Original Research Article

Study of Morphological Qualitative and quantitative Characterization of Different Traits in Tomato (*Solanum lycopersicum* L.) Genotypes

Abstract

Tomato is classified as a warm-season crop and is characterized by two distinct plant growth habits: determinate and indeterminate. The flowers of tomatoes are typically bisexual and possess both male and female reproductive structures, making them perfect flowers. The stigma of the flower is surrounded by a protective anther cone, which promotes self-pollination. This self-pollination trait in tomato plants facilitates their maintenance breeding, and simple selection methods can be employed to effectively improve the crop. The current investigation involved the characterization of twenty-five tomato germplasm genotypes. The experimental was carried out during rabi season 2021-2022 at Horticulture Research Centre, College of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. Seedlings of tomato were transplanted at spacing of 60 x 45 cm in randomized block design with three replications. Data was collected based on eight qualitative traits, namely, plant growth habit, leaf colour, flower colour, fruit size, fruit shape, fruit colour, fruit surface, and stem end fruit shape. The tomato genotypes demonstrated significant variability in all qualitative traits, with the exception of the fruit surface trait. This highlights the importance of focusing on these traits in future crop improvement programs for tomato.

Key Words: *Tomato, Qualitative traits, Variability, Characterization*

1. Introduction

The tomato (*Solanum lycopersicum* L.) belongs to the Solanaceae family and has a chromosome number of 24 (2n=24). It was brought to India by the Portuguese and is native to the regions of Peru and Mexico. Tomato is widely cultivated and holds a prominent position as a "Protective food" worldwide. It is the leading vegetable in terms of processing and holds the first rank in production and the fourth ~~rank~~ in terms of cultivation area in India. From a commercial perspective, tomato is highly valued due to its short duration, high yield, and profitability, leading to a rapid increase in its cultivation area. Tomato cultivation has been practiced for centuries, and its popularity has soared since the mid-nineteenth century. It is a significant and popular vegetable cultivated as a high-value crop in greenhouses during the off-season. As the most important warm-season crop, tomatoes can be grown successfully worldwide. The production of tomatoes is significantly influenced by various environmental factors~~,~~ including temperature, light, relative humidity, and atmospheric carbon dioxide levels. It is~~Being~~ a warm-season crop with some tolerance to heat and drought and ~~, tomatoes~~ can be grown in a wide range of soil and environmental conditions. The optimal temperature for tomato cultivation is around 20-25°C, with the development of excellent quality red colour occurring between 21-24°C. Temperature extremes below 16ºC or above 27ºC are unfavourable for tomato cultivation. When the temperature surpasses 29ºC, the tomatoes turn yellow, whereas they remain green when the temperature drops below 13°C. Intense heat above 43°C leads to plant burn and the dropping of flowers and small fruits, while temperatures below 13°C and above 35°C reduce fruit yield and hinder the production of the characteristic red colour.

Comment [H1]: Reference please

Characterization involves the documentation of highly heritable traits in a crop that can be easily observed with the naked eye and are expressed across different environments. Before initiating any improvement program for tomatoes, it is essential to gather the available germplasm and conduct their characterization, which plays a crucial role in varietal improvement and selection. Evaluating phenotypic traits such as fruit morphology, colour intensity, nutritional quality, firmness, flavour, and aroma poses challenges and requires a significant amount of time due to the quantitative nature of these traits **(IPGRI, 1996; Fiorani and Schurr, 2013).** However, studying phenotypic attributes is necessary as they have been widely utilized to assess genetic diversity, breeding value, and yield potential in tomatoes **(Lopez et al., 1994; Singh and Sahu, 1998; Agong et al., 2001; Dharmatti et al., 2001; Mohanty et al., 2001; Parthasarathy et al., 2002; Naveen et al., 2018; Srivatsava et al., 2018).** Hence, the current study was conducted to characterize and evaluate the morphological qualitative variability of 25 different tomato genotypes.

2. Materials and Methods

Comment [H2]: You could have done both qualitative and quantitative characterization. It is easy to take measurements on leaf size, fruit size, stem height, fruit weight for each genotype.

The experimental trial was carried out during rabi season 2021-2022 at Horticulture Research Centre, College of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.). Twenty-five genotypes of tomato were collected from ~~the~~ different sources. Seedlings of tomato were transplanted at spacing of 60 x 45 cm in randomized block design with three replications. The observations were recorded for morphological qualitative traits such as plant growth habit, leaf colour, flower colour, fruit size, fruit shape, fruit colour, fruit surface and stem end fruit shape.

You could have collected data on Quantitative traits as follows:

A. Vegetative (Leaf size, leaves per plant, stem diameter)
B. Inflorescence (number of flowers, any male or female or hermaphrodite flowers, how about sex ration)
C. Fruits (weight, number of fruits per plant, fruit length)

You could have included some qualitative traits as follows:

- Astringency of the juice
- Disease incidence
- Secondary flowering
- Color
- Shape etc…

Why didn't you collect data on disease incidences?

How about locations and climatic data for the places where genotypes were collected?

Data Analysis

Data on the quantitative and qualitative traits could have been subjected to cluster analysis to conduct similarity estimates using Unweighted pair group method of arithmetic averages (UPGMA) in Multivariate Statistical Package (MVSP) 3.1 (Kovach, 2007) and the principal

component analysis (PCA). The data on quantitative traits could have been also subjected to analysis of variance in MINITAB 15.0.

3. Results and Discussion

I expected to see similarity coefficients and the dendrogram from Euclidean distance of complete linkage clustering method for the tomato genotypes

Twenty-five genotypes of tomato under present investigation were characterized based on eight qualitative traits **(Table 1).**

Plant Growth Habit

The data presented in (Table 1) revealed for both rabi season that seventeen genotypes namely VRT 77, VRT 67, VRT 52, VRT 66, VRT 16, VRT 78, VRT 76, VRT 74, VRT 62, VRT 23, VRT 17, VRT 71, VRT 70, VRT 24-1, Pusa Rohini, Punjab Ratta and Arka Rakshak F1 had determinate plant growth habit. While seven genotypes namely, VRT 58, VRT 10, VRT 63, VRT 29, VRT 27, Pant T-3 and Arka Samrat F1 had semi determinate plant growth habit and genotype Punjab Gaurav had indeterminate plant growth habit. What are your views in relation to the findings?

Leaf Colour

The results presented in (Table 1) revealed for both rabi season that seven genotypes namely, VRT 77, VRT 16, VRT 74, VRT 62, VRT 24-1, Punjab Ratta and Arka Samrat F1 had dark green leaf colour. While nine genotypes namely, VRT 67, VRT 52, VRT 78, VRT 17, VRT 70, VRT 29, VRT 27, Punjab Gaurav and Arka Rakshak F1 had light green leaf colour. Similarly, nine genotypes namely, VRT 66, VRT 58, VRT 76, VRT 23, VRT 10, VRT 63, VRT 71, Pusa Rohini and Pant T-3 had green leaf colour. What are your comments in relation to the findings and other scientists reports?

Flower Colour

The data presented in (Table 1) revealed for both rabi season that nine genotypes namely, VRT 77, VRT 52, VRT 76, VRT 74, VRT 62, VRT 24-1, Pusa Rohini, Punjab Ratta and Punjab Gaurav had light green flower colour. While seven genotypes namely, VRT 67, VRT 16, VRT 78, VRT 63, VRT 70, VRT 29 and Pant T-3 had yellow flower colour. Similarly, nine genotypes namely, VRT 66, VRT 58, VRT 23, VRT 10, VRT 17, VRT 71, VRT 27, Arka Rakshak F1 and Arka Samrat F1 had deep yellow flower colour. What are your comments in relation to the findings and other scientists reports?

Fruit Size

The data presented in (Table 1) revealed for both rabi season that eight genotypes namely, VRT 77, VRT 67, VRT 66, VRT 78, VRT 58, VRT 10, VRT 27 and Pant T-3 had very small fruit size. While six genotypes namely, VRT 76, VRT 74, VRT 63, VRT 17, VRT 70 and Arka Rakshak F1 had small fruit size. Similarly, eleven genotypes namely, VRT 52, VRT 16, VRT 62, VRT 23, VRT 71, VRT 29, VRT 24-1, Pusa Rohini, Punjab Ratta, Punjab Gaurav and Arka Samrat F1 had medium fruit size. What are your comments in relation to the findings?

Fruit Shape

The data presented in (Table 1) revealed for both rabi season that twelve genotypes namely, VRT 77, VRT 67, VRT 52, VRT 76, VRT 74, VRT 62, VRT 71, VRT 70, VRT 24-1, Pusa Rohini, Punjab Ratta and Pant T-3 had round fruit shape. While VRT 66 had cordate fruit shape. Similarly, five genotypes namely, VRT 16, VRT 58, VRT 63, VRT 29 and VRT 27 had flattened fruit shape. However, two genotypes namely, VRT 78 and VRT 17 had semi oval fruit shape. VRT 23 had flat round fruit shape. Two genotypes namely, VRT 10 and Arka Samrat F1 had high round fruit shape. Genotype Arka Rakshak F1 had square round fruit shape. What are your comments in relation to the findings and other scientists reports?

Fruit Colour

The data presented in (Table 1) revealed for both rabi season that eight genotypes namely, VRT 67, VRT 52, VRT 16, VRT 74, VRT 17, VRT 71, VRT 70 and VRT 29 had light red fruit colour. While seven genotypes namely, VRT 66, VRT 76, VRT 62, VRT 10, VRT 63, VRT 27 and Pant T-3 had red fruit colour. Similarly, ten genotypes namely, VRT 77, VRT 78, VRT 58, VRT 23, VRT 24-1, Pusa Rohini, Punjab Ratta, Punjab Gaurav, Arka Rakshak F1 and Arka Samrat F1 had deep red fruit colour. What are your comments in relation to the findings and other scientists reports?

Fruit Surface

The data presented in (Table 1) revealed for both rabi season that all twenty-five genotypes namely, VRT 77, VRT 67, VRT 52, VRT 66, VRT 16, VRT 78, VRT 58, VRT 76, VRT 74, VRT 62, VRT 23, VRT 10, VRT 63, VRT 17, VRT 71, VRT 70, VRT 29, VRT 24-1, VRT 27, Pusa Rohini, Punjab Ratta, Punjab Gaurav, Pant T-3, Arka Rakshak F1 and Arka Samrat F1 had smooth fruit surface. What are your comments in relation to the findings and other scientists reports?

Stem End Fruit Shape

The data presented in (Table 1) revealed for both rabi season that nineteen genotypes namely, VRT 77, VRT 67, VRT 52, VRT 16, VRT 78, VRT 76, VRT 74, VRT 62, VRT 23, VRT 10, VRT 17, VRT 70,

VRT 24-1, Pusa Rohini, Punjab Ratta, Punjab Gaurav, Pant T-3, Arka Rakshak F1 and Arka Samrat F1 had round stem end fruit shape. While five genotypes namely, VRT 58, VRT 63, VRT 71, VRT 29 and VRT 27 had flat stem end fruit shape. Similarly, VRT 66 had Pointed stem end fruit shape. What are your comments in relation to the findings and other scientists reports?

The findings of the study indicate that the tomato germplasm exhibits substantial variability in terms of quality traits. This research makes a significant contribution to the understanding of genetic resource conservation and tomato breeding. The outcomes of this study will prove valuable in selecting desirable traits for future breeding efforts **(Anuradha *et al.* 2018)**.

I expected to see a figure of UPGMA showing the relationship among the twenty five tomato genotypes

You could also present a figure of Principal component analyses of different populations of tomato using quantitative and qualitative traits

4. Conclusion

Based on the findings, it can be concluded that the present genotypes exhibit a wide range of qualitative variability, except for the fruit surface trait. This indicates that there is ample opportunity for the selection of promising genotypes. The research conducted in this study significantly contributes to the knowledge of conserving genetic resources and improving tomato breeding techniques. The results obtained from this study will be valuable in the selection of desirable traits for future breeding programme.

References

1. Agong, S. G., Schittenhelm, S., & Fried, W. (2001). Genotypic variation of Kenyan tomato (Lycopersicon esculentum Mill.) germplasm. Journal of Food Technology in Africa, 6, 13-17.
2. Anuradha, B., Saidaiah, P., Harikishan Sudini, Geetha, A., & Ravinder Reddy, K. (2018). Study of qualitative traits of germplasm of tomato (Solanum lycopersicum L.). Journal of Pharmacognosy and Phytochemistry, 7(6), 539-543.

3. Dharmatti, P. R., Madalgeri, B. B., Mannikeri, I. M., Patil, R. V., & Patil, G. (2001). Genetic divergence studies in summer tomatoes. Karnataka Journal of Agricultural Science, 14, 407-411.
4. Fiorani, F., & Schurr, U. (2013). Future scenarios for plant phenotyping. Annual Review of Plant Biology, 64, 267-291.
5. Lopez, M. R., Santiaguillo, J. F. H., Lomeli Pena, A., Guevas, J. A. S., & Sahagun-Castollanos, J. (1994). Evaluations of 60 accessions of husk tomato in Chapingo, Mexico. Revista-Chapingo. Serie-Horticultura, 1, 131-134.
6. Mohanty, B. K., & Pusti, A. M. (2001). Analysis of genetic distance in tomato. Research on Crops, 2, 282-285.
7. Naveen, B. L., Ravinder Reddy, K., & Saidaiah, P. (2018). Genetic divergence for yield and yield attributes in tomato (Solanum lycopersicum). Indian Journal of Agricultural Sciences, 88(7), 1018-1023.
8. Parthasarathy, V. A., & Aswath, C. (2002). Genetic diversity among tomato genotypes. Indian Journal of Horticulture Science, 59, 162-166.
9. Singh, D. N., & Sahu, A. A. (2002). Performance of tomato cultivars in winter seasons on entisol of Orissa. Environment and Ecology, 16, 760-772.
10. Srivastava, S., Saidaiah, P., Shivraj, N., & Ravinder Reddy, K. (2019). Yield and Quality Based Phenotypic Evaluation of Germplasm of Brinjal (Solanum melongena L.) Under Semi-Arid Conditions. International Journal of Current Microbiology and Applied Sciences, 8(7), 415-422.

Table 1: Qualitative traits of twenty-five Tomato genotypes

Sr. No.	Genotypes	Plant Growth Habit	Leaf Colour	Flower Colour	Fruit Size	Fruit Shape	Fruit Colour	Fruit Surface	Stem End Fruit Shape
1	**VRT 77**	Determinate	Dark Green	Light Yellow	Very Small	Round	Deep Red	Smooth	Round
2	**VRT 67**	Determinate	Light Green	Yellow	Very Small	Round	Light Red	Smooth	Round
3	**VRT 52**	Determinate	Light Green	Light Yellow	Medium	Round	Light Red	Smooth	Round
4	**VRT 66**	Determinate	Green	Deep Yellow	Very Small	Cordate	Red	Smooth	Pointed
5	**VRT 16**	Determinate	Dark Green	Yellow	Medium	Flattened	Light Red	Smooth	Round
6	**VRT 78**	Determinate	Light Green	Yellow	Very Small	Semi Oval	Deep Red	Smooth	Round
7	**VRT 58**	Semi Determinate	Green	Deep Yellow	Very Small	Flattened	Deep Red	Smooth	Flat
8	**VRT 76**	Determinate	Green	Light Yellow	Small	Round	Red	Smooth	Round
9	**VRT 74**	Determinate	Dark Green	Light Yellow	Small	Round	Light Red	Smooth	Round
10	**VRT 62**	Determinate	Dark Green	Light Yellow	Medium	Round	Red	Smooth	Round
11	**VRT 23**	Determinate	Green	Deep Yellow	Medium	Flat Round	Deep Red	Smooth	Round
12	**VRT 10**	Semi Determinate	Green	Deep Yellow	Very Small	High Round	Red	Smooth	Round
13	**VRT 63**	Semi Determinate	Green	Yellow	Small	Flattened	Red	Smooth	Flat
14	**VRT 17**	Determinate	Light Green	Deep Yellow	Small	Semi Oval	Light Red	Smooth	Round
15	**VRT 71**	Determinate	Green	Deep Yellow	Medium	Round	Light Red	Smooth	Flat
16	**VRT 70**	Determinate	Light Green	Yellow	Small	Round	Light Red	Smooth	Round
17	**VRT 29**	Semi Determinate	Light Green	Yellow	Medium	Flattened	Light Red	Smooth	Flat
18	**VRT 24-1**	Determinate	Dark Green	Light Yellow	Medium	Round	Deep Red	Smooth	Round
19	**VRT 27**	Semi Determinate	Light Green	Deep Yellow	Very Small	Flattened	Red	Smooth	Flat
20	**Pusa Rohini**	Determinate	Green	Light Yellow	Medium	Round	Deep Red	Smooth	Round
21	**Punjab Ratta**	Determinate	Dark Green	Light Yellow	Medium	Round	Deep Red	Smooth	Round
22	**Punjab Gaurav**	Indeterminate	Light Green	Light Yellow	Medium	Oval	Deep Red	Smooth	Round
23	**Pant T-3**	Semi Determinate	Green	Yellow	Very Small	Round	Red	Smooth	Round
24	**Arka Rakshak F1**	Determinate	Light Green	Deep Yellow	Small	Square Round	Deep Red	Smooth	Round
25	**Arka Samrat F1**	Semi Determinate	Dark Green	Deep Yellow	Medium	High Round	Deep Red	Smooth	Round

Formatted: Font: Not Bold
Formatted: Font: Not Bold
Formatted: Font: Not Bold
Formatted: Font: Not Bold
Formatted: Font: Not Bold
Formatted ... [1]
Formatted ... [2]
Formatted ... [3]
Formatted ... [4]
Formatted ... [5]
Formatted ... [6]
Formatted ... [7]
Formatted ... [8]
Formatted ... [9]
Formatted ... [10]
Formatted ... [11]
Formatted ... [12]
Formatted ... [13]
Formatted ... [14]
Formatted ... [15]
Formatted ... [16]
Formatted ... [17]
Formatted ... [18]
Formatted ... [19]
Formatted ... [20]
Formatted ... [21]
Formatted ... [22]
Formatted ... [23]
Formatted ... [24]
Formatted ... [25]