04 %) and average fruit weight (30.39 % and 30.29 %). High GCV and PCV provide the possibility of improving and fixing the characters through selection breeding. High heritability along with high estimates of genetic gain were observed for number of fruits per cluster (99.33 % and 101.63 %), number of fruits per plant (99.28 % and 94.66 %), fruit yield per plant (99.52 % and 78.18 %) and average fruit weight (99.35% and 62.19 %). High heritability and genetic gain suggest the possibility of improvement of traits by means of selection due to existence of additive gene effect. Selection for these above characters will be fruitful in improving fruit yield in tomato.

Introduction

Tomato crop is of immense importance, grown throughout the world. This vegetable belongs to family Solanaceae. The crop originated in Peru Ecuador Bolivia, South America. Fruits are consumed either fresh or cooked and used in various processed forms. It is self pollinated and easy for carrying out breeding programmes. In North Indian plains, due to high temperature and rains, the crop is not grown during summer and rainy seasons, thereby giving an opportunity for vegetable growers of Himachal Pradesh to fetch off

season remunerative prices. Since the crop is grown during summer and rainy season in HP, so many diseases, insects and pests appear on the plants leading to fewer yields. Being an important vegetable crop in the state, there is a need to develop high yielding tomato varieties, having resistance or tolerance to diseases and insect pest and suitable to agro ecological conditions. For selecting promising genotypes from a population, proper knowledge about variability existing for various characters in the germplasm is essential. Wider the genetic variability in the qualitative and quantitative traits, better would be the chances of crop improvement through selection. Variability present in the population is assessed by phenotypic and genotypic coefficients of variation. Estimates of heritability alone are not sufficient for predicting the effect of selection and therefore the genetic advance/gain is also equally important (Hanson and Earle, 1956). Burton and De-Vane (1953) has suggested that genetic co-efficient of variability along with heritability estimates would give a reliable indication of expected amount of improvement through selection

Materials and Methods

The experiment was conducted at the Departmental experiment field of Vegetable Science, UHF, Solan, HP in *Kharif*, 2016. Germplasm consisted of thirty five genotypes viz., Punjab Sartaj, Punjab Ratta, DMT KRCCH-4, BCT-8, LO-2410, DMT KRCCH-1, Punjab Gaurav, BCT-10, BCT-5, DMT KRCCH-3, UHF-553, Punjab Red Cherry, BCT-2, BCT-4, DMT KRCCH-6, DMT KRCCH-2, Solan Vajr, S-1001, EC-524082, EC-433607, EC-21132, EC-2997, EC-36293, EC-141827, EC-16788, EC-3526, EC-15998, UHF-571, EC-29414, UHF-95, UHF-90, BT-10-10, Selection-12, Selection-87 and Solan Lalima (check). Seedlings were planted in a randomized complete block design with three replications in plot size of 1.8 m × 1.8 m. Twelve plants of each entry were transplanted in each replication at spacing of 90 cm × 30 cm in April, 2016 The characters studied during the present study were days to 50 % flowering, days to maturity, plant height, fruits per cluster, fruits per plant, fruit weight, yield per plant and per hectare, fruit shape index, pericarp thickness, locules per fruit, harvest duration, total soluble solids and ascorbic acid. Phenotypic coefficient of variation (PCV) and Genetic coefficient of variation (GCV) were computed as per Burton and De Vane (1953), heritability in broad sense as suggested by Allard *et al.,* (1960) and genetic gain as per Johanson *et al.,* (1955).

Results and Discussion

The analysis of variance indicated highly significant differences among the genotypes for all the trait studied, which revealed the existence of sufficient variability in the germplasm. Different genotypes differed significantly with respect to number of days to 50% flowering. Days to 50% flowering varied from 24.67 to 35.67 (Table 1). Genotype Punjab Red Cherry (24.67) took minimum days to reach 50% flowering. UHF-95 (35.67) recorded maximum days for 50% flowering. Among all the genotypes under study, as many as eighteen genotypes have taken lesser number of days to 50% flowering than check variety Solan Lalima (32.67 days). Variability for this character was reported by Sharma *et al.,* (2010), Mohamed *et al.,* (2012), Ahirwar and Prashad (2013), Reddy *et al.,* (2013) and Kumar (2014). Punjab Red Cherry took minimum days to attain marketable maturity (66.00 days). Comparison of genotypes for plant height revealed that different genotypes differed significantly for plant height. It ranged from 52.51 to 123.65 cm. Maximum plant height was recorded in Solan Vajr (123.65 cm), which was statistically at par with EC-2997 (121.33 cm) and Solan Lalima

(120.32 cm). Minimum plant height was recorded in DMT KRCCH-2 (52.51 cm). Two genotypes viz., EC-2997 (121.33 cm) and Solan Lalima (120.32 cm) resulted in more plant height than the check variety Solan Lalima (124.32 cm). Data recorded on number of fruits per cluster showed significant variation among genotypes. Its value ranged from 2.76 to 15.07. Three genotypes resulted in more number of fruits per cluster than check variety Solan Lalima (5.00). Maximum number of fruits per cluster (15.07) were in Punjab Red Cherry. Genotypes DMT KRCCH-2 (2.76) and UHF-95 (2.76) bear minimum number of fruits per cluster. Variability with respect to this trait was reported by Kumar *et al.,* (2013) and Reddy *et al.,* (2013).

Data recorded on number of fruits per plant showed significant variation among genotypes. The number of fruits per plant ranged from 11.25 to 70.02. Maximum number of fruits per plant (70.02) were in Punjab Red Cherry, which was statistically superior over all other genotypes and check variety. However, minimum numbers of fruits per plant were recorded in DMT KRCCH-1 (11.25). Check variety Solan Lalima recorded 26.37 fruits per plant. Considerable variability regarding this trait was in accordance with the findings of Buckseth *et al.,* (2012), Khan and Samadia (2012), Kumar *et al.,* (2013), Reddy *et al.,* (2013) and Kumar (2014). Maximum average fruit weight (84.00 g) was observed in Punjab Sartaj, which was statistically superior than all other genotypes. Minimum value for average fruit weight was recorded in the genotype Punjab Red Cherry (10.53 g). Check variety Solan Lalima recorded average fruit weight of 65.00 g. Twelve genotypes recorded more average fruit weight than check Solan Lalima. Wide genetic variation with respect to this character was also reported by Asati *et al.,* (2008), Ara *et al.,* (2009), Ghosh *et al.,* (2010), Shashikanth *et al.,* (2010), Khan and Samadia (2012), Reddy *et al.,* (2013), Kumar *et al.,* (2013), Premalakshmi *et al.,* (2014) and Sharma and Jaipaul (2014). Maximum fruit yield per plant was recorded in Punjab Sartaj (1.59 kg). Whereas, minimum fruit yield per plant was recorded in EC-36293 (0.41 kg). Check variety Solan Lalima recorded 1.54 kg fruit yield per plant. Similarly, observation on yield per hectare showed that maximum yield per hectare was recorded by Punjab Sartaj (471.11 q/ha). Whereas, minimum yield per hectare was observed in genotype EC-36293 (121.48 q/ha) Check variety Solan Lalima recorded yield per hectare of about 456.29 q. Wide variation with respect to this character was recorded by Asati *et al.,* (2008), Ara *et al.,* (2009), Ghosh *et al.,* (2010), Shashikanth *et al.,* (2010), Khan and Samadia (2012), Reddy *et al.,* (2013), Kumar *et al.,* (2013), Singh *et al.,* (2014), Premalakshmi *et al.,* (2014) and Kumar (2014).

Significant differences were observed for fruit shape index. The mean performance of genotypes showed maximum fruit shape index value in DMT KRCCH-1 (1.19), which was statistically at par with DMT KRCCH-4 (1.17) and BT-10-10 (1.13) whereas, minimum value was observed in DMT KRCCH-6 (0.79). Index values for all the genotypes have been presented in table 2. Seven genotypes were found to have oval shape with an index value one and above, while twenty four genotypes fall under spherical group and four under flat round group. Similarly, tomato genotypes were also classified into oval, spherical and flat round categories by Buckseth *et al.,* (2012), Kumar (2014) and Kharshandi (2015) as per the method suggested by Roy and Choudhary (1972). Pericarp thickness varied from 2.12 to 6.13 mm. Six genotypes had more pericarp thickness than the check variety Solan Lalima (5.20 mm). Maximum pericarp thickness (6.13 mm) was observed in S-1001. Whereas, minimum pericarp thickness (2.12 mm) was recorded in Punjab Red Cherry. The

mean values of different genotypes for number of locules per fruit revealed that EC-29414 (2.50) and UHF-90 (2.50) had the lowest number of locules per fruit, which was statistically at par with fourteen genotypes viz., Punjab Red Cherry (2.53), EC-524082 (2.69), BCT-5 (2.73), UHF-571 (2.80), BCT-10 (2.87), Solan Vajr (2.92), BCT-2 (2.93), S-1001 (2.93), check variety Solan Lalima (2.99), EC-21132 (3.00), BT-10-10 (3.03), EC-2997 (3.07), Selection-87 (3.20) and BCT-8 (3.20). Maximum number of locules per fruit were recorded in UHF-553 (5.00) Variation with respect to this character was reported by Joshi *et al.*, (2004), Manna and Paul (2012), Buckseth *et al.,* (2012) and Kumar (2014). Total soluble solids ranged from 3.27 to 6.32 ^{0}B. Seventeen genotypes recorded maximum value for total soluble solids than population mean. Maximum total soluble solids (6.32 ^{0}B) were recorded in EC-21132, which was statistically at par with EC-16788 (5.54 ^{0}B), EC-36293 (5.71 ^{0}B), EC-141827 (5.93 ^{0}B), EC-433607 (5.97 ^{0}B) and Punjab Red Cherry (6.04 ^{0}B). Minimum total soluble solids (3.27 ^{0}B) were observed in DMT KRCCH-3. Twelve genotypes recorded maximum value for total soluble solids than the check variety Solan Lalima (4.94 ^{0}B). Considerable variability regarding this trait was in accordance with the findings of Buckseth *et al.,* (2012) and Kumar (2014).

Ascorbic acid content showed significant differences among the genotypes and ranged from 14.49 to 36.55 mg/100 g. Genotype DMT KRCCH-2 had maximum ascorbic acid content (36.55 mg/100 g) which was statistically at par with DMT KRCCH-1 (35.39 mg/100 g), EC-524082 (36.32 mg/100 g) and DMT KRCCH-6 (36.51 mg/100 g). Minimum value for this trait was found in UHF-95 (14.49 mg/100 g). Nineteen genotypes recorded maximum value for total soluble solids than the check variety Solan Lalima (25.60 mg/100 g). Considerable variability with respect to this trait was reported by Dar and Sharma (2011), Reddy *et al.,* (2013) and Kumar (2014).

Harvest duration varied between 27.00 to 42.67. Maximum harvest duration (42.67 days) was recorded in genotype Solan Lalima, which was statistically at par with EC-2997 (42.00 days), EC-524082 (42.00 days), Punjab Gaurav (41.67 days) and BT-10-10 (41.67 days). Minimum harvest duration was recorded in DMT KRCCH-3 (27.00 days). Eighteen genotypes including check were found to had more harvest duration than population mean. Considerable variability regarding this trait was found and similar findings were observed by Ara *et al.*, (2009), Sharma and Jaipaul (2014), Kumar (2014) and Rai *et al.,* (2016).

Parameters of variability

The parameters of variability viz., mean, range, coefficients of variation (genotypic and phenotypic), heritability (broad sense), genetic advance and genetic gain were worked out for various characters and are presented in table 2.

Coefficients of variation

For all the characters studied, PCV (Phenotypic coefficient of variation) was higher in magnitude than the corresponding GCV (Genotypic coefficient 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.

The investigation showed marked extent of variation for all the characters studied. The PCV and GCV were higher for fruits per cluster (49.66 % and 49.50 %), fruits per plant (46.28 % and 46.11 %), yield per plant (38.13 % and 38.04 %) and average fruit weight (30.39 % and 30.29 %). Ghosh *et al.,* (2010)

and Kumar *et al.,* (2013) reported high PCV and GCV for average fruit weight, fruits per cluster and fruits per plant. High PCV and GCV were reported for yield per plant and fruits per plant by Shashikanth *et al.,* (2010).

Similarly high amount of PCV and GCV for average fruit weight, fruits per plant and yield per plant was observed by Khan and Samadia (2012). High PCV and GCV were also reported by Singh and Singh (2019) for fruits per plant, fruits per cluster, average fruit weight, yield per plant and per hectare. High PCV and GCV were recorded for yield per plant and fruit weight by Basfore *et al.,* (2020).

Moderate phenotypic and genotypic coefficients of variation were observed for plant height (24.38 % and 24.26 %), total soluble solids (21.73 % and 21.59 %), number of locules (20.28 % and 20.11 %), fruit shape index (19.84 % and 19.69 %) and pericarp thickness (16.90 % and 16.70 %). For plant height, moderate phenotypic and genotypic coefficients of variation were reported by Reddy *et al.,* (2013) and Singh and Singh (2019). Patel *et al.,* (2013) reported moderate phenotypic and genotypic coefficients of variation for total soluble solids and locules per fruit. Dar *et al.,* (2012) recorded moderate phenotypic and genotypic coefficients of variation for characters like pericarp thickness and number of locules per fruit. Kumar *et al.,* (2012) and Basfore *et al.,* (2020) also reported moderate phenotypic and genotypic coefficient of variation for total soluble solids and pericarp thickness. Low values of phenotypic and genotypic coefficient of variation were observed for ascorbic acid (13.65 % and 13.43 %), harvest duration (9.66 % and 9.33 %), days to 50 % flowering (6.15 % and 5.65 %) and days to marketable maturity (5.91 % and 5.38 %). Reddy *et al.,* (2013) reported low PCV and GCV for harvest duration, days to 50 % flowering and days to maturity. Similarly low amount of PCV and GCV for harvest duration and days to marketable maturity were also observed by Ara *et al.,* (2009) and Patel *et al.,* (2013). Kumar (2014), Singh *et al.,* (2015) and Singh and Singh (2019) reported low phenotypic and genotypic coefficients of variation for days to 50 % flowering.

Heritability

Heritability (broad sense) estimates ranged from 82.99 percent to 99.52 percent. High heritability was recorded for fruit yield per plant (99.52 %), average fruit weight (99.35 %), number of fruits per cluster (99.33 %), number of fruits per plant (99.22 %), harvest duration (98.96 %), total soluble solids (98.73 %), fruit shape index (98.50 %), number of locules per fruit (98.33 %), plant height (97.93 %), pericarp thickness (97.71 %), ascorbic acid (96.72 %), days to 50 % flowering (84.40 %) and days to marketable maturity (82.99 %). High heritability estimates for the characters number of fruits per plant, number of fruits per cluster and pericarp thickness were reported by Kumar *et al.,* (2012). Khan and Samadia (2012) observed high heritability estimates for the characters fruit yield per plant and plant height. Similar results to present study were also reported by Premalakshmi *et al.,* (2014) and Rai *et al.,* (2016) who recorded high heritability for number of fruits per plant and average fruit weight. Meena and Bahudur (2014) and Hasan *et al.,* (2016) noted high heritability estimates for plant height, days to 50 % flowering, fruits per plant, average fruit weight, yield per plant, harvest duration, total soluble solids and ascorbic acid. Singh and Singh (2019) recorded high heritability for fruits per plant, fruits per cluster, average fruit weight and yield per plant. Basfore *et al.,* (2020) observed high heritability for plant height, fruit weight, pericarp thickness, locule number and yield per plant.

Table.1 Mean performance of tomato genotypes for various characters

Genotypes	Days to 50% flowerings	Days to marketable maturity	Plant height (cm)	Numbers of fruits per cluster	Numbers of fruits per plant	Average fruit weight (g)	Yield per plant (kg)	Yield per hectare (q)	Fruit Shape index	Pericarp thickness (mm)	Number of locules per fruit	Total soluble solids (^{0}B)	Ascorbic acid (mg/100 g)	Harvest duration (days)
Punjab Sartaj	31.67	74.67	107.44	4.92	22.80	84.00	1.59	471.11	0.98	4.48	3.47	3.32	23.74	40.33
Punjab Ratta	31.00	73.67	75.33	5.30	23.27	62.73	1.42	420.74	1.03	5.22	3.33	3.77	33.18	39.67
DMT KRCCH-4	33.33	79.00	69.01	3.70	14.80	69.07	1.02	302.22	1.17	4.54	3.47	3.31	31.63	28.67
BCT-8	32.67	70.00	69.88	4.80	14.50	75.80	1.09	322.96	0.88	5.30	3.20	3.66	29.29	29.67
LO-2410	32.00	71.67	112.39	3.10	18.60	42.53	0.62	183.70	0.89	4.08	3.93	4.53	33.03	35.33
DMT KRCCH-1	31.67	75.00	64.41	3.00	11.25	62.53	0.48	142.22	1.19	4.28	3.40	3.52	35.39	29.67
Punjab Gaurav	31.67	80.33	105.13	5.27	21.88	75.67	1.53	453.33	0.99	5.45	3.53	3.49	21.48	41.67
BCT-10	32.00	75.33	60.53	4.99	12.72	78.80	1.00	296.30	0.89	4.16	2.87	4.97	29.99	31.33
BCT-5	31.33	77.67	55.00	3.74	13.25	74.73	0.98	290.37	0.96	4.53	2.73	4.21	29.84	27.67
DMT KRCCH-3	32.00	78.00	58.93	4.49	15.00	62.53	0.93	275.55	0.93	4.20	3.80	3.27	18.62	27.00
UHF-553	33.00	67.00	93.15	3.84	23.80	65.00	1.20	355.55	0.91	4.50	5.00	4.44	26.58	37.00
Punjab Red Cherry	24.67	66.00	85.45	15.07	70.02	10.53	0.70	207.40	1.03	2.12	2.53	6.04	28.42	28.33
BCT-2	32.67	68.00	71.67	3.80	14.20	70.00	0.99	293.33	0.94	4.52	2.93	3.74	23.52	31.00
BCT-4	31.67	75.33	65.98	3.72	13.50	74.20	1.00	296.29	0.99	5.32	3.47	3.31	26.55	36.00
DMT KRCCH-6	33.00	77.33	73.95	3.16	14.00	63.93	0.83	245.92	0.79	3.54	3.93	3.53	36.51	35.33
DMT KRCCH-2	31.67	76.33	52.51	2.76	13.20	73.93	0.73	216.29	0.82	5.46	3.87	3.41	36.55	28.33
Solan Vajr	32.33	80.00	123.65	4.16	21.83	71.00	1.23	364.44	0.96	5.18	2.92	3.67	24.88	39.67
S-1001	29.67	77.00	75.90	4.28	22.33	70.15	1.32	391.11	1.02	6.13	2.93	3.89	29.67	36.67
EC-524082	34.67	72.67	116.78	3.97	23.07	37.67	0.87	257.77	0.96	3.24	2.69	4.35	36.32	42.00
EC-433607	32.67	70.33	117.2	4.20	20.00	38.73	0.77	228.14	0.98	3.67	4.00	5.97	26.65	40.00

			4											
EC-21132	29.00	69.00	76.04	3.56	18.51	43.00	0.60	177.77	0.85	3.37	3.00	6.32	25.16	35.33
EC-2997	31.67	68.67	121.33	3.99	21.57	57.01	0.93	275.55	0.91	3.98	3.07	4.95	19.77	42.00
EC-36293	33.00	70.00	64.61	2.79	16.33	42.60	0.41	121.48	0.98	4.54	4.03	5.71	33.21	32.00
EC-141827	32.33	71.33	92.05	3.14	17.60	47.87	0.48	142.22	0.88	3.24	3.63	5.93	18.20	34.33
EC-16788	32.67	72.67	77.05	3.41	18.00	43.57	0.48	142.22	0.90	3.63	4.40	5.54	23.49	32.00
EC-3526	34.33	68.67	94.78	3.24	19.39	34.63	0.65	192.59	0.87	3.10	3.67	4.84	26.43	39.00
EC-15998	35.00	70.67	114.09	4.03	20.94	66.50	0.84	248.88	0.93	4.18	3.73	4.43	19.83	39.67
UHF-571	31.33	74.33	94.56	3.14	22.48	55.69	0.97	287.40	0.91	4.31	2.80	5.15	23.25	36.00
EC-29414	32.67	72.00	84.35	2.83	17.34	36.08	0.44	130.37	1.02	3.37	2.50	5.19	28.49	35.33
UHF-95	35.67	67.67	84.82	2.76	16.40	37.09	0.43	127.40	0.87	3.59	3.47	4.40	14.49	33.33
UHF-90	34.33	70.33	85.09	2.97	18.30	31.13	0.53	157.03	0.98	3.34	2.50	5.33	16.50	38.33
BT-10-10	32.00	67.67	109.99	4.51	24.53	45.58	1.11	328.88	1.13	4.54	3.03	4.68	23.47	41.67
Selection-12	33.67	74.33	104.14	3.40	23.80	45.74	1.08	320.00	0.87	4.31	3.37	5.12	24.85	40.33
Selection-87	32.67	79.67	107.20	3.49	24.13	51.00	1.22	361.48	0.86	4.25	3.20	4.65	26.49	39.00
Solan Lalima (check)	32.67	73.33	120.32	5.00	26.37	65.00	1.54	456.29	0.94	5.20	2.99	4.94	25.60	42.67
Mean	32.24	73.02	88.13	4.12	20.27	56.17	0.91	271.00	0.95	4.25	3.35	4.50	26.60	35.60
$CD_{(0.05)}$	2.62	4.77	3.57	0.27	1.32	2.42	0.04	11.90	0.10	0.50	0.79	0.83	1.84	1.43

Table.2 Categories of genotypes on the basis of fruit shape index values

Fruit shape index values	Shapes	Genotypes
1 or more	**Oval**	Punjab Ratta, DMT KRCCH-4, DMT KRCCH-1, Punjab Red Cherry, S-1001, EC-29414, BT-10-10
0.86-0.99	**Spherical**	Punjab Sartaj, BCT-8, LO-2410, Punjab Gaurav, BCT-10, BCT-5, DMT KRCCH-3, UHF-553, BCT-2, BCT-4, Solan Vajr, EC-524082, EC-433607, EC-2997, EC-36293, EC-141827, EC-16788, EC-3526, EC-15998, UHF-571, UHF-95, UHF-90, Selection-12, Solan Lalima (check)
0.71-0.85	**Flat round**	DMT KRCCH-6, DMT KRCCH-2, EC-21132, Selection-87

Table.3 Estimation of phenotypic and genotypic coefficients of variation, heritability, genetic advance and genetic gain for various traits in tomato

Characters	Mean	Range		Coefficient of variability (%)		Heritability (Broad sense) (%)	Genetic advance	Genetic gain (%)
		Minimum	Maximum	Phenotypic	Genotypic			
Days to 50% flowerings	32.24	24.67	35.67	6.15	5.65	84.40	3.45	10.70
Days to marketable maturity	73.02	66.00	80.33	5.91	5.38	82.99	7.37	10.10
Plant height (cm)	88.13	52.51	123.65	24.38	24.26	98.96	43.81	49.71
Numbers of fruits per cluster	4.12	2.76	15.07	49.66	49.50	99.33	4.19	101.63
Numbers of fruits per plant	20.39	11.25	70.02	46.28	46.11	99.28	19.56	94.66
Average fruit weight (g)	56.17	10.53	84.00	30.39	30.29	99.35	34.93	62.19
Fruit yield/plant (Kg)	0.92	0.41	1.61	38.13	38.04	99.52	0.72	78.18
Fruit shape index	0.95	0.79	1.19	19.84	19.69	98.50	1.71	40.26
Pericarp thickness (mm)	4.25	2.12	6.13	16.90	16.70	97.71	1.14	34.02
Number of locules per fruit	3.35	2.50	5.00	20.28	20.11	98.33	1.85	41.09
Total soluble solids (^{0}B)	4.50	3.27	6.32	21.73	21.59	98.73	11.76	44.21
Ascorbic acid (mg/100g)	26.60	14.49	36.55	13.65	13.43	96.72	9.69	27.21
Harvest duration (days)	35.60	27.00	42.67	9.66	9.33	93.37	0.17	18.58

Genetic advance and genetic gain

The genetic gain (genetic advance expressed as per cent of population mean) was low to high in nature and ranged from 10.10 to 101.63 percent. High genetic gain was recorded for number of fruits per cluster (101.63 %), fruit yield per plant (78.18 %), number of fruits per plant (94.66 %) and average fruit weight (62.19 %). High genetic gain was recorded for number of fruits per cluster, average fruit weight, number of fruits per plant and fruit yield per plant was in accordance with the findings of Kumar *et al.,* (2013), Basavaraj *et al.,* (2015) and Singh and Singh (2019). Genetic gain was moderate for plant height (49.71 %), total soluble solids (44.21 %), number of locules per fruit (41.09 %), fruit shape index (40.26 %), pericarp thickness (34.02 %) and ascorbic acid (27.21 %). Moderate genetic gain for total soluble solids was observed by Reddy *et al.,* (2013) and Basavaraj *et al.,* (2015), for pericarp thickness, plant height and number of locules per fruit by Kingsley (2015) and for ascorbic acid by Reddy *et al.,* (2013). Moderate genetic gain for plant height and days to 50 % flowering were observed by Singh and Singh (2019). Low genetic gain was observed for harvest duration (18.58 %), days to 50 % flowering (10.70 %) and days to marketable maturity (10.10 %). Low values of genetic gain for harvest duration were also observed by Ara *et al.,* (2009) and Patel *et al.,* (2013), for days to 50% flowering and days to marketable maturity by Mehta and Asati (2008), Patel *et al.,* (2013) and Kumar *et al.,* (2014).

High heritability along with high estimates of genetic gain were observed for number of fruits per cluster (99.33 % and 101.63 %), number of fruits per plant (99.28 % and 94.66 %), fruit yield per plant (99.52 % and 78.18 %) and average fruit weight (99.35% and 62.19 %). Khan and Samadia (2012) reported high heritability along with high estimates of genetic gain for characters like number of fruits per plant and average fruit weight. Basavaraj *et al.,* (2015) reported high heritability and high estimates of genetic gain for fruits per cluster and fruits per plant. Singh *et al.,* (2015) and Rai *et al.,* (2016) observed high heritability and high estimates of genetic gain for fruit yield per plant. High heritability along with high genetic gain for number of fruits per cluster, average fruit weight, number of fruits per plant and fruit yield per plant was in accordance with the findings of Singh and Singh (2019). Basfore *et al.,* (2020) observed high genetic gain and high heritability for plant height, fruit weight, pericarp thickness, locule number and yield per plant. High heritability along with moderate genetic gain was observed for plant height (98.96 % and 49.71 %), total soluble solids (98.73 % and 44.21 %), number of locules per fruit (98.33 % and 41.09 %), fruit shape index (98.50 % and 40.26 %), pericarp thickness (97.71 % and 34.02 %) and ascorbic acid (96.72 % and 27.21 %). High heritability coupled with moderate genetic gain for pericarp thickness was noted by Kumar *et al.,* (2013) and for ascorbic acid content by Reddy *et al.,* (2013). Singh *et al.,* (2015) observed high heritability and moderate genetic gain for total soluble solids and number of locules per fruit. Kumar *et al.,* (2012) recorded high heritability and moderate gain for plant height, pericarp thickness and total soluble solids. High heritability along with low genetic gain was observed for harvest duration (93.37 % and 18.58 %), days to 50 % flowering (84.40 % and 10.70 %) and days to marketable maturity (82.99 % and 10.10 %).

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