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ASSESSMENT OF GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE FOR YIELD AND QUALITY RELATED TRAITS IN CHERRY TOMATO (*SOLANUM LYCOPERSICUM* L. VAR. *CERASIFORME*)

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ABSTRACT

A study was conducted during the rabi season of 2023-2024 at the Vegetable Research Farm, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.), to evaluate genetic diversity, heritability and genetic advance across sixteen traits in twenty-seven genotypes of cherry tomato. The analysis of variance revealed significant genetic variation among the genotypes, indicating considerable genetic diversity within the studied material. The findings highlight the potential of selective breeding to enhance the key traits. The phenotypic coefficient of variation (PCV) was generally higher than the genotypic coefficient of variation (GCV), indicating the presence of both genetic and environmental influences, though the relatively small difference suggests that genetic factors had a predominant role in the expression of the traits. Among the traits, lycopene content displayed the highest GCV (35.93%) and PCV (36.07%), followed by average fruit weight, pericarp thickness, and fruit yield per plant, suggesting that these traits exhibit a high degree of genetic diversity and are responsive to selection. The genetic advance (GA) as a percentage of the mean (GAM) was highest for lycopene content (73.71%), followed by average fruit weight (57.40%) and pericarp thickness (56.12%) coupled with the high heritability, indicates that these traits are likely to show significant improvement when subjected to selection.

Keywords : Coefficient of variation, heritability, genetic advance, cherry tomato.

Introduction

Cherry tomato (*Solanum lycopersicum* L. var. *cerasiforme*) is an ancestor of the cultivated tomatoes belonging to the solanaceae family. It is diploid having chromosome number of 2n=2X=24, and it believed to have originated in South America. The cherry tomato found in Peru, Central America and other related areas. They are grown in large area in Central American regions and expand all over California, Korea, Germany, Mexico, and Florida (Renuka *et al.,* 2014). China was the leading producer with 68.2 million tonnes, followed by India with 20.7 million tonnes. In India tomato is cultivated extensively across various agro-climatic zones and hols significant importance in both fresh market and processing sectors (FAO, 2024). The cherry tomato plant exhibits a vigorous, indeterminate growth pattern with robust, trailing branches. The foliage is smooth with a slight curl and the plants produces hermaphrodite flowers. The anthers dehiscence occurs one or two days after the petals have opened. The fruit, technically classified as a berry, develops in compact, branched clusters. These tomatoes are particularly rich in lycopene and carotene compounds known for their antioxidant, antibacterial, and detoxifying properties, which contribute to better intestinal health (Ramya *et al.,* 2016). Being a warm season crop they require extended growing periods and well- suited for protected cultivation like polyhouses (Vidyadhar *et al.,* 2014). As consumer demand for cherry tomatoes rises both in the fresh produce market and for processing purposes there is a pressing need to develop high yielding stress-resistant varieties adaptable to different agro-climatic conditions. While numerous studies have assessed cultivated tomatoes, cherry tomato have not been explored as extensively. With this objective, a study was undertaken to evaluate twenty-seven cherry tomato genotypes for their qualitative and quantitative traits under natural field conditions, aiming to identify promising lines for breeding and commercial cultivation.

Materials and Methods

The present investigation was carried out during the rabi season of 2023-2024 at the Vegetable Research Farm, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.), India using twenty-seven cherry tomato genotypes. The experiment followed the Randomized Block Design (RBD) with three replications. Uniform and healthy seedlings, four to five weeks old, were carefully uprooted from the nursery beds and treated with 0.1% bavistin solution for thirty minutes before transplanting. These treated seedlings were transplanted to main field, and the genotypes were evaluated for various traits under replicated conditions. The seedlings were transplanted into the main field with the spacing of 60cm × 60cm between the plants. Ten plants per genotype were allowed in each replication. In order to ensure good crop growth, the cultivation followed the tactics and guidelines that were recommended. Five randomly chosen plants from each plot were taken into consideration for recording observations for sixteen different yield and quality traits. The data were statistically analysed using analysis of variance (ANOVA), methodology outlined by (Panse and Sukhatme 1967) and using the formula developed by (Burton and De Vane 1953), the genotypic and phenotypic coefficients of variability for each traits were calculated. According to the guidelines of (Weber and Moorthy 1952) broad sense heritability was estimated and the genetic gain was computed using the method recommended by (Johnson *et al.*, 1955).

Results and Discussion

The variance analysis revealed significant differences between the several genotypes, suggesting that the genotypes used in the experiment exhibited a high degree of variability across a range of attributes. They are eligible for the further genetic research because of their diversity (Table-1). Lists the relative differences in variability between, several attributes (Table-2). Provides comprehensive results, for each of the sixteen traits, including a average values, range, phenotypic and genotypic coefficients of variation (PCV and GCV), broad-sense heritability (h^2), and predicted genetic advancement as a percentage of the mean (GAM).

Genotypic and Phenotypic coefficient of variation

For the majority of the traits among the twenty-seven genotypes of cherry tomato, the highest GCV and PCV estimates were obtained for the lycopene content (35.93%-36.07%), average fruit weight (28.69%-29.54%), pericarp thickness (27.89%-28.55%), fruit yield per plant (24.55%-25.96%), yield per hectare (24.42%-25.65%) and primary branches per plant (21.03%-23.02%). Moderate (10-20%) GCV and PCV estimates observed for. The higher values of PCV and GCV for the aforementioned traits denotes their significant genetic variability contribution, which suggests that parental lines selected based on these traits may be used in subsequent crossing programmes to produce high-quality transgressive segregants.

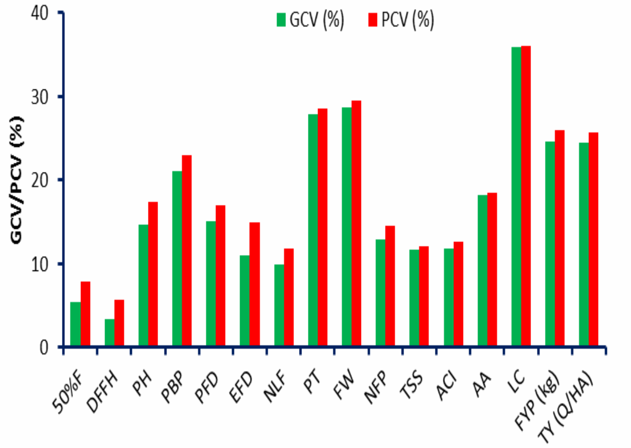

Fig. 1: Genotypic and Phenotypic coefficient of variation

Heritability and Genetic advance

Broad-sense heratability offers insight into the proportion of genetic versus environmental influence within a germplasm pool. In the currrent study, heritability values documented for several traits including lycopene content (99.21%), ascorbic acid (97.59%), pericarp thickness (95.42%), average fruit weight (94.31%), total soluble solids (93.62%), yield per hectare (90.64%), fruit yield per plant (89.43%), titratable acidity (87.60%), and number of primary branches (83.49%).These findings are consistent with the reports of (Shankar *et al.*, 2013), (Ligade *et al.,* 2017), and (Panchbhaiya *et al.,*2018). The substantial heritability values imply that these traits were less influenced by environmental factors. The observed genetic advancement ranged widely across all traits ranging from (4.05%) to (73.71%). The greatest value was observed for lycopene content (73.71%), average fruit weight (57.40%), pericarp thickness (56.12%), fruit yield per plant (47.82%). Genetic advance as a percent of mean (genetic gain) ranged from 0.14% to 97.19%. Notably, the highest values were noted for yield per hectare (97.19%), number of fruits per plant (55.15%), plant height (38.15%) and ascorbic acid (12.40%). The high genetic advance in lycopene content is particularly noteworthy, given the increasing demand for biofortified tomatoes with higher antioxidant content. Similarly, average fruit weight and pericarp thickness are essential traits for improving fruit quality, and the high genetic advance in these characteristics suggests that effective genetic improvements can be made through selection.

For instance, (Bhattarai *et al.* 2016) reported high heritability and genetic advance for fruit quality traits, including lycopene content and fruit size, in cherry tomato genotypes. (Dhaka *et al.* 2017) also found high genetic variability and heritability for yield-related traits in cherry tomatoes, which underscores the potential for improving fruit yield and quality in this crop. Furthermore, (Sharma *et al.* 2014) emphasized the importance of high heritability and genetic advance in traits like fruit weight and pericarp thickness for enhancing tomato breeding programs, particularly in small-fruited varieties like cherry tomatoes. For traits such as days to first fruit harvest and equatorial fruit diameter, the heritability values were relatively lower, the more advanced breeding strategies, such as marker-assisted selection, may be needed to achieve desired improvements. Similarly, average fruit weight and pericarp thickness are essential traits for improving fruit quality, and the high genetic advance in these characteristics suggests that effective genetic improvements can be made through selection.

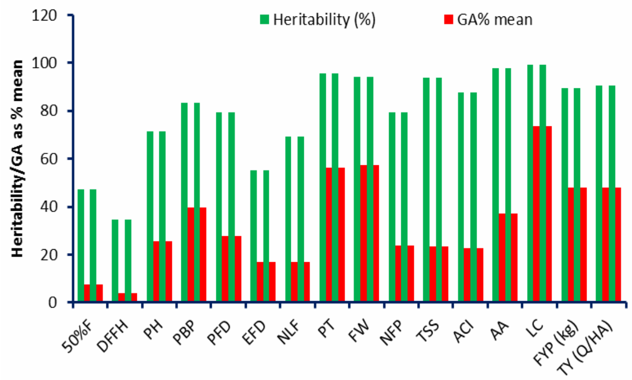

Fig. 2: Heritability and Genetic advance

Conclusion

The current study showed that the experimental material had a significant exploitable variability in sixteen yield and quality related traits. The phenotypic coefficient of variation (PCV) was generally higher than the genotypic coefficient of variation (GCV), indicating the presence of both genetic and environmental influences, though the relatively small difference suggests that genetic factors had a predominant role in the expression of the traits. Overall, the genetic variability, high heritability, and substantial genetic advance observed in traits like lycopene content, fruit weight, and pericarp thickness suggest that these traits offer significant potential for improvement through conventional breeding methods in cherry tomatoes.

Table 1 : ANOVA table for various characters in cherry tomato germplasm.

S. No.	Characters	Source of variation		
		Replication	**Treatment**	**Error**
	Degree of freedom	2	26	52
1.	Days to 50% flowering	0.48	13.70**	3.74
2.	Days to first harvest	5.95	29.00**	11.21
3.	Plant height(cm)	401.43	1630.76**	191.48
4.	Number of primary branches per plant	0.003	3.505**	0.217
5.	Polar diameter of fruit(cm)	0.051	0.767**	0.062
6.	Equatorial diameter of fruit(cm)	0.011	0.365**	0.078
7.	Number of locules per fruit	0.004	0.221**	0.029
8.	Pericarp thickness (mm)	0.016	0.469**	0.007
9.	Average fruit weight (g)	0.146	3.167**	0.062
10.	Number of fruits per plant	331.61	2945.35**	235.21
11.	TSS (□ Brix)	0.005	1.730**	0.038
12	Titrable acidity (%)	0.001	0.017**	0.001
13	Ascorbic acid (mg/100g)	0.087	112.23**	0.91
14.	Lycopene content (mg/100gm)	0.004	6.286**	0.017
15.	Fruit yield per plant(kg)	0.043	0.128**	0.005
16.	Fruit yield (q/ha)	196.88	7621.03**	253.74

*, ** significant at 5% and 1% level, respectively

Table 2 : Genetic variability and genetic advance for inter-traits relationship in cherry tomato

Characters	Mean	Min	Max	var (g)	var (p)	Heritability (%)	GA	GA% mean	GCV (%)	PCV (%)
50% flowering	33.93	29.67	38.00	3.32	7.06	47.05	2.57	7.59	5.37	7.83
Days to first fruit harvest	72.82	67.00	80.67	5.93	17.14	34.60	2.95	4.05	3.34	5.68
Plant hight (cm)	149.34	120.47	206.18	479.76	671.24	71.47	38.15	25.54	14.67	17.35
Primary branches per plant	4.98	3.80	7.31	1.10	1.31	83.49	1.97	39.59	21.03	23.02
Polar fruit diameter (cm)	3.22	2.34	4.23	0.24	0.30	79.21	0.89	27.65	15.08	16.94
Eequatorial fruit diameter (cm)	2.80	2.16	3.60	0.10	0.17	55.32	0.47	16.96	11.07	14.88
Number of locule per fruit	2.57	2.10	3.34	0.06	0.09	69.16	0.43	16.90	9.87	11.86
Pericarp thickness(mm)	1.41	0.66	2.18	0.15	0.16	95.42	0.79	56.12	27.89	28.55
9. Average fruit weight (g)	3.55	2.01	6.96	1.03	1.10	94.31	2.04	57.40	28.69	29.54
10. Number of fruit per plant	232.96	137.90	272.97	903.38	1138.59	79.34	55.15	23.67	12.90	14.48
Total soluble solids (Brix)	6.39	5.00	7.98	0.56	0.60	93.62	1.50	23.42	11.75	12.14
Titrable acidity(%)	0.62	0.44	0.76	0.01	0.01	87.60	0.14	22.78	11.81	12.62
Ascorbic acid (mg/100g fruit)	33.36	22.99	43.59	37.11	38.02	97.59	12.40	37.16	18.26	18.48
Lycopene content(mg/100g fruit)	4.02	1.96	6.78	2.09	2.11	99.21	2.97	73.71	35.93	36.07
fruit yield per plant (kg)	0.82	0.39	1.21	0.04	0.05	89.43	0.39	47.82	24.55	25.96
yield per hectare (q)	202.94	95.45	313.79	2455.77	2709.50	90.64	97.19	47.89	24.42	25.65

DF-50 % flowering, **DFFH-**Days to first fruit harvest, **PH-**Plant height, **PBP-**Primary branches per plant, **PFD-**Polar fruit diameter (cm), **EFD-**Equatorial fruit, diameter, **NLF-**Number of locule per fruit, **PT-**Pericarp thickness (mm), **FW-**Average fruit weight (g), **NFT-**Number of fruit per plant, **TSS-**Total soluble solids (Brix), **ACI-**Titrable acidity (%), **AA-**Ascorbic acid (mg/100g fruit), **LC-**Lycopene content (mg/100g fruit), **FYP-**fruit yield per plant (kg), **TY-**yield per hectare (q)

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