



Study of Genetic Variability, Heritability and Genetic Advance in Tomato Genotypes for Yield and Its Components

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

To select prospective genotype variants for future breeding programs, research is currently being done to evaluate the degree of genetic variability, heritability, and genetic progress among various tomato varieties using morphological features.

Experimental material comprising thirty-seven species of tomato genotype was raised in the three-replication using Randomized Block Design during the Rabi 2020-21 season and data were recorded in morphological and quality aspects. On the basis of mean performance of weight of fruits per plant, genotype superior to check genotype are 7053, 8105, 8202, 8623, 8730 as compared to the best checks 8716 and 9426. Analysis of variance (ANOVA) in Randomized Block

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Design experiments revealed significant for all morphological characters. The result showed higher phenotypic coefficients of variation of all characters compared to genotypic coefficients of variation. High Phenotypic Coefficient of Variation as recorded by fruit number per plant (38.07) followed by fruit weight per plant (33.49) and days to flowering (28.09) while high Genotypic Coefficient of Variation was identified by fruit number per plant (37.60) and followed by fruit weight per plant (32.94) and flowering days (27.52). All the characters showed high divergence. The number of fruits per plant showed high genetic advance (53.66) followed by maturity days (23.27) and plant height (20.73). The study provided an opportunity to identify genotypes and appropriate parameters like number of fruits per plant, days to plant height to be used in future breeding programs.

Keywords: Genetic advance; heritability; phenotypic coefficient of variation; genotypic coefficient of variation variability.

1. INTRODUCTION

“Tomatoes are a green fruit vegetable and belongs to the family Solanaceae, which includes about 100 species and 2500 species, including a few other important agronomic plants namely, potatoes, eggplant, peppers, and tobacco” [1]. “*Solanum lycopersicum* has a relatively inter-related genome between the Solanaceae species, which is characterized by its diploid chromosome number ($2n = 2X = 24$). It is about 950 Mbp in size, and has one of the most notable genes in the Solanaceae” [2]. Tomatoes are successfully grown under different agro-climate conditions. It is a warm-growing plant that needs a long growing season to produce a profitable crop.

“Tomatoes are one of the most important vegetable crops of special economic value in the horticulture industry, native to South America and many varieties are now grown in temperate climates” [3]. “It is the most popular vegetable that is part of the Solanum variety, the similarity between the leaves and flowers of potatoes and tomato plants seems to confirm this taxonomic group” [4,5]. “There are about a dozen species among the Lycopersicon species. On the basis of fruit color, these varieties are divided into two subgroups, namely, Eulycopersicon (red fruit habit and year of growth) and Eriopersicon (green with anthocyanin pigmentation). The cultivated varieties of Tomato (*L. esculentum*) and wild varieties (*L. pimpinellifolium*) belong to Eulycopersicon and these species are further subdivided into five species. There are 16 wild tomato species, including *S.habrochaites*, *S.pennellii*, *S.pimpinellifolium*, *S.cheesmaniae*, *S.galapagense*, *S.peruvianum*, *S.corneliomulleri*, *S.chilense*, *S.chmielewskii*, *S.arcanum*, *S.neorickii*, *S.huaylasense*, *S.lycopersicoides*, *S.ochranthum*, *S.jugandifolium*, and *S.sitiens*” [6,7]. “One of these varieties, namely, *L.*

esculentum var. *Ceraceformea* (cherry tomato) is considered to be the ancestor of modern planted tomatoes” [8]. “These species in the tomato clade are considered to have evolved primarily by genetic mutations rather than chromosomal regeneration on a large scale” [9]. “Because of its high per capita consumption, tomatoes are nutritious because of their high vitamin A-and vitamin-C value and prioritize their nutritional contribution to food. The fruit is rich in ascorbic acid and the taste of the fruit is controlled by various variable components and sugar balance: acid-ratio. Tomato fruit is widely used in salads and in various processed forms namely, pastes, sauces, pulps, juices, sauces and flavoring ingredients in dishes, meat or fish dishes” [10]. “The fruit contains large amounts of lycopene pigment, beta-carotene, magnesium, iron, phosphorus, potassium, riboflavin, niacin, sodium and thiamine. It has antioxidant properties and potentially beneficial health effects” [11].

“The research has been conducted at Vegetable Research Farm, Kalyanpur, Department of Vegetable Science, C. S. Azad University of Agriculture and Technology, Kanpur during the rabbi season 2020-21. Thirty-seven genotype was taken from Chandra Shekhar Azad university of Agriculture and Technology, Kanpur. The experiments are laid out in three replications in random block design and the size of the building is kept at 75 x 60 cm² for Plant to plant and 2 x 2 m² distance for rows to row. The morphological characters were recorded in five randomly selected plants for each replication and treatment. The observation of the following characters were recorded namely, days to flowering, ripening dates, plant length, number of branches per plant, fruit number per cluster, fruit length per fruit, fruit length, number of locules per fruit, fruit number per plant, fruit weight, fruit weight per plant. The mean values of genotypes in each replication were used for statistical

analysis. The steps involved in the analysis of the Randomized Block Design" were as described by [12]. "Heritability broad sense h^2 (b) was computed as a ratio of genotypic variance to phenotypic variance by applying the method of Allard (1960). The expected genetic advance under selection for the different characters was estimated" as suggested by [13].

2. MATERIALS AND METHODS

The research has been conducted at Vegetable Research Farm, Kalyanpur, Department of Vegetable Science, C. S. Azad University of Agriculture & Technology, Kanpur during the rabbi season 2020-21. Thirty-seven genotype was taken from Chandra Shekhar Azad university of Agriculture and Technology, Kanpur. The experiments are laid out in an area of 480m² with three replications in random block design and the size of the building is kept at 75 x 60 cm² for Plant to plant and 2 x 2 m² distance for rows to row. The morphological characters were recorded in five randomly selected plants for each replication and treatment. The observation of the following characters were recorded namely, days to flowering, ripening dates, plant length, number of branches per plant, fruit number per cluster, fruit length per fruit, fruit length, number of locules per fruit, fruit number per plant, fruit weight, fruit weight per plant. The mean values of genotypes in each replication were used for statistical analysis. The steps involved in the analysis of the Randomized Block Design were as described by Panse and Sukhatme (1985). Heritability in broad sense h^2 (b) was computed as a ratio of genotypic variance to phenotypic variance by applying the method of Allard, (1960). The expected genetic advance under selection for the different characters was estimated as suggested by Johnson et al. (1955).

3. RESULTS AND DISCUSSION

Analysis of Variance has shown significant difference for all morphological characters under study and it is presented in (Table 1). A variety of genotypes can be helpful in the development of high yielding variety. The similar results for these characters were observed by Golani [14].

3.1 Mean and Range for Genotypes for Each Characters

Data obtained from 7 genotypes were analyzed and the results were interpreted in comparison

with the best check 8716, 9426 performances of promising genotypes given in (Table 3). Specify the range of characters for all 10 characters provided (Table 2). The similar results for these characters were observed by Golani.

3.2 Analysis of Coefficient of Variation

The phenotypic coefficient of variation (PCV) ranged from 14.59 to 38.07 and the value was recorded the number of fruits per plant (38.07) followed by the fruit weight per plant (33.49) and day to flowering (28.09), number of locule (23.75), Fruit length (22.97), number of fruits per cluster (22.65), fruit width (21.95), number of branch (21.80), plant height (18.11), days to maturity (14.49). The genotypic coefficient of variance (GCV) ranges from 14.31 to 37.60. The highest GCV was obtained by fruit number per plant (37.60) and followed by fruit weight per plant (32.94) and day to flowering (27.52), fruit length (22.15), number of locule (22.15), fruit width (20.98), number of branch (20.46), number of fruit per cluster (19.37), plant height (17.80), days to maturity (14.31). Phenotypic variability was high compared to genotypic variability in all the character under the study. These results are similar to the comments recorded by [15]. PCV was higher than the appropriate GCV for all characters exhibiting natural traits that influence by environment to some extent, these results agree with Henareh's comments, (2015). The results of this study are closely related to the results of Nair and Thamburaj [16] which are an important component of the yield.

3.3 Heritability

Heritability ranging from 73.20% in fruit per cluster to 97.60 in number fruit/vegetable. The highest heritability was observed for number of fruits per plant (97.60) followed by weight of fruit per plant (96.70), plant height (96.50), days to maturity (96.10), days to flowering (96.00), fruit length (93.00), fruit width (91.40), number of branch (88.10), number of locule (87.00), number of fruits per cluster (73.20). All Character indicates a high heritability. The results are closely related to Golani observed the high inheritance of fruit weight, fruit length, number of locules per fruit and fruit yield.

3.4 Genetic Advance

Genetic improvement of various factors ranging from 1.31 per fruit weight per plant to 53.66 per

Table 1. Analysis of variance for 10 characters in tomato

S.V	D.F	Mean Sum of Square									
		1	2	3	4	5	6	7	8	9	10
Replication	2	2.45	2.15	5.79	1.16	0.69	0.19	0.27	0.10	1.06	0.02
Treatment	36	105.03	403.43	318.34	9.53	5.49	2.59	2.54	1.19	2103.69	1.12
Error	72	1.43	5.32	3.76	0.41	0.59	0.06	0.07	0.05	17.38	0.01

1. days to flowering, 2. days to Maturity, 3. Plant height, 4. Number of Branches per plant, 5. Number of Fruits per cluster, 6. Fruit Length, 7. Fruit width, 8. Number of Locules per fruit, 8. Number of fruits per Plant, 9. Weight of fruits per plant

Table 2. Estimates of variability parameters for yield and quality traits in tomato

Character	Mean	Range (min-max.)	PCV (%)	GCV (%)	Heritability (%)	GA
Days to Flowering	21.35	12.00 - 31.00	28.09	27.52	96.00	11.86
Days to Maturity	80.51	63.00 - 109.00	14.59	14.31	96.10	23.27
Plant height	57.54	38.50 - 80.00	18.11	17.80	96.50	20.73
No. of Branch	8.52	6.00 – 12.50	21.80	20.46	88.10	3.37
No. of Fruit/cluster	6.59	4.00 – 11.00	22.65	19.37	73.20	2.25
Fruit Length	4.15	2.72 – 6.50	22.97	22.15	93.00	1.83
Fruit width	4.32	3.22 – 6.60	21.95	20.98	91.40	1.79
No. of Locule	2.78	2.00 – 5.20	23.75	22.15	87.00	1.18
No. of fruit/Plant	70.13	27.00 – 130.00	38.07	37.60	97.60	53.66
Weight of fruit/plant(kg)	1.96	0.83 – 3.11	33.49	32.94	96.70	1.31

PCV: Phenotypic coefficient of variation, GCV: Genotypic coefficient of variation, H^2 bs: Heritability in broad sense, GA: Genetic advance (%)

Table 3. Promising genotype identified on the basis of mean value for All Character

S No.	Characters	Genotype
1	Days to Flowering	8730, 9424, 9425, 9429, 1903
2	Days to Maturity	8761, 9424, 9425
3	Plant height	8730, 8731, 8202, 8203, 7053, 7206, 8708,
4	No. of Branch	8731, 6512, 7053, 8203, 8506, 8623
5	No. of Fruit/cluster	8752
6	Fruit Length	1904,9432, 1901, 1902,1903,8767, 1905,1906
7	Fruit width	1904, 9432, 1901, 1903, 1905, 1906, 8506, 9429, 1902,
8	No. of Locule	9432,1906,1903,9429, 8761
9	No. of fruit/Plant	8730, 7202
10	Weight of fruit/plant(kg)	7053, 8105, 8202, 8623, 8730

fruit yield per plant. The number of fruits per plant showed high genetic growth (53.66) followed by day to maturity (23.27) and plant length (20.73) and other remaining characters showed low genetic advance. The results are obtained in the same way as Golani observed. High heritability coupled with high genetic advance were observed for number of fruits per plant, day to maturity, plant height.

4. CONCLUSION

On the basis of mean performance of weight of fruits per plant, genotype superior to check genotype are 7053, 8105, 8202, 8623, 8730 as

compared to the best checks **8716** and **9426**. The high value for both phenotypic and genotypic coefficient of variation recorded the number of fruits per plant and fruit weight per plant. The number of fruits per plant, day to maturity, plant height has high heritability with high genetic advance indicate Additive Gene action and other Character shows high heritability with low genetic advance indicate non additive gene action and presence of epistasis. High heritability coupled with high genetic advance are the best character combination for its improvement and this character should be select in future tomato breeding program for its improvement and variety development.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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