Assessment of Genetic Diversity in Tomato (*Solanum lycopersicum*) Under Protected Condition

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A B S T R A C T

In the present study, 22 tomato (*Solanum lycopersicum* L.) genotypes were evaluated to study the extent of genetic diversity through 20 quantitative traits. The genotypes were categorized into 5 distinct clusters using D^2 statistics. Cluster I had the maximum number of genotypes (8), followed by clusters IV and V (4 genotypes each) and clusters II and III (3 genotypes each). Highest intra cluster was recorded in cluster III, while the inter cluster distance was maximum between cluster V and cluster IV (53,348.13) indicating the presence of wide range of variability among genotypes of the cluster. Fruit yield per plant contributed the maximum (64.50 %) to the genetic diversity, followed by fruit volume, number of fruits per plant, average fruit weight, number of locules per fruit, fruit diameter and fruit length. The cluster III recorded highest mean for the characters like fruit length (4.28 cm), fruit diameter (5.12 cm), fruit volume (115.58 cc), average fruit weight (114.20 g), pericarp thickness (6.70 mm) and fruit yield per plant (1.64 kg).

Introduction

Tomato (*Solanum lycopersicum* L.) is an important vegetable of solanaceae family having diploid chromosome number of 2n=2x=24. It has originated in Peru- Equador- Bolivia region of the Andes, South America (Rick, 1969). It is commonly considered as "Protective Food", as it contains high amount of several nutritive phytochemical compounds especially carotenoids such as, lycopene and β-carotene (provitamin A), flavonoids, phenolic acids, ascorbic acid and minerals like calcium, iron and phosphorus. In India, tomato ranks second among vegetables in area and production after potato. It occupies in an area of 1.20 million hectares with an annual production of 19.40 million tonnes with an average yield of 16.16 tonnes per hectare. By realizing remuneration of tomato under protected cultivation there is a perpetual need for crop improvement in indeterminate types of tomato regarding longer harvest duration, fruit yield and fruit

quality. Genetic improvement can be done by designing the genetic makeup of the plant with desirable characters and by eliminating the undesirable genes.

The scope of crop improvement depends upon the genetic diversity of the initial plant material. The progenies derived from diverse parents are expected to display a broad spectrum of genetic variability and greater heterosis which provides better scope to isolate superior recombinants (Lahbib *et al.,* 2010; Srivastava *et al.,* 2014). Characterization of genetic divergence for selection of suitable and diverse genotypes should be based on sound statistical procedures. The generalized D^2 statistic, revised by Mahalanobis (1936), is a powerful technique to identify diverse groups in any material. Further, grouping of the accessions based on Tocher's method will be more useful in choosing suitable parents for heterosis breeding (Prashanth *et al.,* 2008). Keeping these points, present investigation was taken up to study the genetic divergence among the selected tomato germplasm.

Materials and Methods

The experimental material comprising of twenty-two genotypes of tomato which includes both semi determinate and indeterminate types and these were collected from institutes like IIHR Bengaluru, IIVR Varanasi, NBPGR New Delhi and IARI Delhi. Evaluation of these accessions was carried out to estimate the variability and for grouping them into different clusters using D^2 statistics of Mahalanobis. The genotypes were evaluated in randomized block design with two replications during Rabi, 2019-20 at Department of Vegetable Science, College of Horticulture Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga, India. The twenty-five days old seedlings of selected genotypes were transplanted in the experimental field with the spacing 60 cm x 45 cm, in a such a way that to accommodate twelve plants in each plot (3.5 m^2). The recommended package of practices was followed for raising all the genotypes. Necessary prophylactic plant protection measures were taken up to safe guard the genotypes from pests and diseases.

Twenty quantitative characters *viz.,* plant height at last harvest (cm), stem girth at last harvest (cm), number of primary branches per plant at last harvest, number of secondary branches per plant at last harvest, days taken for first flowering, days taken for fifty per cent flowering, number of flowers per cluster, number of fruits per cluster, number of fruit clusters per plant, days taken for fruit set, days taken for fruit harvest, days taken from first harvest to last harvest, number of fruits per plant, fruit length (cm), fruit diameter (cm), fruit volume (cc), average fruit weight (g), pericarp thickness (mm), number of locules per fruit and fruit yield per plant (kg) were taken into consideration for estimating genetic diversity. The mean values of five plants were taken for the analysis of genetic divergence following Mahalanobis (1936). The genotypes were grouped into different clusters following Tocher's method as described by Rao (1952). The average intra and inter cluster distances and contribution of characters towards genetic divergence were estimated by using the method as described by Singh and Chaudhary (1985).

Results and Discussion

On the basis of D^2 analysis, twenty-two genotypes were grouped into five clusters (Table 1). Maximum number of genotypes were grouped into cluster I (8 genotypes) followed by cluster IV and V (4 genotypes each), cluster II and III (3 genotypes each). The results of the present study revealed that clustering was not allied with geographic

origin because some genotypes collected from the same geographic origin were grouped in different clusters. The findings of the present investigation are supported by the findings of Chernet *et al.,* (2013), Hussain *et al.,* (2018), Raj *et al.,* (2019). Thus, there is no direct relationship between geographical distribution and genetic distance.

Intra and inter cluster average D^2 values are presented in Table 2. Among the five clusters, cluster III with 3 genotypes showed the maximum intra cluster distance (4540.01) followed by cluster V (4434.02) and cluster II (3836.99), cluster I (2653.48) and cluster IV (2572.86). Based on distances between clusters, i.e., inter cluster distances, the maximum divergence was observed between cluster V and IV (53,348.13), followed by cluster IV and III (42,314), cluster V and II (31,707.76), cluster V and I (28,411.42), cluster III and I (26,222.69), cluster II and III (19,933.32), cluster V and III (11,911.94),

cluster IV and I (9,960.24), cluster II and IV (8,012.84) and cluster II and I had least inter cluster distance (6,825.89). In accordance to the findings, Hazra *et al.,* (2010) and Meena and Bahadur (2015) reported that the maximum inter cluster D2 values revealed that these can be utilized for getting superior recombinants or transgressive segregants as they represent very diverse group of genotypes.

The relative contribution of different characters for genetic divergence (D^2) is given in Figure 1. Fruit yield per plant contributed the maximum (64.50 %) to the genetic diversity among the characters followed by fruit volume (19.91 %), number of fruits per plant (6.49 %), average fruit weight (4.33 %), number of locules per fruit (3.03 %), fruit diameter and fruit length (0.87 % each). Similar to the present findings was recorded by Babu *et al.,* (2018), Naveen *et al.,* (2018) and Prakash *et al.,* (2019).

Table.1 Cluster composition based on D^2 statistics in tomato genotypes

| Clusters	Number of genotypes	Genotypes included in the cluster
I	8	Kashi Vishesh, EC 521039, Kashi Eyan, EC 13736, Arka Alok, Arka Sourabh, Pusa Ruby, VRT 51
II	3	EC 531804, IIHR 2615, VRT 13
III	3	EC 362941, Marglobe, Arka Megali
IV	4	EC 27251, ToLEV 32, EC 521076, VRT 06
V	4	EC 15127, EC 521061, EC 521069, Arka Vikas

Table.2 Average intra and inter clusters D^2 values for twenty characters formed by twenty- two genotypes of tomato

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Cluster 1	**2653.48**	6825.89	26222.69	9960.24	28411.42
Cluster 2		**3836.99**	19933.32	8012.84	31707.76
Cluster 3			**4540.01**	42314	11911.94
Cluster 4				**2572.86**	53348.13
Cluster 5					**4434.02**

Table.3 Mean values of twenty characters for five clusters in tomato genotypes

Sl. No.	Characters	Clusters				
		I	II	III	IV	V
1	Plant height (cm) at last harvest	237.75	203.39	230.63	215.81	312.03
2	Stem girth (cm) at last harvest	4.32	4.50	4.77	5.53	4.27
3	Number of primary branches per plant at last harvest	7.97	8.93	8.05	8.21	9.02
4	Number of secondary branches per plant at last harvest	20.55	26.39	22.43	20.86	26.21
5	Days taken for first flowering	25.46	26.72	25.25	25.10	24.28
6	Days taken for per cent flowering	29.14	30.53	28.90	29.29	29.37
7	Number of flowers per cluster	5.25	6.64	4.93	6.79	5.22
8	Number of fruits per cluster	5.07	5.29	4.87	5.57	3.99
9	Number of fruit clusters per plant	31.17	28.33	23.13	35.87	29.16
10	Days taken for fruit set	8.93	7.55	8.22	8.37	8.28
11	Days taken for first harvest	64.16	64.74	55.86	56.23	62.16
12	Days taken from first harvest to last harvest	39.37	42.99	47.97	45.31	49.59
13	Number of fruits per plant	34.59	33.03	19.66	44.47	29.54
14	Fruit length (cm)	2.91	3.59	4.28	3.42	3.41
15	Fruit diameter (cm)	3.12	4.53	5.12	3.68	3.46
16	Fruit volume (cc)	32.10	73.15	115.58	36.28	47.25
17	Average fruit weight (g)	35.79	83.31	114.42	47.79	50.4
18	Pericarp thickness (mm)	4.37	5.22	6.70	4.54	4.74
19	Number of locules per fruit	3.24	3.88	4.78	2.76	3.09
20	Fruit yield per plant (kg/plant)	1.27	1.70	1.64	1.62	1.25

Fig.1 Per cent contribution from different characters to the total divergence in tomato genotypes
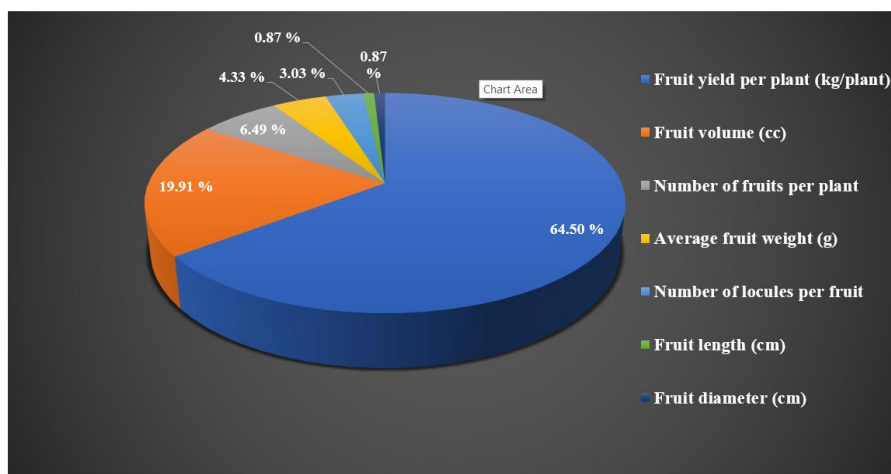
The cluster means for 20 characters indicated, considerable difference among clusters for all the characters (Table 3). The Cluster II recorded highest mean for the characters like number of secondary branches per plant at last harvest (26.39), whereas the cluster III recorded highest mean for the characters like fruit length (4.28 cm), fruit diameter (5.12 cm), fruit volume (115.58 cc), average fruit weight (114.20 g), pericarp thickness (6.70 mm) and fruit yield per plant (1.64 kg). The cluster IV recorded highest mean for the characters like stem girth at last harvest (5.53 cm), number of flowers per cluster (6.79), number of fruits per cluster (5.57), number of fruit clusters per plant (35.87) and number of fruits per plant (44.47). The cluster V recorded highest mean for the characters like plant height at last harvest (312.03 cm), number of primary branches per plant at last harvest (9.02) and days taken from first harvest to last harvest (49.59). Hence, crosses between these clusters may improve respective selected traits.

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