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Study of Genetic Variability and Heritability in Cherry Tomato (*Solanum lycopersicum* L. Var. *cerasiforme*) Genotypes

Afroza Akhter[1*], Ambreen Nabi[1], Baseerat Afroza[1], Zahoor Ahmad Dar[1], Ajaz Ahmad Malik[1], Gowhar Ali[1], Sabia Akhter[1], Sayed Azrah Indrabi[1], Amreena Sultan[1] and Insha Javeed[1]

[1]Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus-190025, Srinagar, Jand K, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Twenty-nine genotypes of cherry tomato (*Solanum lycopersicum* L. var. *cerasiforme*) were evaluated for their genetic variability and heritability. A wide range of genetic variability was observed for twenty traits of cherry tomato genotypes. The analysis of variance was significant for all the characters indicating genetic variability in the genotypes under the study except number of locules per fruit. The highest phenotypic and genotypic coefficient of variation were observed for lycopene (43.12, 42.94), total carotenoids (42.82, 42.51), average fruit weight (42.52, 42.50), fruit yield per hectare (42.29, 42.24). In general Phenotypic Coefficient of Variation (PCV) was marginally higher than the corresponding Genotypic Coefficient of Variation (GCV) indicating the less influence of environment in the expression of traits under study. High heritability coupled with high genetic advance as percentage of mean was observed for almost all characters indicating that most of the traits studied were mainly controlled by additive gene effect and thus selection may be effective.

**Corresponding author: E-mail: afrozaakhter93@gmail.com;*

Keywords: Cherry tomato; genotypic coefficient of variation; heritability; phenotypic coefficient of variation

1. INTRODUCTION

Cherry tomato (*Solanum lycopersicum* L. var. *cerasiforme*) is regarded as a botanical variety of the cultivated tomato. Cherry tomato has become more popular all over the world because of a good source of vitamin A, vitamin C, solids content and good taste [1]. Its fruits are consumed more as fruit rather than vegetable. Cherry tomato is also called as salad tomato. It is beneficial to human health because of its high content of antioxidant and phytochemical compounds, including lycopene, beta-carotene, flavonoids, vitamins and many essential nutrients [2]. Cherry tomato has gained importance as a cash crop but is still new in India. It is therefore essential to assess the quantum of genetic variability, nature of character association with respect to different characters, which would help plant breeders in planning a successful breeding programme. Genetic parameters like genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance are useful biometrical tools for determination of genetic variability. Heritable variation can be effectively studied in conjunction with genetic advance. High heritability alone is not enough to make efficient selection in segregating generation and needs to be accompanied by a substantial amount of genetic advance. The estimates of different genetic parameters and the association of different characters are important for better understanding of the nature and the magnitude of genetic variability present in the breeding material. The characters showing high heritability along with high estimates of genetic advance are more effective for selection. So, the present study was undertaken with main objective to explore the characters highly responsible for the yield of cherry tomato by estimating variability, heritability and genetic advance of different characters.

2. MATERIALS AND METHODS

The present investigation was carried out at Vegetable Experimental Farm, Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar (J and K), Srinagar during Kharif Season 2018.The experiment was laid in Randomised Block Design with three replications. The plots of size 3 × 2 m (6 m^2), consisted of one row of each genotype in each replication at spacing of 100 × 40 cm. Twenty nine diverse genotypes of cherry tomato, maintained by the division were evaluated for various yield and yield attributing traits. The observations were recorded on twenty quantitative and qualitative traits *viz*., plant height (cm), number of branches, days to first flowering, number of flowers $cluster^{-1}$, number of fruits $cluster^{-1}$, average fruit length (cm), average fruit width (cm), pericarp thickness (mm), number of locules $fruit^{-1}$, days to first fruit harvesting, average fruit weight (g), fruit yield $plot^{-1}$(kg), fruit yield $hectare^{-1}$(q), TSS content (˚Brix), juice to pulp ratio, 100 seed weight (g), ascorbic acid ($mg100g^{-1}$), acidity (% citric acid), lycopene content ($mg100g^{-1}$) and total carotenoids ($mg100g^{-1}$).The genotypic and phenotypic coefficient of variation [3], heritability in broad sense [4] and expected genetic advance [5] were estimated for all the characters.

3. RESULTS

The genetic variability estimates including mean, range, genotypic variance (GV), phenotypic variance (PV), phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h^2) and genetic advance as a per cent of mean are presented in Table-1.

Wide range of variability was observed for most of the traits under study. Plant height showed mean value of 115.87 and ranged from 85.83 to 157.26. A range of 18.73 to 31.56 with mean value of 25.24 was observed for number of branches. Days to first flowering exhibited a range of 19.40 to 32.60 with mean value of 26.21. Days to first fruit harvest exhibited a range of 71.93 to 85.86 with mean value of 78.30. Number of flowers $cluster^{-1}$ and number of fruits $cluster^{-1}$ exhibited a range of 5.60 to 8.86 and 4.20 to 8.20 respectively and mean values of 7.67 and 6.27 respectively. Average fruit weight, fruit length and fruit width demonstrated mean values of 9.47, 2.34 and 2.14 with a range of 2.27 to 18.72, 1.32 to 3.59 and 1.26 to 3.34 respectively. Pericarp thickness and number of locules $fruit^{-1}$ showed mean value of 1.54 and 2.39 with a range of 0.12 to 2.77 and 2.00 to 3.60 respectively. The mean values of 4.06 and 67.79 were recorded for fruit yield $plot^{-1}$ and fruit yield $hectare^{-1}$with a range of 1.18 to 9.65 and 19.77 to 160.86 respectively.100 seed weight showed a range of 0.16 to 0.96 with mean value

of 0.78. The quality traits i.e., TSS, juice to pulp ratio, ascorbic acid, tritrable acidity and total carotenoids showed mean values of 5.32, 1.50, 35.34, 0.53, 0.81 and 0.88 with a range of 2.35 to 8.20, 1.01 to 3.43, 20.02 to 58.56, 0.31 to 0.88, 0.24 to 2.71 and 0.06 to 2.48 respectively.

The phenotypic coefficients of variation were found to be higher than the corresponding genotypic coefficients of variation. Low PCV and GCV were observed for days to first fruit harvesting (4.41 and 4.33). Plant height (15.78 and 15.73), number of branches (15.56 and 15.01), days to first flowering (14.97 and 14.44), number of flowers cluster^{-1} (14.11 and 12.50), number of fruits cluster^{-1} (19.55 and 19.23) and 100 seed weight (17.99 and 17.99) depicted moderate values of PCV and GCV. Moreover the average fruit length (28.78 and 28.70), average fruit width (26.37 and 26.34), pericarp thickness (37.80 and 36.73), number of loculesfruit^{-1} (30.33 and 29.64), average fruit weight (42.52 and 42.50), fruit yield plot^{-1} (39.09 and 39.02), fruit yield hectare^{-1} (42.29 and 42.24), total soluble solids (33.37 and 33.36), juice to pulp ratio (32.41 and 32.35), ascorbic acid (27.08 and 26.91), acidity (30.13 and 29.52), lycopene content (43.13 and 42.94) and total carotenoids (42.82 and 42.51) exhibited high Phenotypic Coefficient of Variation (PCV) and Genotypic Coefficient of Variation (GCV). Highest phenotypic and genotypic variances were recorded for fruit yield hectare^{-1}(822, 820) followed by plant height (334.50, 332.54) and ascorbic acid (91.63, 90.52). Rest of the characters recorded lower values of phenotypic and genotypic variances. Broad sense heritability was found to be high for all traits (greater than 70 per cent). Highest genetic advance as percentage of mean was recorded in lycopene (87.94) followed by average fruit weight (86.73), total carotenoids (86.44) and fruit yield hectare^{-1}(86.25). While as the lowest genetic advance as percent of mean was observed for days to first fruit harvest (8.74).

Discussion

In general the phenotypic and genotypic coefficients of variation were almost similar with slightly higher phenotypic coefficients of variation, which indicates the role of environment in the expression of traits under observation. This was in agreement with Ghosh *et al.* [6] and Kaushik *et al.* [7] their findings also confirmed that most of the yield attributes were under the influence of environment. It is evident from the data presented in Table 1 that Fruit yield hectare-1 (42.29 and 42.24), fruit yield plot-1 (39.09 and 39.02), pericarp thickness (37.80 and 36.73), total soluble solids (33.37 and 33.36), juice to pulp ratio (32.41 and 32.35), number of locules fruit^{-1} (30.33 and 29.64), acidity (30.13 and 29.52), average fruit weight (42.52 and 42.50), lycopene content (43 (26.37 and 26.34) recorded high phenotypic and genotypic coefficients of variation, indicating that genotypes had broad genetic base for these characters. The same was observed by Ligade *et al.* [8] which found that high values of GCV and PCV for number of locules plant^{-1}, average fruit weight, fruit yield plot^{-1}, fruit yield hectare^{-1}, Renuka *et al.* [9] for average fruit weight, Kumar *et al.* [10] For number of locules plant^{-1} and pericarp thickness. Plant height (15.78 and 15.73), number of branches (15.56 and 15.01), days to first blooming (14.97 and 14.44), number of flowers cluster-1 (14.11 and 12.50), number of fruits cluster-1 (19.55 and 19.23), and 100 seed weight (17.99 and 17.99) showed moderate phenotypic and genotypic coefficients of variation, implying that the genetic population tested has moderate diversity. Similar results have been reported by Ara et al. [11] for plant height; Kumar and Thakur [12] for number of branches; Kumari et al. [13]. For number of fruits clusters^{-1}; Prema et al. [1] for average fruit weight, pericarp thickness and fruit yield plant^{-1}. The days to first fruit harvesting exhibited low PCV and GCV as reported by Ara *et al.* [11]. From Table 1 it is evident that lycopene content, TSS exhibited high phenotypic and genotypic coefficient of variation, confirmed by Renuka *et al.* [9] which found TSS had high Genotypic Coefficient of Variation (GCV) and Phenotypic Coefficient of Variation (PCV). Shiksha and Sharma [14] found that high Phenotypic Coefficient of Variation (PCV) and Genotypic Coefficient of Variation (GCV), heritability and genetic advance were observed for number of fruits cluster^{-1} for lycopene content.

The estimation of heritability has a greater role to play in determining the effectiveness of selection of a character provided it is considered in conjunction with the predicted genetic advance as suggested by Panse and Sukhatme [15] and Johnson *et al.* [5] Heritability (h^2)was high for all the characters and ranged from 78 to 99 per cent indicating that the characters are less influenced by environmental effects and the characters are effectively transmitted to the progeny, suggesting major role of genetic constitution in the expression of a character and thus selection based on phenotypic expression could be relied

Table 1. Estimates of mean, range, phenotypic variance, genotypic variance, phenotypic and genotypic coefficients of variation, heritability (h^2) and genetic advance (as % of mean) for growth, maturity, yield attributing and quality characters in cherry tomato (*Solanum lycopersicum*L.var. *cerasiforme*)

S. No.	Parameters	Mean	Range	Phenotypic variance (PV)	Genotypic variance (GV)	Phenotypic coefficient of variation (PCV)	Genotypic coefficient of variation (GCV)	Heritability (h^2)	Genetic advance (as % of mean)
1	Plant height (cm)	115.87	85.83-157.26	334.50	332.54	15.78	15.73	0.99	32.32
2	No. of branches	25.24	18.73-31.56	15.45	14.36	15.56	15.01	0.93	29.82
3	Days to first flowering	26.21	19.40-32.60	15.41	14.34	14.97	14.44	0.93	28.69
4	No. of flowers cluster^{-1}	7.67	5.60-8.86	1.17	0.92	14.11	12.50	0.78	22.82
5	No. of fruits cluster^{-1}	6.27	4.20-8.20	1.50	1.45	19.55	19.23	0.96	38.95
6	Average fruit length (cm)	2.34	1.32-3.59	0.45	0.45	28.78	28.70	0.99	58.95
7	Average fruit width (cm)	2.14	1.26-3.34	0.32	0.31	26.37	26.34	0.96	54.20
8	Pericarp thickness (mm)	1.54	0.12-2.77	0.34	0.32	37.80	36.73	0.94	73.31
9	No. of locules fruit^{-1}	2.39	2.00-3.60	0.22	0.21	30.33	29.64	0.95	38.40
10	Days to first fruit harvesting	78.30	71.93-85.86	11.96	11.50	4.41	4.33	0.96	8.74
11	Average fruit weight (g)	9.47	2.27-18.72	16.22	16.20	42.52	42.50	0.99	86.73
12	Fruit yield plot^{-1} (kg)	4.06	1.18-9.65	2.52	2.51	39.09	39.02	0.99	79.74
13	Fruit yield ha^{-1}(q)	67.79	19.77-160.86	822	820	42.29	42.24	0.99	86.25
14	TSS content (˚Brix)	5.32	2.35-8.20	3.15	3.15	33.36	33.36	0.99	68.72
15	Juice to pulp ratio	1.50	1.01-3.43	0.23	0.23	32.41	32.35	0.99	66.53
16	100-seed weight (g)	0.78	0.16-0.96	0.02	0.01	17.99	17.99	0.99	37.05
17	Ascorbic acid (mg100g^{-1})	35.34	20.02-58.56	91.63	90.52	27.08	26.91	0.98	55.11
18	Tritrable acidity (% citric acid)	0.53	0.31-0.88	0.02	0.02	30.13	29.52	0.96	59.61
19	Lycopene content (mg 100g^{-1})	0.81	0.24-2.71	0.12	0.12	43.12	42.94	0.99	87.94
20	Total carotenoids (mg100g^{-1})	0.88	0.06-2.48	0.14	0.14	42.82	42.51	0.98	86.44

upon. Similar results were observed by Reddy *et al.* [16], Ligade *et al.* [8], Rajolli *et al.* [17], Kumar *et al.* [18] and Shiksha and Sharma, [14]. High heritability along with high genetic advance as per cent of mean for this trait suggested the possibility of selecting high yielding cultivars from the present collection. Similar results have also been reported by Reddy *et al.* [16], Rajoli *et al.* [17], Renuka *et al.* [9] and Ligade *et al.* [8] which also found that high heritability coupled with high genetic advance as percent mean was observed for plant height, number of branches, average fruit weight, pericarp thickness, number of locules, ascorbic acid and yield plant^{-1}.

4. CONCLUSION

The phenotypic coefficient of variation was in general higher than the genotypic coefficient of variation for all the characters except days to first fruit harvesting which may be due to environmental effect. The high genetic variability demonstrated directional selection could be essential for desired genetic improvement. High heritability coupled with high genetic advance as per cent of mean specify the significance so, that these characters can be utilized for choosing superior genotypes. Moderate genetic advance as per cent of mean with high heritability suggests the action of both additive and non-additive genes and favourable influence of environment in the expression. The breeder should adopt suitable breeding methodology to utilize both additive and non- additive gene effects simultaneously, since varietal and hybrid development will go a long way in the breeding programmes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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