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Research Article

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Genetic variability studies in cherry tomato for growth, yield, and quality traits in open field conditions

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ABSTRACT

The goal of this study was to learn more about the nature and extent of genetic diversity, heritability, and genetic progress in cherry tomatoes for various growth, yield, and quality traits. Ten diverse lines of cherry tomato were crossed in diallel fashion (excluding reciprocals) and evaluated for genetic variability studies in open field conditions. The experimental findings revealed that the phenotypic variation and the genotypic variation were equal in magnitude for all the traits indicating less influence of environment on all these traits. High PCV, GCV, and genetic advance as percent mean was observed for several fruits plant^{-1}, average fruit weight (g), fruit yield hectare^{-1} (q), reducing sugar (%), non-reducing sugar (%), total sugars (%), titratable acidity (%) and ascorbic acid content (mg100g^{-1}), indicating the additive genetic effect. Phenotypic selection for their improvement could be achieved by simple selection.

Keywords: Cherry tomato, Genetic variability, Heritability, Genetic advance.

INTRODUCTION

In its original habitat, the cherry tomato is a perennial crop, but in temperate climates, it is commonly produced as an annual crop. The plant's growth habit is usually indeterminate, and it can grow up to 3 meters tall. Because of its widespread distribution in Central America and the existence of reduced style length in the flower, it is thought to be the ancestor of the cultivated tomato (Cox, 2000; Grandillo *et al.*, 2011). It is endemic to the Andean area of South America, which includes Ecuador and Peru, and during the Spanish colonization of the Americas, it spread all over the planet (Rick, 1976; Smith, 1994; Grandillo *et al.*, 2011). It's also high in vitamins including vitamin A, vitamin B9, and vitamin C (>57 mg 100g^{-1}) as well as minerals like phosphorus, calcium, potassium, manganese, sodium, magnesium, and iron (Aguirre et al., 2012). (Oyetayo *et al.*, 2012 and Ramya *et al.*, 2016). Because of its high content of antioxidants such as -carotene, vitamin C, carotenoids, polyphenols, phenolics, ascorbate, free amino acids, and flavonoids, it is also known as a 'Protective Food.' (Lenucci *et al.*, 2006; Kavitha *et al.*, 2014).

It is critical to examine and split the entire diversity present in germplasm into genetic, phenotypic, and environmental components to make selection and crop improvement programs efficient. The occurrence of genetic variation in a crop is a necessary condition for genetic improvement. This allows the breeder to choose an appropriate breeding scheme. As a result, unpredictability is a critical component in determining the amount of progress that may be achieved through selection. As a result, a plant breeder's understanding of the level of diversity contained in the available cherry tomato accessions is critical for launching a successful breeding program. Taking this into account, attempts were made to learn more about the nature and extent of genetic diversity in cherry tomatoes for various growth, yield, and quality traits.

MATERIALS AND METHODS

The genetic variability studies in cherry tomatoes were carried out at Vegetable Experimental Farm, Division of Vegetable Science, SKUAST-Kashmir, Shalimar, India during *Kharif* season, 2020 in open field conditions. Fifty-seven treatments comprising of 45 F_1's, 10 parents, and 2 checks were evaluated for various growth, yield, and quality traits in Augmented Block Design. All accessions and crosses had their seeds sowed in the nursery before being moved to the main field at a 60 × 60 cm spacing between rows and plants. To raise a healthy crop, a recommended package of practices was followed. On 16 quantitative and 9 quality traits, observations were made viz., plant height, number of primary branches plant^{-1}, days to first flowering, days to first fruit set, days to first fruit maturity, number of clusters plant^{-1}, number of flowers cluster^{-1}, number of fruits cluster^{-1}, number of fruits plant^{-1}, number of locules fruit^{-1}, fruit length, fruit diameter, average fruit weight, pericarp thickness, fruit yield plant^{-1}, fruit yield hectare^{-1}, dry matter content, total soluble solids, titratable acidity, ascorbic acid content, lycopene content, total sugars, reducing sugar, non-reducing sugar, and juice to pulp ratio by selecting five random plants and the average was worked out.

RESULTS AND DISCUSSION

The presence of adequate genetic diversity among the lines, which can be exploited through selection, as indicated by analysis of variance in respect of 57 treatments for twenty-five distinct phenotypes, revealing significant mean squares for all the traits under consideration (Table 1.0-3.0).

Genetic Variability

For growth and yield traits, the phenotypic variance and the genotypic variance ranged from 0.11 for number of primary branches plant^{-1} to 49674.93 for fruit yield hectare^{-1} (q). The phenotypic coefficient of variation (PCV) and the genotypic coefficient of variation (GCV) ranged from 5.56 for days to first frit maturity to 57.47 for several fruits plant^{-1}. The study thus revealed that the phenotypic variation was high as compared to genotypic variation for fruit yield hectare^{-1} (q) but equal in magnitude for all the traits indicating the high influence of environment on fruit yield hectare^{-1} (q) and less influence on all other traits. The phenotypic coefficient of variation (PCV) and the genotypic coefficient of variation (GCV) was found higher for number of fruits plant^{-1}, average fruit weight (g), fruit yield hectare^{-1}(q), and pericarp thickness (mm), which indicated the prevalence of greater phenotypic and genotypic variability among the accessions (Table 4.0).

For quality traits, the phenotypic variance and the genotypic variance ranged from 0.01 for titratable acidity (%) to 226.78 for ascorbic acid content (mg100g^{-1}) (Fig.1.0). The phenotypic coefficient of variation (PCV) and the genotypic coefficient of variation (GCV) ranged from 6.86 for total Soluble Solids (^{0}Brix) to 48.78 for reducing sugar (%). The study found that phenotypic and genotypic variance were of identical magnitude for all traits, indicating that environment had little influence on these traits. The phenotypic coefficient of variation (PCV) and the genotypic coefficient of variation (GCV) were found higher for reducing sugar (%), non-reducing sugar (%), total sugars (%), and titratable acidity (%), which indicated the prevalence of greater phenotypic and genotypic variability among the accessions (Fig. 2.0), which indicated the prevalence of greater phenotypic and genotypic variability among the accessions (Table 5.0).

Heritability and Genetic advance

For growth and yield traits, the estimates of h^2 (broad sense heritability) were found high for all the traits of interest (i.e., 97.00 to 100%) except for several locules fruit^{-1}. In case of quality traits, the estimates of h^2 (broad-sense heritability) were found high for all the traits of interest i.e., 100%. Such high values of heritability indicate that it may be due to environmental influence and the selection based on phenotypic performance would be reliable whereas, in the traits with low heritability, the influence of environmental factors is strong for their expression and the selection of these characters based on their genotype may be postponed to the later generations (Table 4.0 – 5.0).

High genetic advance was observed for fruit yield hectare^{-1} (q), several fruits plant^{-1}, ascorbic acid content (mg100g^{-1}), and dry matter content (%). This indicates that these traits may be controlled by additive gene action. High heritability with low genetic advance was recorded for a number of primary branches plant^{-1}, fruit length (cm), fruit diameter (cm), titratable acidity (%), non-reducing sugar (%), and total Soluble Solids (^{0}Brix), which implies that these traits are controlled by non-additive gene action (Table 4.0 – 5.0).

Similar, findings have been reported by Golani *et al.* (2007), Singh (2009), Ara (2009), Sajjan (2016), Xavier Flemine *et al.* (2016), Pinnamwar and Dhatt (2017), Tsagaye *et al.* (2020) and Zorb *et al.* (2020).

CONCLUSION

According to the findings, the information obtained from this study can be used to continue breeding programs in cherry tomatoes. A number of fruits plant^{-1}, average fruit weight (g), fruit yield hectare^{-1} (q), reducing sugar (%), non-reducing sugar (%), and ascorbic acid content (mg 100g^{-1}) all have strong heritability (>95%) and high genetic advance as percent mean (mg100g^{-1}). As a result, additive gene action is mostly responsible for these features, and there is still room for crop improvement through selection.

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Fig. 1.0 Estimates of mean, components of variance, heritability, and genetic advance for various quality traits in Cherry tomato.

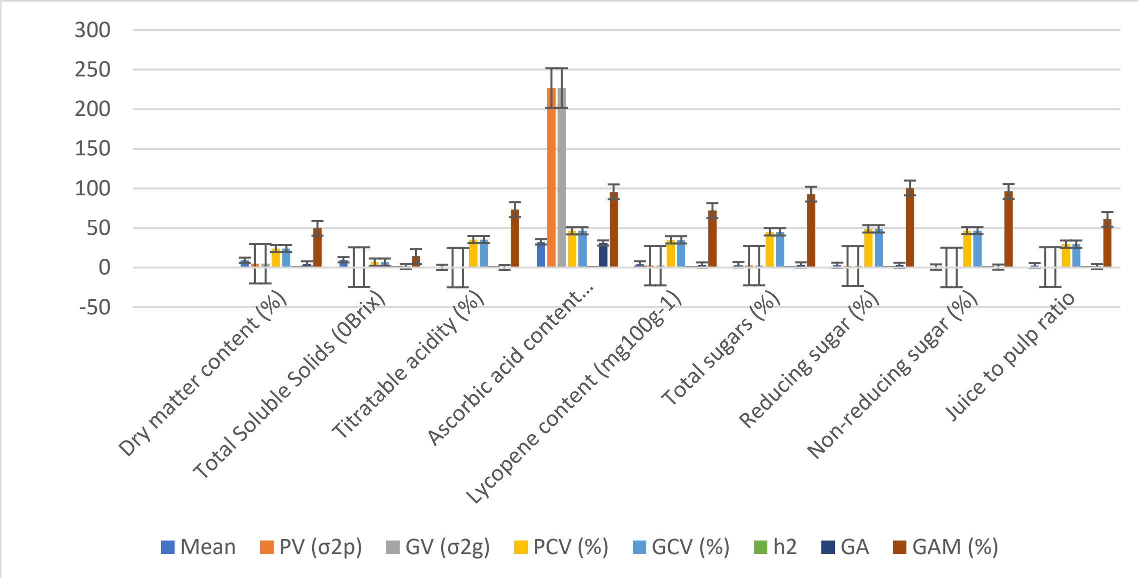

Fig. 2.0 Estimates of mean, components of variance, heritability, and genetic advance for AA, LC, RS, and NRS in Cherry tomato.

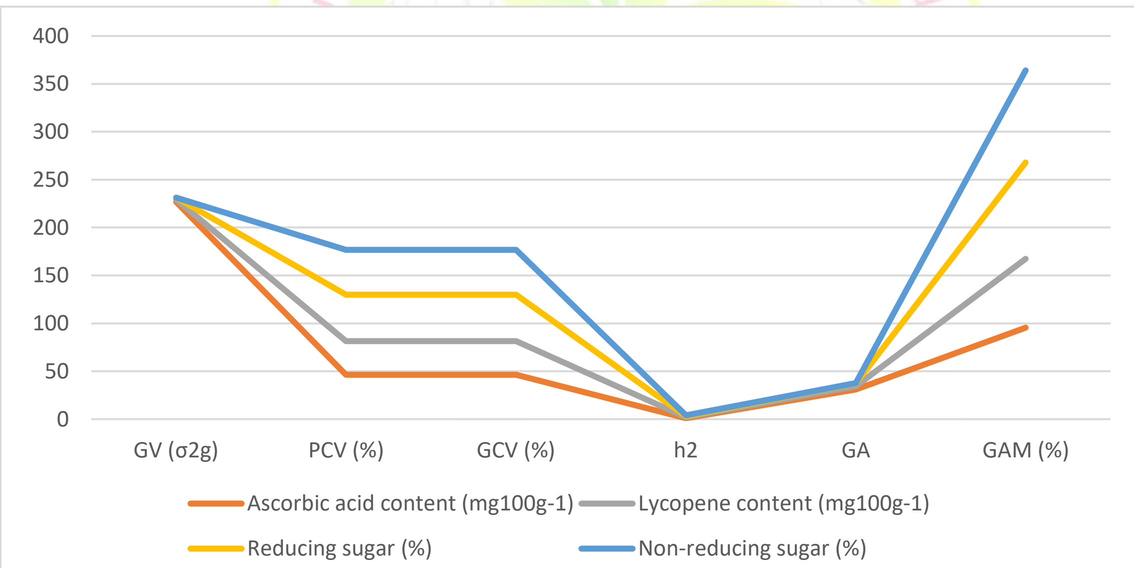

Table 1.0: Analysis of variance for growth, yield, and yield attributing traits in Cherry tomato.

Source of Variation	d.f	Plant height (cm)	Number of primary branches plant^{-1}	Days to first flowering	Days to first fruit set	Days to first fruit maturity	Number of clusters plant^{-1}	Number of flowers cluster^{-1}	Number of fruits cluster^{-1}
Replication	2	738.72**	9.12**	20.52**	20.52**	20.52**	20.52**	20.52**	20.52**
Treatment	56	970.34**	0.33**	33.23**	34.79**	34.31**	489.27**	4.20**	3.28**
Error	112	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

** Significant at 1 percent level.

Table 2.0: Analysis of variance for growth, yield, and yield attributing traits in Cherry tomato.

Source of Variation	d.f	Number of fruits plant^{-1}	Number of locules fruit^{-1}	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)	Pericarp thickness (mm)	Fruit yield plant^{-1} (Kg)	Fruit yield hectare^{-1} (q)
Replication	2	20.52**	0.18**	0.05**	0.05**	60.47**	0.05**	0.67**	74360.35**
Treatment	56	8061.83**	1.12**	0.56**	0.62**	634.09**	2.01**	1.34**	149277.65**
Error	112	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

** Significant at 1 percent level.

Table 3.0: Analysis of variance for quality traits in Cherry tomato.

Source of Variation	d.f	Dry matter content (%)	Total Soluble Solids (^{0}Brix)	Titratable acidity (%)	Ascorbic acid content (mg100g^{-1})	Lycopene content (mg100g^{-1})	Total sugars (%)	Reducing sugar (%)	Non-reducing sugar (%)	Juice to pulp ratio
Replication	2	0.05**	2.28**	0.05**	89.06**	0.01**	0.01**	0.01**	0.01**	0.05**
Treatment	56	14.87**	1.36**	0.04**	680.35**	7.48**	7.53**	6.05**	0.24**	1.67**
Error	112	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

** Significant at 1 percent level.

Table 4.0: Estimates of range, mean, components of variance, heritability, and genetic advance for growth, yield, and yield attributing traits in Cherry tomatoes.

Trait	Range		Mean	PV (σ^2p)	GV (σ^2g)	PCV (%)	GCV (%)	h^2	GA	GAM (%)
	Min.	Max.								
Plant height (cm)	113.60	185.40	146.66	323.45	323.45	12.26	12.26	1.00	37.05	25.60
Number of primary branches plant^{-1}	1.40	2.80	1.94	0.11	0.11	17.03	17.03	1.00	0.68	35.09
Days to first flowering	21.00	35.40	30.12	11.04	11.04	11.04	11.04	1.00	6.86	22.76
Days to first fruit set	39.60	53.80	48.75	11.60	11.60	6.98	6.98	1.00	7.02	14.39
Days to first fruit maturity	51.60	66.00	60.79	11.44	11.44	5.56	5.56	1.00	6.97	11.46
Number of clusters plant^{-1}	21.20	78.20	40.80	163.09	163.09	31.30	31.30	1.00	26.31	64.48
Number of flowers cluster^{-1}	5.20	10.60	8.00	1.40	1.40	14.79	14.79	1.00	2.44	30.47
Number of fruits cluster^{-1}	4.20	9.20	6.73	1.09	1.09	15.52	15.52	1.00	2.15	31.99
Number of fruits plant^{-1}	22.87	232.20	90.21	2687.28	2687.28	57.47	57.47	1.00	106.79	118.38
Number of locules fruit^{-1}	2.00	4.40	2.32	0.38	0.37	26.58	26.19	0.97	1.23	53.16
Fruit length (cm)	1.20	3.04	1.96	0.19	0.19	22.04	22.04	1.00	0.89	45.40
Fruit diameter (cm)	1.24	2.80	2.01	0.21	0.21	22.71	22.71	1.00	0.94	46.78
Average fruit weight (g)	5.92	59.34	25.74	211.36	211.36	56.49	56.49	1.00	29.95	116.37
Pericarp thickness (mm)	1.06	4.28	2.39	0.67	0.67	34.33	34.33	1.00	1.69	70.72
Fruit yield plant^{-1} (Kg)	0.45	3.08	1.80	0.45	0.45	37.13	37.04	1.00	1.37	76.10
Fruit yield hectare^{-1} (q)	149.02	1026.39	601.42	49927.78	49674.93	37.15	37.06	1.00	457.97	76.15

PV = Phenotypic variance, GV = Genotypic variance PCV= Phenotypic coefficient of variation, GCV= Genotypic coefficient of variation, h^2= heritability (broad sense), GA=Genetic advance, GAM= Genetic advance as percent of Mean.

Table 5.0: Estimates of range, mean, components of variance, heritability, and genetic advance for quality traits in Cherry tomato.

Trait	Range		Mean	PV	GV	PCV	GCV	h^2	GA	GAM
	Min.	Max.		(σ^2p)	(σ^2g)	(%)	(%)			(%)
Dry matter content (%)	5.39	14.85	9.22	4.96	4.96	24.14	24.14	1.00	4.59	49.72
Total Soluble Solids (⁰Brix)	8.30	11.00	9.80	0.45	0.45	6.86	6.86	1.00	1.39	14.12
Titratable acidity (%)	0.13	0.57	0.31	0.01	0.01	35.48	35.48	1.00	0.23	73.08
Ascorbic acid content ($mg100g^{-1}$)	13.75	70.00	32.45	226.78	226.78	46.40	46.40	1.00	31.02	95.58
Lycopene content ($mg100g^{-1}$)	1.20	8.57	4.52	2.49	2.49	34.91	34.91	1.00	3.25	71.92
Total sugars (%)	0.98	5.87	3.52	2.51	2.51	45.02	45.02	1.00	3.26	92.74
Reducing sugar (%)	0.68	4.88	2.91	2.02	2.02	48.78	48.78	1.00	2.93	100.48
Non-reducing sugar (%)	0.13	1.01	0.61	0.08	0.08	46.66	46.66	1.00	0.58	96.12
Juice to pulp ratio	1.22	4.62	2.52	0.56	0.56	29.62	29.62	1.00	1.54	61.01

V = Phenotypic variance, GV = Genotypic variance PCV= Phenotypic coefficient of variation, GCV= Genotypic coefficient of variation, h^2= heritability (broad sense), GA=Genetic advance, GAM= Genetic advance as percent of Mean.

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