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Studies on Genetic Diversity and Interdependence of Growth and Quality Traits in Cherry Tomato [*Solanum lycopersicum* (L.) var *cerasiforme* Mill.]

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ABSTRACT

Background: Cherry tomato [*Solanum lycopersicum* (L.) var. *cerasiforme* Mill.] belonging to Solanaceae family, having chromosome number 2n=2x=24 is a table purpose tomato with small fruits of bright red colour bearing resemblance to a cherry. With ever increasing demand of cherry tomato in both fresh market and processing industries there is a need to make the crop both agronomically and economically more desirable. Therefore, cherry tomatoes present great future in breeding programmes for bringing about the required improvements and hence it is necessary to evaluate the germplasm and select genotypes which are high yielding and disease resistant.

Methods: Genetic diversity for growth and quality traits in twenty four genotypes of cherry tomato was studied under mid hills of Kullu valley (32.2°N latitude 77°E longitude), Himachal Pradesh during *kharif* season of 2020. Observations with respect to morphological and physicochemical characters were recorded on five randomly selected plants from each plot in each replication and their means were worked out for statistical analysis.

Result: The genetic variability in general indicated that phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the characters studied; however, the difference was very narrow. For number of branches per plant, days to per cent flowering, number of cluster per plant number of seeds per plant, total soluble solids (TSS) and titratable acidity the difference was very high, indicating the role of environment in expression of these characters. The heritability and genetic gain were high for number of fruits per cluster and fruit yield per plant. High heritability along with moderate genetic gain was observed for total number of fruits per plant and average fruit weight. Fruit yield per plant had significant and positive correlation with total number of fruits per plant, number of fruit clusters, average weight, pericarp thickness and titratable acidity. Positive direct effect on fruit yield per plant was highest from total number of fruits per plant followed by pericarp thickness, days to 50 per cent flowering, plant height, TSS, number of branches, titratable acidity, average fruit weight, fruit shape index and number of seeds. Based on analysis of genetic divergence through Mahalanobis D^2 statistics, the genotypes were divided into four different clusters and the cluster III and IV had the genotypes with the requisite traits for future improvement of yield.

Key words: Advance, Cherry tomato, Coefficient, Genetic, Heritability.

INTRODUCTION

Cherry tomato [*Solanum lycopersicum* (L.) var. *cerasiforme* Mill.] having chromosome number 2n=2x=24 belongs to Solanaceae family and considered to be the ancestor of cultivated tomato. It is one of the most important warm-season fruit vegetable cultivated all over the world. It is an important crude material for different processed products such as juice, ketchup, sauce, pickles, chutneys, canned fruits, puree, paste *etc.* The wild cherry tomato was first found throughout tropical and subtropical America and then propagated in the tropics of Asia and Africa (Gharezi *et al.,* 2012). The wild relatives of tomato have significant genetic diversity for important quality attributes such as color, texture, aroma and flavour (Miller and Tanksley, 1990). Thus, the presence of wide and valuable genetic diversity provides a great potential in breeding programs for selection of parental materials. Cherry tomato has various pharmaceutical properties and is advantageous for body in general. It has the potential of becoming a valuable cash crop. Its value has increased in the retail chains and is being sold at higher prices in comparison to regular tomatoes. The fundamental requirement for the incorporation of desirable characters is the knowledge of genetic variability already existing in the population with respect to those

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characters. Therefore, the study was aimed to evaluate different genetic parameters such as coefficients of variability, heritability, genetic gain and genetic diversity in cherry tomato for growth, yield and quality.

MATERIALS AND METHODS

The field experiment was conducted under the mid hill conditions in the research farm of Regional Horticultural Research and Training Station, Bajaura, Kullu, HP, located at 1090 m above mean sea level, between 32.2°N latitude 77°E longitude during 2021-22. Twenty four cherry tomato genotypes namely EC2791, EC2795, EC2796, EC2798, EC7911, EC7912, EC10662, EC10664, EC521074, EC16778, EC521079, EC27251, EC139040, EC139041, EC139042, EC164650, EC164658, EC164660, EC177370, EC521044, EC521045, EC521076, EC531802 and EC531803 and the check variety were planted in a randomized block design with three replications. Transplanting was done at a spacing of 90 cm × 30 cm and fourteen characters of selected plants for each genotype and replication were analyzed for variance as per Panse and Sukhatme (1957). The phenotypic and genotypic coefficients of variability and heritability in the broad sense was calculated and expressed in per cent by the method given by Burton and De-Vane (1953) and Allard (1960). The method proposed by Johnson *et al.* (1955) was used to estimate genetic gain. The phenotypic and genotypic coefficients of correlation were calculated based on the method advocated by Al-Jibouri *et al.* (1958). Dewey and Lu (1959) method was used to work out the direct and indirect effects. The genetic divergence was estimated by using Mahalanobis D^2 statistics (1936).

RESULTS AND DISCUSSION

The efficiency of selection depends on the nature and extent of genetic variability and degree of transmissibility of desirable characters. The genetic variability (Table 1) in general indicated that phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the traits; however, the difference was very narrow for most of the traits suggesting the less influence of environment on expression of these traits. The phenotypic and genotypic coefficients of variation were high (>30%) for number of fruits per cluster and fruit yield per plant which suggested a higher phenotypic as well as genotypic variation among the genotypes and their acceptance for these traits for further improvement with selection. However, for number of branches per plant, days to 50% flowering, number of cluster per plant, number of seeds per fruit, total soluble solids (TSS) and titratable acidity the difference between PCV and GCV was high, indicating the role of environment in controlling the expression of these characters. These results were in consonance with Prema *et al.* (2011); Doddamani *et al.* (2017) and Renuka *et al.* (2017).

The heritability in broad sense (Table 1) was recorded from 43.49% to 97.59% for different parameters under the study. High broad sense heritability (>80%) was observed for characters *viz.*, number of fruits per plant, average fruit weight, fruit yield per plant, pericarp thickness, plant height and number of fruits per cluster. These high estimates of heritability indicated that these characters were least influenced by the environment. Moderate heritability (50%-80%) was observed for characters *viz.*, number of branches, number of clusters, fruit shape index, days to 50% flowering, TSS, number of seeds per fruit and days to first harvest. Low heritability was recorded for titratable acidity. Similar results were found in the studies conducted by Prema *et al.* (2011); Renuka *et al.* (2017) and Thakur (2020).

The genetic advance as per cent of mean (GAM) *i.e.*, genetic gain (Table 1) ranged from 3.88% (days to first harvest) to 63.84% (fruits yield per plant). Higher estimates of

Table 1: Estimation of phenotypic and genotypic coefficients of variation, heritability, genetic advance and genetic gain for various traits in cherry tomato.

Characters	Mean	Range	Coefficient of variability		Heritability	Genetic	Genetic
			Phenotypic	Genotypic	(Broad sense) (%)	advance	gain (%)
Days to 50% flowering (DAT)	20.99	18.33-32.67	15.67	12.34	62.01	4.20	20.02
Plant height (cm)	139.01	114.67-158.33	7.68	7.27	89.62	19.71	14.18
No. of branches	7.46	5.83-9.67	14.09	12.52	78.99	1.71	22.92
Days to first harvest (DAT)	69.61	67.67-78.33	3.54	2.58	53.22	2.70	3.88
Number of fruits per plant	164.40	93.33-239.67	22.18	21.91	97.59	73.31	44.59
Number of fruits per cluster	8.81	6.66-21.33	33.89	31.11	84.22	5.18	58.81
Number of clusters	20.34	12.33-29.58	21.85	18.38	70.77	6.48	31.85
Average fruit weight (g)	14.49	7.50-18.83	19.08	18.77	96.71	5.51	38.02
Pericarp thickness (mm)	2.79	2.07-3.33	11.47	11.07	93.12	0.62	22.00
Fruit shape index	0.92	0.75-0.99	7.92	6.47	66.68	0.10	10.88
No. of seeds per fruit	64.17	33.63-90.18	28.42	21.61	57.78	21.71	33.83
Total soluble solids (°B)	5.64	4.98-7.32	12.60	9.63	58.38	0.86	15.15
Titratable acidity (%)	0.50	0.30-0.62	22.39	14.77	43.49	0.10	20.06
Fruit yield per plant (kg)	1.96	0.82-2.89	32.07	31.52	96.64	1.25	63.84

Table 2: Genotypic and phenotypic coefficients of correlation among different traits in cherry tomato.

Characters		Plant height (cm)	No. of branches	Days to first harvest	No. of fruits per plant	No. of fruits per cluster	No. of clusters	Average fruit weight (g)	Pericarp thickness (mm)	Fruit shape index	No. of seeds per fruit	Total soluble solids (°B)	Titratable acidity (%)	Fruit yield per plant (kg)
Days to 50%	G	-0.43*	-0.46*	0.97*	-0.40*	0.10	-0.51*	-0.21	-0.18	0.38*	0.34*	0.32*	-0.37*	-0.51*
flowering	P	-0.34*	-0.35*	0.93*	-0.31*	0.03	-0.28*	-0.17	-0.16	0.24*	0.27*	0.16	-0.15	-0.40*
Plant height	G		-0.12	-0.51*	0.05	0.04	0.01	0.24*	0.22	-0.20	-0.04	-0.05	0.06	0.22
(cm)	P		0.03	-0.36*	0.06	0.03	0.02	0.22*	0.21	-0.15	-0.01	-0.06	0.08	0.22
No. of	G			-0.39*	0.28*	0.08	0.19	-0.03	-0.02	-0.35*	-0.27*	-0.34*	0.38*	0.22
branches	P			-0.26*	0.26*	0.05	0.16	-0.03	-0.01	-0.26*	-0.18	-0.27*	0.28*	0.21
Days to first	G				-0.43*	0.10	-0.58*	-0.26*	-0.23*	0.43*	0.39*	0.33*	-0.42*	-0.55*
harvest	P				-0.32*	-0.03	-0.24*	-0.19	-0.18	0.18	0.28*	0.14	-0.14	-0.41*
No. of fruits	G					0.60*	0.49*	-0.23*	-0.20	-0.22	-0.45*	-0.08	0.17	0.61*
per plant	P					0.56*	0.42*	-0.22	-0.19	-0.15	-0.33*	-0.06	0.11	0.61*
No. of fruits	G						-0.38*	-0.53*	-0.50*	0.08	-0.42*	0.54*	-0.48*	-0.04
per cluster	P						-0.48*	-0.49*	-0.45*	0.12	-0.27*	0.34*	-0.25*	-0.03
No. of clusters	G							0.30*	0.30*	-0.27*	-0.07	-0.59*	0.65*	0.72*
	P							0.27*	0.25*	-0.26*	-0.06	-0.32*	0.30*	0.62*
Average fruit	G								0.99*	-0.41*	0.47*	-0.50*	0.51*	0.62*
weight (g)	P								0.98*	-0.36*	0.38*	-0.40*	0.36*	0.62*
Pericarp	G									-0.42*	0.44*	-0.48*	0.50*	0.62*
thickness (mm)	P									-0.36*	0.34*	-0.38*	0.35*	0.62*
Fruit shape	G										0.07	0.32*	-0.34*	-0.52*
index	P										-0.01	0.22	-0.20	-0.42*
No. of seeds	G											0.09	-0.18	0.043
per fruit	P											-0.06	0.04	0.056
Total soluble	G												-0.99*	-0.57*
solids (°B)	P												-0.97*	-0.44*
Titratable	G													0.63*
acidity (%)	P													0.44*

Table 3: Estimates of direct and indirect effects of different traits on yield of cherry tomato.

Characters	Days to 50% flowering	Plant height (cm)	No. of branches	Days to first harvest	No. of fruits per plant	No. of fruits per cluster	No. of clusters	Average fruit weight (g)	Pericarp thickness (mm)	Fruit shape index	No. of seeds per fruit	Total soluble solids (°B)	Titratable acidity (%)	Genotypic correlation coefficient with fruit yield/Plant
Days to 50% flowering	0.208	-0.032	-0.027	-0.103	-0.676	-0.100	0.316	-0.008	-0.114	0.012	0.010	0.022	-0.014	-0.506
Plant height (cm)	-0.090	0.073	-0.007	0.054	0.092	-0.036	-0.007	0.009	0.144	-0.006	-0.001	-0.003	0.002	0.224
No. of branches	-0.096	-0.009	0.059	0.041	0.465	-0.080	-0.118	-0.001	-0.010	-0.011	-0.008	-0.024	0.015	0.224
Days to first harvest	0.203	-0.038	-0.023	-0.106	-0.719	-0.102	0.360	-0.010	-0.152	0.014	0.012	0.023	-0.016	-0.553
No. of fruits per plant	-0.084	0.004	0.016	0.045	1.680	-0.584	-0.307	-0.008	-0.133	-0.007	-0.013	-0.006	0.006	0.609
No. of fruits per cluster	0.021	0.003	0.005	-0.011	1.010	-0.972	0.236	-0.019	-0.323	0.003	-0.012	0.037	-0.019	-0.042
No. of clusters	-0.105	0.001	0.011	0.061	0.829	0.368	-0.623	0.011	0.196	-0.009	-0.002	-0.041	0.025	0.722
Average fruit weight (g)	-0.043	0.018	-0.002	0.027	-0.380	0.514	-0.186	0.037	0.646	-0.013	0.014	-0.034	0.020	0.618
Pericarp thick ness (mm)	-0.037	0.016	-0.001	0.025	-0.345	0.483	-0.188	0.037	0.649	-0.013	0.013	-0.033	0.019	0.625
Fruit shape index	0.079	-0.014	-0.020	-0.045	-0.363	-0.077	0.169	-0.015	-0.275	0.032	0.002	0.022	-0.013	-0.519
No. of seeds per fruit	0.070	-0.003	-0.016	-0.042	-0.755	0.406	0.046	0.017	0.287	0.002	0.029	0.006	-0.007	0.043
Total soluble solids (°B)	0.067	-0.004	-0.020	-0.035	-0.138	-0.521	0.371	-0.018	-0.312	0.010	0.003	0.069	-0.039	-0.567
Titratable acidity (%)	-0.077	0.004	0.022	0.044	0.280	0.469	-0.402	0.019	0.321	-0.010	-0.005	-0.069	0.039	0.633

genetic gain (more than 50 per cent) were observed for fruit yield per plant and number of fruits per cluster which explained the possibility to make a large extent of improvement. Moderate genetic gain was observed for number of fruits per plant, average fruit weight, number of seeds per fruit and number of clusters per plant. Whereas low genetic gain was reported for days to first harvest, fruit shape index, plant height, TSS, days to 50% flowering, titratable acidity, pericarp thickness and number of branches. These results were found to be in accordance with the results of Aralikatti *et al.* (2018), Shiksha and Sharma (2018) and Thakur (2020).

The results for high heritability with high genetic gain for number of fruits per cluster were in accordance with the findings of Patil (2017) and Thakur (2020) and for fruit yield per plant, Shiksha and Sharma (2018) and Mukherjee *et al.* (2020) found the same results. High heritability along with moderate genetic gain for number of fruits per plant and days to 50% flowering was also reported by Harogeri (2016).

Correlation coefficient analysis (Table 2) revealed that fruit yield per plant was positively and significantly correlated with total number of fruits per plant (0.61, 0.61), number of fruit clusters (0.72, 0.62), average fruit weight (0.62, 0.62), pericarp thickness (0.62, 0.62) and titratable acidity (0.63, 0.44) at both phenotypic and genotypic levels. Whereas negative and significant correlation of fruit yield per plant was found with days to 50% flowering (-0.51, -0.40), days to first harvest (-0.55, -0.41), fruit shape index (-0.52, -0.42) and TSS (-0.57, -0.44) at both phenotypic and genotypic levels. The results are in accordance with the findings of Harogeri (2016) and Thakur (2020).

The path coefficient analysis (Table 3) revealed that total number of fruits per plant (1.680) had the greatest positive direct contribution towards fruit yield per plant followed by pericarp thickness (0.649), days to 50% flowering (0.208), plant height (0.073), TSS (0.069), number of branches (0.059), titratable acidity (0.039), average fruit weight (0.037), fruit shape index (0.032) and number of seeds (0.029). Whereas negative direct contribution from number of fruits per cluster (-0.972), number of clusters (-0.623) and days to first harvest (-0.106) was observed towards fruit yield. The results were in consonance with the results of Doddamani *et al.* (2019), Thakur (2020) and Vijaylaxmi *et al.* (2021).

Mahalanobis D^2 statistics grouped 25 genotypes into four clusters (Table 4) and the (Fig 1) gives a clear picture of the cluster pattern of the cherry tomato genotypes. The maximum intra cluster (Table 5) was observed in cluster I (77.84) followed by cluster III (77.59), cluster II (22.73) and cluster IV (0). The maximum inter cluster (Table 5) was observed between cluster III and IV (621.61), followed by cluster II and IV (541.63), I and IV (430.96), II and III (369.44), I and III (168.18) and I and II (138.27). The genotypes having broad genetic base and desirable characters are always favored in hybridization program. Therefore based on the results of inter cluster distance the genotypes from cluster III and IV can result in efficient hybridization for the improvement of various horticultural attributes.

Table 4: Clustering pattern of 25 genotypes of cherry tomato on the basis of genetic divergence.

Cluster	Number of genotypes	Genotypes
I	18	EC2796, EC2798, EC7911, EC7912, EC10662, EC10664, EC16778, EC27251, EC139041, EC139042, EC164650, EC164658, EC164660, EC177370, EC521044, EC521045, EC521076 and EC531803
II	2	EC2795 and EC139040
III	4	EC2791, EC521074, EC521079 and EC531802
IV	1	Solan red round

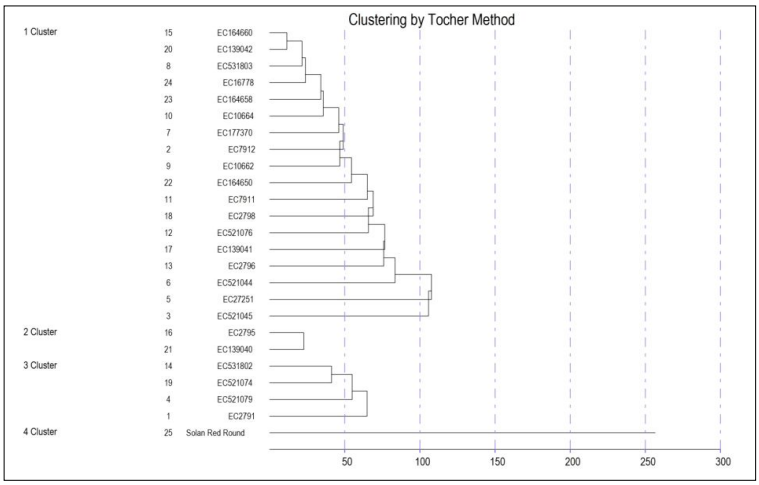


Fig 1: Dendrogram of cherry tomato genotypes depicting cluster pattern.

Table 5: Average intra and inter cluster distance.

Clusters	I	II	III	IV
I	77.84			
II	138.27	22.73		
III	168.18	369.44	77.59	
IV	430.96	541.63	621.61	0

CONCLUSION

On the ground of the mean performance of the genotypes, EC27251, EC164658, EC177370 and EC531802 along with check variety Solan Red Round performed better than other genotypes for yield and other imperative horticultural characters. The phenotypic and genotypic coefficients of variation, heritability and genetic gain were high for number of fruits per cluster and fruit yield per plant**.** High heritability along with moderate genetic gain was observed for total number of fruits per plant and average fruit weight which suggests the possibility of improvement through simple selection. Fruit yield per plant had significant and positive correlation with total number of fruits per plant, number of fruit clusters, average weight, pericarp thickness and titratable acidity. Positive direct effect on fruit yield per plant was highest from total number of fruits per plant followed by pericarp thickness, days to 50% flowering, plant height, TSS, number of branches, titratable acidity, average fruit weight, fruit shape index and number of seeds. Based on analysis of genetic divergence through Mahalanobis D^2 statistics, the genotypes from cluster III and IV can result in efficient hybridization for the improvement of different horticultural attributes.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

All animal procedures for experiments were approved by the Committee of Experimental Animal Care and Handling Techniques were approved by the University of Animal Care Committee.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish or preparation of the manuscript.

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