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STUDY OF GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE FOR INTER-TRAITS RELATIONSHIP FOR YIELD AND QUALITY TRAITS IN CHERRY TOMATO (*SOLANUM LYCOPERSICUM* L. VAR. *CERASIFORME*)

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ABSTRACT

The Experiment was conducted during the autumn-winter season of 2023–24 at the Main Experimental Station of Acharya Narendra Deva University of Agriculture & Technology in Kumarganj, Ayodhya, Uttar Pradesh, India. The aim was to assess the genetic diversity among twenty-eight cherry tomato genotypes including a standard check variety, (*Solanum lycopersicum* L. var. *cerasiforme*) using sixteen traits. The field experiment followed a randomized block design with three replications. The study emphasized identifying genotypes with potential for yield enhancement and improved nutritional quality, focusing particularly on heritability and genetic gain. Analysis of variance (ANOVA) revealed significant differences across all evaluated traits, indicating substantial genetic variability in phenological, morphological, yield, and quality parameters. Among the genotypes, NDCT-23-2 stood out for its superior yield, while NDCT-23-17 was notable for early fruit maturity. Significant variation was also observed in nutritional traits such as lycopene and ascorbic acid content, underscoring their importance in improving fruit quality. Heritability estimates ranged from 45.51% (days to first fruit harvest) to 99.26% (ascorbic acid), demonstrating a strong genetic component in several traits. High heritability combined with substantial genetic advance in traits like fruit yield per plant, lycopene concentration, and average fruit weight suggests these can be effectively targeted through direct selection. Conversely, traits with lower heritability may require more intricate breeding strategies. In summary, the findings underscore the genetic improvement potential in cherry tomato and provide valuable insights for breeding programs focused on developing high-yielding and nutritionally enhanced varieties.

Keywords: cherry tomato, genetic variability, heritability, genetic advance.

Introduction

Cherry tomato (*Solanum lycopersicum* L. var. *cerasiforme*) is considered the progenitor of all modern cultivated tomato varieties, possessing a diploid chromosome number of 2n = 24. Originally native to tropical and subtropical regions of the Americas, it later spread to the tropical zones of Asia and Africa (Gharezi *et al*., 2012). This crop thrives in warm climates, demonstrating tolerance to heat and drought, and adapts well to diverse soil types and environmental conditions, making it highly suitable for cultivation in protected environments. Due to its rising popularity and consumer preference, cherry tomatoes command higher market prices than conventional tomato varieties (Vidyadhar *et al*., 2014).

Characterized by small, bright red fruits with a distinctive cherry-like appearance and appealing flavour, cherry tomatoes are favoured for fresh consumption and are also processed into products such as juice, sauce, ketchup, puree, paste, canned tomatoes, and condiments like pickles and chutneys when harvested green (Charlo *et al.,* 2007). Additionally, they serve as raw material for industrial products like tomolive and tomatine, which hold commercial significance (Venkadeswaran *et al.,* 2018).

The plant typically exhibits indeterminate growth with vigorous, trailing branches and slightly curled flat leaves. Its fruits, botanically classified as berries, grow in clusters and range in size from that of a fingertip to a golf ball, varying in shape from round to mildly oblong. The flowers are perfect and hermaphroditic (Prema *et al.,* 2011). Across India, cherry tomato genotypes display extensive genetic diversity in terms of horticultural traits such as fruit size, shape, colour, growth pattern, and yield potential. Given its commercial value and adaptability, there is a strong need for genetic improvement to develop varieties tailored to specific agro-ecological conditions and intended uses. Therefore, this study aimed to assess the degree of genetic variation among different cherry tomato genotypes to support targeted crop improvement strategies.

Materials and Methods

The research was carried out during the 2023–2024 rabi season at the Main Experimental Station of Acharya Narendra Deva University of Agriculture and Technology, situated in Kumarganj, Ayodhya, Uttar Pradesh, India. The study involved twenty-eight cherry tomato genotypes, including a standard check variety, exhibiting growth habits ranging from semi-determinate to indeterminate. These genotypes were assessed under open-field conditions.

The experiment was conducted in Randomized Block Design (RBD) with three replicates per genotype was used for the experiment. Seeds were first raised in nursery beds, and the seedlings were subsequently transplanted into the main field with a plant spacing of 60 cm × 60 cm. Each experimental plot contained 10 plants. Standard agronomic practices were followed throughout the crop cycle to ensure proper management.

Data collection encompassed a variety of traits. Quantitative traits recorded included days to 50% flowering, number of primary branches per plant, days to first fruit harvest, fruit dimensions (polar and equatorial diameters), number of locules per fruit, pericarp thickness, average fruit weight, number of fruits per plant, fruit yield per plant, fruit yield per hectare, and plant height. Qualitative traits measured were total soluble solids (°Brix), titratable acidity, ascorbic acid content, and lycopene concentration. For each replicate, observations were made on five randomly selected plants, while fruit-related data were collected from five randomly chosen fruits.

Results and Discussion

This study aimed to examine genetic variability, heritability, and the potential for genetic improvement among twenty-eight cherry tomato genotypes by evaluating sixteen qualitative and quantitative traits. Provides comprehensive results for each of the sixteen qualities in (Table 1 and 2) including average values, range, phenotypic and genotypic coefficients of variation (PVC and GCV), broad-sense heritability (h^2), and predicted genetic advancement as a percentage of the mean (GAM).

Analysis of Variance (ANOVA)

The ANOVA findings revealed highly significant differences among the twenty-eight genotypes across all sixteen traits studied, as indicated by the treatment mean squares (Table 1). This significant variation in growth, morphological, quality, and yield-related characteristics demonstrates a considerable scope for selection and breeding enhancement in cherry tomato improvement efforts.

Genotypic and Phenotypic coefficient of variation

For the majority of the traits among the twenty-eight genotypes of cherry tomato, the highest GCV and PCV estimates were obtained, *viz*., the average fruit weight (45.09% and 45.79%) and lycopene content (35.69% and 35.82%), fruit yield per plant (33.82% and 34.29%), yield per hectare (33.27% and 33.69%), number of locules (29.72% and 30.59%) and primary branch per plant (20.43% and 21.96%). Moderate (10–20%) PCV and GCV estimates were observed for ascorbic acid (18.17% and 18.24%), plant height (13.87% and 15.39%), total soluble solid (13.40% and 13.55%), titrable acidity (13.02% and 13.83%), number of fruits per plant (12.36% and 14.63%) and polar fruit diameter (10.65% and 12.61%). The higher values of PCV and GCV for the aforementioned traits denote their significant genetic variability contribution, which suggests that parental lines selected based on these features may be used in subsequent crossing programmes to produce high-quality transgressive segregants.

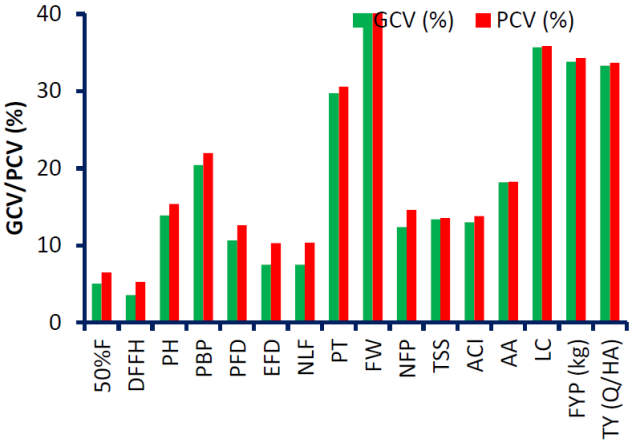

Fig. 1: Genotypic and Phenotypic coefficient of variation

Heritability and Genetic Advance

Broad-sense heritability offers insight into the proportion of genetic versus environmental influence within a germplasm population. In the present study, heritability estimates ranged from 45.51% for days to first fruit harvest to 99.26% for ascorbic acid content (mg/100g), as shown in Table 3. Following the classification by Warshamana (2005), traits were grouped into high (>80%), moderate (50–80%), and low (<50%) heritability categories. Traits such as ascorbic acid (99.26%), lycopene (99.25%), total soluble solids (97.74%), yield per hectare (97.51%), fruit yield per plant (97.26%), average fruit weight (96.97%), pericarp thickness (94.44%), titratable acidity (88.73%), number of primary branches (86.53%), and plant height (81.24%) exhibited high heritability. Moderate heritability was noted for polar fruit diameter (71.37%), number of fruits per plant (71.37%), 50% flowering (59.98%), equatorial diameter (53.14%), and number of locules (52.67%). The trait with the lowest heritability was days to first fruit harvest (45.51%).

Genetic advance as a percentage of the mean (GA%) is a vital measure in plant breeding, as it reflects the effectiveness of selection strategies in enhancing desirable traits (Pooja *et al.,* 2022). A high GA% paired with substantial heritability indicates a greater likelihood of achieving genetic progress through selection (Eppakayala *et al.,* 2021). In the current study, traits such as average fruit weight (91.46%), lycopene content (73.23%), fruit yield per plant (68.70%), yield per hectare (67.67%), and pericarp thickness (59.50%) demonstrated both high GA% and heritability, suggesting strong potential for selection. This combined assessment is more predictive of breeding outcomes than heritability alone, aiding in the identification of promising genotypes (Shankar *et al.,* 2013). The notable correlation between high GA% and heritability in average fruit weight implies the predominance of additive gene effects, enhancing the efficiency of selection for this trait (Mahebub *et al.*, 2021). Moderate GA% values were noted for traits like the number of primary branches per plant (39.15%) and ascorbic acid content (37.30%), indicating that selection on an individual plant basis can still contribute to genetic gains. Conversely, traits such as total soluble solids (27.29%), plant height (25.75%), titratable acidity (25.26%), number of fruits per plant (21.51%), polar diameter (18.54%), equatorial diameter (11.27%), number of locules per fruit (11.25%), days to 50% flowering (8.03%), and days to first fruit harvest (4.95%) exhibited lower GA% despite moderate to high heritability. In these cases, hybridization may be required to enhance genetic variability, thereby improving the effectiveness of selection (Behera *et al*., 2020). Specifically, genetic gain values range from (0.16% to 138.72%). Notably, traits such as yield per hectare (138.72%), number of fruits per plant (47.96%) and plant height (38.55%), ascorbic acid (12.56%). These observations align with the findings reported by Shankar *et al.* (2013), Ligade *et al.* (2017), and Panchbhaiya *et al.* (2018). heritability values for all traits exceeded their genetic advance as a percentage of the mean values, underscoring their relatively minor susceptibility to environmental variations and affirming that the observed phenotypes genuinely represented the genotypes, thus establishing the credibility of phenotypic-based selection.

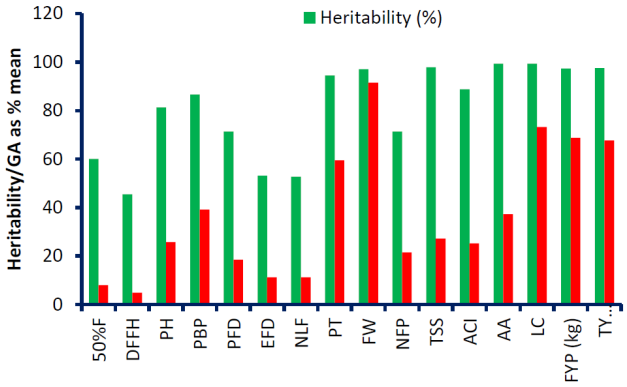

Fig. 2: Heritability and Genetic Advance

Conclusion

The current cherry tomato study showed that the subject material had significant exploitable variability in 16 yield and quality related characteristics. This suggests a significant chance to improve genetics via hybridization and selection. The study also showed that the expression of yield and its main components was significantly influenced by both additive and non-

additive genetic variables. High GCV, significant heritability, and genetic progress relative to the mean were seen for the majority of the examined variables. This suggests that additive genetic factors have a dominant role in determining how these traits manifest and presents a possible path toward genetic improvement via phenotypic selection.

Table 1 : ANOVA table for various characters in cherry tomato genotypes

S. No.	Characters	Source of variation		
		Replication	Treatment	Error
	Degree of freedom	2	26**	52
1.	Days to 50% flowering	1.53	10.43**	1.90
2.	Days to first harvest	5.58	25.67**	7.32
3.	Plant height(cm)	366.77	1392.72**	99.54
4.	Number of primary branches per plant	0.095	2.991**	0.148
5.	Polar diameter of fruit(cm)	0.190	0.385**	0.045
6.	Equatorial diameter of fruit(cm)	0.026	0.164**	0.037
7.	Number of locules per fruit	0.267	0.153**	0.035
8.	Pericarp thickness (mm)	0.016	0.543**	0.010
9.	Average fruit weight (g)	0.081	9.177**	0.095
10.	Number of fruits per plant	136.99	2582.71**	304.63
11.	Total Soluble Solid (^{0}Brix)	0.081	2.196**	0.017
12	Titrable acidity (%)	0.002	0.021**	0.001
13	Ascorbic acid (mg/100g)	0.14	112.58**	0.28
14.	Lycopene content (mg/100gm)	0.015	6.625**	0.017
15.	Fruit yield per plant(kg)	0.003	0.241**	0.002
16.	Fruit yield (q/ha)	331.45	14069.46**	118.52

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

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

Characters	Mean	Min	Max	var (g)	var (p)	Heritability (%)	Genetic Gain %	GA% mean	GCV (%)	PCV (%)
50% flowering	33.53	29.67	36.67	2.84	4.74	59.98	2.69	8.02	5.03	6.49
Days to first fruit harvest	69.38	63.33	74.67	6.12	13.44	45.51	3.44	4.95	3.56	5.28
Plant hight (cm)	149.71	120.70	185.44	431.06	530.60	81.24	38.55	25.75	13.87	15.39
Primary branches per plant	4.77	3.70	7.40	0.95	1.10	86.53	1.87	39.15	20.43	21.96
Polar fruit diameter (cm)	3.16	2.73	4.22	0.11	0.16	71.37	0.59	18.54	10.65	12.61
Equatorial fruit diameter (cm)	2.74	2.14	3.15	0.04	0.08	53.14	0.31	11.27	7.50	10.29
Number of locule per fruit	2.63	2.24	3.25	0.04	0.07	52.67	0.30	11.25	7.53	10.37
Pericarp thickness (mm)	1.42	0.58	2.42	0.18	0.19	94.44	0.84	59.50	29.72	30.59
Average fruit weight (g)	3.86	1.63	8.35	3.03	3.12	96.97	3.53	91.46	45.09	45.79
Number of fruits per plant	222.95	151.15	266.74	759.36	1063.99	71.37	47.96	21.51	12.36	14.63
Total soluble solids (Brix)	6.36	4.08	8.00	0.73	0.74	97.74	1.74	27.29	13.40	13.55
Titrable acidity (%)	0.63	0.44	0.78	0.01	0.01	88.73	0.16	25.26	13.02	13.82
Ascorbic acid (mg/100g fruit)	33.66	23.00	43.76	37.43	37.72	99.26	12.56	37.30	18.17	18.24
Lycopene content (mg/100g fruit)	4.16	1.95	6.80	2.20	2.22	99.25	3.05	73.23	35.69	35.82
fruit yield per plant (kg)	0.83	0.45	1.43	0.08	0.08	97.26	0.57	68.70	33.82	34.29
yield per hectare (q)	204.99	104.51	343.75	4650.31	4768.83	97.51	138.72	67.67	33.27	33.69

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), **PY-**yield per hectare (q)

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