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Research Note

Genetic diversity analysis in Tomato (*Solanum lycopersicum* L.)

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Abstract

The genetic diversity among 50 genotypes in tomato showed highly significant differences among the genotypes for all the characters indicating presence of sufficient amount of variability in all the traits. Mahalanobis D^2 statistics revealed that considerable genetic diversity within and among nine clusters. The characters viz., fruit weight, number of fruits per plant, root length and plant height were the potent factors in differentiating the germplasm of tomato under this study., In addition to the genetic divergence, considering the mean performance, eleven genotypes for fruit yield from I, II, III and IX clusters, eight genotypes for earliness from II, III, IV, VI, VIII and IX clusters, nine genotypes for root length from I, II, III IV and VII clusters and seven genotypes for RDW/SDW from I, III and VIII clusters were superior and they can be used for future breeding programmes. There was a considerable variation among the genotypes for all the nine qualitative characters.

Key words:
Tomato, genetic diversity, yield, germplasm.

Tomato (*Solanum lycopersicum* L., 2n = 2x = 24) is one of the widely grown vegetable crops cultivated for its fleshy fruits in the world. It is the most imperative warm-season fruit vegetable grown throughout the world. Tomato is the very important vegetable crop next only to potato because of its wider adaptability, high yielding potential and multipurpose uses. Tomato is protective supplementary food and considered as important commercial and dietary vegetable crop. It is also a good source of polyphenolic compounds, such as flavonoids and hydroxycinnamic acids (Bugianesi et al., 2004). As it is short duration crop and gives high yield, it is important from economic point of view and hence area under its cultivation is increasing day by day. To meet the ever rising demand for this vegetable crop, there is a need for development of hybrids and varieties with improvement in yield, quality and resistance to different biotic and abiotic stresses. Tomato breeding strategy involves assembling or generating variable germplasm and selection of superior genotypes for utilizing them in hybridization programme to develop a superior variety or hybrid. To achieve these targets, collection of germplasm from indigenous and exotic sources is very important and utilization of these genetic resources requires their proper and systematic evaluation to understand and estimate the genetic variability, heritability, genetic advance and character association with yield components. Genetic diversity is an essential aspect for any heritable improvement. Knowledge of genetic diversity, its nature and degree is useful for selecting desirable parents from a germplasm for the successful breeding programme. Mahalanobis D^2 technique appears to be a fruitful approach which is based on multivariate analysis and serves to be a good index of genetic diversity. Hence in the present study, an attempt was carried out to assess the genetic diversity among 50 genotypes of tomato.

The experimental materials comprised 50 accessions received from National Bureau of Plant Genetic Resources (NBPGR), India. The experiment was carried out at the Vegetable Research Station, Rajendranagar, Hyderabad, India during *rabi*, 2011-12. The experiment was laid out in a randomized block design with three replications. Twenty-five days old ten seedlings per replication were transplanted on well prepared and leveled field with single seedling per hill adopting 60 X 45 cm spacing. Need based plant protection was taken up during crop period. The genetic divergence between genotypes was estimated using Mahalanobis D^2 statistics. Five randomly selected plants in each replication of each entry were labeled and used for recording the observations. The mean of five plants was worked out and taken for analysis. Observations *viz*., stem girth; plant height (cm); primary branches per plant; days to 50% flowering; number of fruits per plant; number of clusters per plant; number of locules per fruit ; days to first fruit set; average fruit weight; fruit size (cm) ; shoot dry weight (g) ; root dry weight (g), root dry weight /shoot dry weight (g); peri carp thickness ; total soluble solids and root length (cm) were recorded. The qualitative traits (morphological) for the best genotypes were characterized based on NBPGR, India. The genetic diversity for 50 genotypes were assessed quantitatively for yield and yield related attributes along with four fruit quality attributes by employing Mahalonobis D^2 statistics and grouped by the procedure suggested by Tocher (Rao, 1952)

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Based on D^2 values, the 50 genotypes were grouped into nine clusters (Table 1). Among the nine clusters, cluster IV was the largest, comprising of 12 genotypes followed by cluster I with 10 genotypes, cluster IX with six genotypes, cluster VII and VIII with five genotypes, cluster III with four genotypes, cluster II and VII with three genotypes and cluster V with two genotypes.The inter and intra cluster D^2 values are given in Table 2. The inter cluster distance was maximum between the cluster VIII and cluster V (7.16). The minimum inter cluster distance was observed between cluster VIII and cluster IV (3.18). Cluster VIII was the most diverse as many other clusters showed maximum inter cluster distance with it. The intra cluster distance values ranged from 2.36 to 3.36. The maximum intra cluster distance was observed in cluster III (3.36) followed by cluster VII (3.20). The nearest and farthest clusters from each cluster based on D^2 values in tomato germplasm are indicated in Table 3. The results of Mahalanobis D^2 statistics revealed substantial genetic diversity among 50 germplasm lines included in the present study. Several authors also reported profound diversity in the germplasm of tomato by assessing genetic divergence on the basis of quantitative traits following Mahalanobis D^2 statistics (Basavaraj et al. 2010 and Evgenidis et al. 2011). Murthy and Arunachalam (1960) pointed that Mahalanobis D^2 statistics is an important breeding tool to evaluate the clustering pattern. Average inter and intra cluster distances revealed that, in general, inter cluster distances were much higher than those of intra cluster distances, suggesting homogeneous and heterogeneous nature of the germplasm lines within and between the clusters, respectively. These results are in accordance with the findings of Parthasarathy and Aswath (2002), Mahesha et al. (2006) and Sekhar et al. (2008) in tomato. In general, the genotypes grouped together in one cluster are less divergent than those which are placed in a different cluster. Further, higher intra cluster distance indicates high degree of divergence within that cluster.

In general, the characters responsible for discrimination between populations can narrow down the problem of selecting divergent parents for breeding programme. Amongst the yield contributing characters, the fruit weight, number of fruits per plant and plant height were the major contributors towards divergence. Mohanty and Prusti (2001) also observed such maximum contribution of fruit weight and number of fruits per plant to total divergence of tomato germplasm. De et al. (1988) opined that traits contributing maximum towards the D^2 values need to be given more emphasis for deciding the clusters to be taken for the purpose of choice of parents for hybridization. In addition to the genetic divergence, considering the mean performance (Table 4) eleven genotypes for fruit yield from I, II, III and IX clusters; eight genotypes for earliness from II, III, IV, VI, VIII and IX clusters; nine genotypes for root length from I, II, III IV and VII clusters and seven genotypes for RDW/SDW from I, III and VIII clusters were superior and they can be used for future breeding programmes even under moisture stress conditions.

Qualitative traits are useful for characterization of germplasm against high heritability and stable traits. Further, association of any qualitative character with desirable traits/yield components serves as phenotypic marker in the selection process. Pubescence is an important character which can reduce the radiant heat load of leaves by increasing the reflection of the leaf surface. Increased pubescence was observed under stress in some species and cultivars. Ehleringer et al. (1976) and Ehleringer (1980) suggested that leaf or stem pubescence is often cited as a feature of desert shrub adapted to arid environments. In the present study (Table 5), there was a considerable variation among the genotypes for all the nine qualitative characters.

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Table 1. Clustering pattern of 50 genotypes of tomato (Tocher's method)

Cluster	No. of genotypes	Genotypes
I	**10**	EC162516, EC241148, EC164838, EC168096, EC164667, EC310301, EC165952, EC164665, EC164845, IC249512
II	**3**	EC162600, EC251578, NS 537
III	**4**	EC251646, EC164670, EC635525, IC249511
IV	**12**	EC274122, BSBS141, EC164656, EC163663, EC315478, IC249503, EC257580, IC249505, IC249504, EC315480, EC251709, IC249507
V	**2**	NS 526, BSBS 47
VI	**3**	EC164656, EC257489, EC162515
VII	**5**	PSR 10693, EC165700, EC645166, EC191538, EC645179
VIII	**5**	EC251750, IC249514, EC645165, EC497390, IC249506
IX	**6**	EC23528 , EC163606, EC164677, EC164836, EC164654, IC249513

Table 2. Average intra (bold) and inter-cluster D^2 values for nine clusters in 50 genotypes of tomato (Tocher's method)

Clusters	I	II	III	IV	V	VI	VII	VIII	IX
I	**2.98**								
II	4.38	**2.51**							
III	4.43	6.16	**3.36**						
IV	3.88	5.02	4.39	**2.91**					
V	4.88	4.75	5.55	6.46	**2.36**				
VI	4.32	5.50	4.96	3.76	6.09	**2.75**			
VII	5.25	5.42	3.75	3.86	5.46	4.45	**3.20**		
VIII	4.62	5.80	4.09	3.18	7.16	4.49	4.57	**2.96**	
IX	3.10	5.02	4.26	3.40	4.60	4.07	4.76	4.72	**2.36**

*Bold diagonal values indicate intra cluster distance, rest of the values show the inter cluster distances.

Table 3. The nearest and farthest clusters from each cluster based on D^2 values in tomato germplasm

Cluster No.	Nearest cluster with D^2 values	Farthest cluster with D^2 value
I	IX (3.10)	VII(5.25)
II	I (4.38)	III(6.16)
III	VI (3.75)	II(6.16)
IV	VIII (3.18)	V(6.46
V	IX (4.60)	VIII(7.16)
VI	IV (3.76)	V(6.09)
VII	III (3.75)	V(5.46)
VIII	IV (3.18)	V(7.16)

IX	I(3.10)	II(5.02)

Values in the parenthesis indicate D^2 values.

Table 4. Mean values of clusters for 17 characters in 50 genotypes of tomato (Tocher's method)

Cluster	SG	PH	NPBP	D50% F	DFFS	FS	NFP	NLF	AFW	NCP	FYP	SDW	RDW	RDW/SDW	PT	TSS	RL
I	12.16	68.52	5.92	57.15	65.37	6.78	42.64	2.77	36.26	47.73	1442.12	34.52	12.65	0.36	2.34	4.30	58.20
II	19.98	91.03	6.88	55.00	59.89	6.24	40.82	2.82	25.27	52.33	2075.24	74.44	14.25	0.19	1.81	5.53	54.08
III	7.85	145.00	6.04	68.18	76.17	6.57	43.54	4.04	23.79	45.42	1462.52	62.87	25.40	0.41	3.04	6.08	46.35
IV	11.23	124.61	6.25	65.45	73.67	4.20	51.70	2.76	16.58	40.61	1283.33	50.18	8.18	0.17	2.02	5.00	50.69
V	11.61	66.00	7.00	53.00	59.83	8.67	15.29	3.18	41.93	30.67	2050.34	82.62	22.37	0.23	3.23	6.78	54.30
VI	11.02	92.44	8.00	57.33	64.56	4.00	59.31	4.17	19.36	30.00	1233.33	65.94	16.69	0.28	1.89	3.99	63.01
VII	9.78	129.67	6.40	63.00	72.47	4.33	45.33	2.99	14.85	36.60	1410.62	106.66	25.74	0.25	2.22	7.77	58.21
VIII	13.13	103.13	7.73	72.53	82.60	3.41	52.51	2.81	13.45	49.67	1322.56	52.76	16.88	0.34	2.47	4.51	42.24
IX	9.40	83.54	6.19	64.09	69.89	6.83	27.83	3.34	37.83	30.89	1501.69	51.52	12.24	0.24	1.84	4.37	41.73

SG= Stem Girth; PH= Plant height (cm); NPBP= Primary branches per plant ; D50% F = Days to 50% flowering ; NFP= Number of fruits per plant; NFP= Number of clusters per plant; NLF= Number of locules per fruit ; DFFS= Days to first fruit set; AFW= Average fruit weight; FS= Fruit size (cm) ; SDW=Shoot dry weight (g) ; RDW=Root dry weight (g) RDW/SDW= Root dry weight /Shoot dry weight (g); PT= Pericarp thickness ; TSS (%); = Total soluble solids RL= Root length.

Table 5. Qualitative traits of 50 genotypes of tomato

Genotypes	Plant growth habit	Stem type	Leaf type	Leaf size	Pubescence	Flower size	Flower colour	Fruit shape	Blossom end shape
NS526	Determinate	Angular	Peruvianum	Medium	Sparse	Large	Yellow	Cylindrical	Round
BSBS47	Semi determinate	Round	Potato	large	High	Medium	Yellow	Round	Round
EC23528	Indeterminate	Angular	Peruvianum	Medium	Medium	Medium	Light yellow	Round	Round
EC162600	Indeterminate	Angular	Standard	Medium	Medium	Medium	Deep Yellow	Flattend Round	Round
EC145622	Indeterminate	Angular	Potato	Medium	Medium	Small	Deep Yellow	Round	nippled
EC163606	Determinate	Round	Standard	Medium	Medium	Medium	Light yellow	Round	Round
EC164656	Indeterminate	Round	Standard	large	Medium to high	Medium	Deep yellow	Round	Round
EC257509	Indeterminate	Angular	Peruvianum	Medium	Medium	Small	Yellow	Round	Round
EC251578	Indeterminate	Round	Standard	Medium	Medium	Medium	Light Yellow	Round	Round
NS537	Indeterminate	Round	Standard	Medium	Medium	Large	Yellow	Square Round	Round
EC274122	Indeterminate	Round	Standard/hirsutum	Medium	Sparse	Large	Deep Yellow	Round	Round
PSR10693	Semi determinate	Round	Potato	Large	Medium	Large	Light Yellow	Round	Round
EC164677	Determinate	Round	Narrow	Small	High	Large	Yellow	Square Round	Round
EC165700	Indeterminate	Angular	Narrow	Medium	Medium	Medium	Light Yellow	Round	Round
EC165036	Determinate	Round	Standard	Medium	Medium to high	Medium	Deep Yellow	Flattend Round	Round
BSBS141	Determinate	Round	Standard	Medium	Medium	Medium	Yellow	Round	Round
EC645166	Indeterminate	Round	Potato	Medium	Sparse	Small	Yellow	heart	Round
EC251750	Indeterminate	Round	Hirsutum	Medium	Sparse	Large	Deep Yellow	Round	Round
EC162516	Determinate	Angular	Standard	Large	Medium	Large	Light Yellow	Heart	nippled
EC191538	Semi determinate	Round	Standard	Medium	High	Large	Yellow	Cylindrical	Round
EC251646	Semi determinate	Round	Standard	Medium	Medium	Medium	Yellow	Heart	Round

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Table 5. Qualitative traits of 50 genotypes of tomato (contd..)

Genotypes	Plant growth habit	Stem type	Leaf type	Leaf size	Pubescence	Flower size	Flower colour	Fruit shape	Blossom end shape
EC164654	Indeterminate	Round	Potato	Medium	Sparse	Medium	Light Yellow	Flat Round	Round
EC163663	Indeterminate	Round	Standard	Medium	Medium	Medium	Yellow	Slightly flattend	Round
EC164670	Indeterminate	Angular	Standard	Medium	Medium	Medium	Yellow	Oval	Round
IC249513	Indeterminate	Angular	Standard	Medium	Sparse	Medium	Light Yellow	Flat Round	Round
EC315478	Indeterminate	Round	Peruvianum	Medium	High	Medium	Yellow	Round	Round
IC249503	Indeterminate	Angular	Standard	Medium	Sparse	Medium	Yellow	Flattend Round	Round
IC249514	Semi determinate	Round	Standard	Medium	Sparse	Medium	Yellow	Round	Round
EC257580	Indeterminate	Angular	Standard	Medium	High	Medium	Yellow	Round	Round
IC249505	Semi determinate	Round	Standard	Medium	Sparse	Medium	Yellow	Oval Round	Round
IC249504	Semi determinate	Angular	Peruvianum	Medium	High	Medium	Yellow	Square Round	Round
EC315500	Determinate	Angular	Potato	Medium	Sparse	Medium	Light Yellow	Slightly flat	Round
EC645179	Semi determinate	Round	Standard	Medium	Sparse	Medium	Light yellow	Round	Round
EC251709	Indeterminate	Round	Potato	Medium	Sparse	Medium	Yellow	Round	Round
EC241148	Semi determinate	Angular	Standard	Medium	High	Medium	yellow	Flattend Round	Round
IC249507	Indeterminate	Angular	Standard	Medium	Medium	Medium	Yellow	Round	Round
EC645165	Indeterminate	Round	Standard	Medium	Sparse	small	Yellow	Round	Round
EC497390	Indeterminate	Round	Potato	Medium	Medium	Medium	Yellow	Oval	Round
IC249506	Indeterminate	Angular	Standard	Medium	Sparse	Medium	Yellow	Flattend Round	Round
EC162515	Indeterminate	Round	Standard	Small	Sparse	Medium	Deep Yellow	Flattend Round	Round
EC165038	Indeterminate	Angular	Standard	Large	High	Medium	Light Yellow	Flattend Round	Round

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Table 5. Qualitative traits of 50 genotypes of tomato (contd..)

Genotypes	Plant growth habit	Stem type	Leaf type	Leaf size	Pubescence	Flower size	Flower colour	Fruit shape	Blossom end shape
EC168096	Semi determinate	Angular	Standard	Medium	Sparse	Medium	Yellow	Round	Round
EC635525	Indeterminate	Round	Standard	Medium	Sparse	Medium	Yellow	Oval	Round
EC164667	Indeterminate	Round	Standard	Medium	Sparse	Small	Yellow	Flatend Round	Round
EC310301	Indeterminate	Angular	Standard	Medium	High	Medium	Yellow	Pyriform	Round
EC165952	Determinate	Angular	Standard	Medium	High	Medium	Yellow	Heart	Round
EC164665	Determinate	Angular	Standard	Medium	High	Medium	Yellow	Flattend Round	Round
IC 249511	Indeterminate	Round	Standard	Medium	High	Medium	Yellow	Round	Round
EC165045	Indeterminate	Angular	Peruvianum	Medium	High	Medium	Yellow	Flattend Round	Round
EC249512	Indeterminate	Round	Standard	Medium	Medium	Medium	Yellow	Round	Round