Research Article

# Genetic Variability, Heritability and Genetic Advance in Tomato (*Solanum Lycopersicon* L.)

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**Abstract**

The experiment was conducted during Autumn-Winter Season, at the Vegetable Research Area, Bihar Agriculture University, Sabour, Bhagalpur (Bihar). Genotypic variability, heritability and genetic advance for biochemical and biochemical contributing characters were studied on 29 tomato genotypes (including cultivated and wild species). Data were recorded on seven characters *viz.*, Total Soluble Solids, Titratable acidity, Ascorbic acid content, Lycopene content, Total carotenoids content, Total phenolics content and Total antioxidant capacity. Very little differences were observed between genotypic coefficient of variation and phenotypic coefficient of variation for all the characters. Total Antioxidant Capacity showed the highest genotypic and phenotypic variance (33.98% and 34.01%) whereas TSS showed the lowest (6.84% and 7.48%). Higher GCV and PCV were recorded for most of the characters indicating higher magnitude of variability for these characters. The highest heritability (broad senses) estimates were observed for Titratable Acidity (100%) and Total Antioxidant Capacity (100%) while the lowest was for the TSS (84%). Highest genetic advance as percent of mean was recorded for (69.93%) and lowest for TSS (12.90%). The exploration of genetic variability in the available germplasm is a prerequisite in a breeding programme for effective selection of superior genotype of tomato.

**Keywords:** Tomato, GCV, PCV, heritability, genetic advance

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## Introduction

Tomato (*Lycopersicon esculentum* L.) is an annual crop belonging to the family Solanaceae. The genus *Lycopersicon* consists of annual or short-lived perennial herbaceous plants. Tomato is a typical day neutral plant and is mainly self-pollinated, but a certain percentage of cross-pollination also occurs [1]. It is a warm season crop reasonably resistant to heat and drought and grows under wide range of soil and climatic conditions. Although tomato has a good potential to be cultivated every location in the universe but it confronts many abiotic stresses in which, high temperature is a crucial problem now a days [2]. It is known as protective vegetable due to its nutritional values, which protects human body from several ailments. It is also most extensively used vegetable in processing industry. Tomato ranks first in canned vegetables. Ripe fresh tomato fruit is consumed fresh as salads and consumed after cooking and utilized in the preparation of range of processed products such as puree, paste, powder, ketchup, sauce, soup and canned whole fruits. Unripe green fruits are used for preparation of pickles and chutney. Tomatoes are important source of lycopene (an antioxidant), ascorbic acid and b-carotene and valued for their color and flavor. The area and production of tomato has been increasing constantly over the years. India is the second largest producer of tomato next to China [3]. The basic key to bring about genetic improvement to a crop is to utilize the available or created genetic variability. If the variability in the population is largely due to genetic cause with least environmental effect, the probability of isolating superior genotype is possible [4].

The variability available in the population can be partitioned into heritable and non-heritable component viz., phenotypic and genotypic coefficients of variation, heritability and genetic advance on which selection can be effectively carried out [5]. Heritability denotes the proportion of phenotypic variation due to genotypes thus help the breeders to select the elite variety for a character. However, heritability indicates only the effectiveness in which selection of a genotype can be based on phenotypic performance but it fails to indicate the expected genetic progress in one cycle of selection. High heritability alone is not enough to make efficient selection in segregating generations, unless information is accompanied for substantial amount of genetic advance. Genetic advance denotes the improvement in the mean genotypic values of selected families over base population and thus helps the breeder to select the progenies in the earlier generation itself [3].

## Materials and Methods

The experimental materials consisted of 29 tomato genotypes along with one F1 commercial check *i.e.* BSS- 488 and these were laid out in Randomized Block Design (RBD) with 3 replications. Transplanting was done at the spacing of 60 × 60 cm. Data were recorded for 7 biochemical characters *viz,*. Total Soluble Solids (%), Titratable acidity (%), Ascorbic acid content (mg/100g FW), Lycopene content (mg/100g FW), Total carotenoids content (mg/100g FW), Total phenolics content (mg catechol equivalent /100g FW) and Total antioxidant capacity (µ mol/TE/g). Analysis of variance was done based on RBD for each of the characters separately. The phenotypic and genotypic coefficient of variance was estimated according to [6] and [7]. Heritability in broad sense was estimated according to [8] and genetic advance was estimated as per [9].

## Results and Discussion

### *Genetic variability*

The mean performance of 29 genotypes for seven characters exhibited a wide range of variations and the mean performances were observed for all the traits (**Table 1**). Analysis of variance was carried on various biochemical and biochemical contributing traits for studying the variation. Variance due to genotypes were highly significant for all the characters studied, indicating that the genotypes selected for the present study were genetically different. The estimation of these variances showed that genotypic variations contributed maximum to the phenotypic variations for all the traits studied (**Table 3**). The analysis of variance revealed significant mean square estimates for all the characters indicating sufficient genetic difference among the genotypes. The variation in the genotypes would be helpful in the development of superior varieties in further breeding programme.

**Table 1** Analysis of variance for 24 characters for the design of experiment in tomato

| Sr. No. | Characters | Mean Sum of Squares | | | | | |
|---|---|---|---|---|---|---|---|
| | | Replication (df= 2) | Treatment (df= 27) | Parents (df= 6) | Hybrids (df= 20) | Parents vs. Hybrids (df= 1) | Error (df= 54) |
| 1 | TSS | 0.00 | 0.39** | 0.35** | 0.36** | 1.07** | 0.02 |
| 2 | TA | 0.00 | 0.02** | 0.01** | 0.02** | 0.00** | 0.00 |
| 3 | AA | 0.27 | 51.06** | 22.10** | 60.82** | 29.62** | 0.80 |
| 4 | TPC | 0.08 | 150.12** | 61.30** | 146.78** | 749.86** | 5.27 |
| 5 | T.A | 0.00 | 2.68** | 2.83** | 2.76** | 0.00 | 0.00 |
| 6 | LC | 0.01 | 0.94** | 0.83** | 1.01** | 0.24** | 0.01 |
| 7 | T.C. | 0.01 | 1.29** | 1.14** | 1.32** | 1.55** | 0.02 |

* **Significant at 5 % level of significance and Significant at 1 % level of significance, respectively.
**Characters**: Total soluble solid (TSS), Ascorbic acid content (AA), Titrable acidity (TA), Total phenol content (TPC) and Total antioxidant capacity (A.A), lycopene content (LC), Total carotenoids (TC).

The phenotypic coefficient of variance (PCV) ranged from 7.48% to 34.01% and the maximum variance was recorded for Total antioxident capacity (34.01%) followed by Total carotenoids content (22.07%) and Titratable acidity (18.61%) whereas the lowest was recorded for TSS (7.48%) followed by Total phenolics content (12.37%) and Ascorbic acid content (13.66%) (Table 3). The genotypic coefficient of variance (GCV) ranged from 6.84% to 33.98%. High GCV was observed for Total antioxidant capacity (33.98%) followed by Total carotenoids content (21.94%) and Titratable acidity (18.58%) whereas the lowest GCV was recorded in TSS (6.84%) followed by Total phenolics content (11.75%) and Ascorbic acid content (13.36%) (Table 3). The investigation revealed that the phenotypic variation was high as compared to genotypic variation for all the traits studied indicating the influence of environment and it was found maximum for Total antioxident capacity and total carotenoids content. A similar result was observed by [10] and [11]. Wide difference between GCV and PCV implied its susceptibility to environmental fluctuation.

### *Heritability and Genetic Advance*

As per the classification given by [12] for broad sense heritability (h2b) measurement, all the characters were shows high h2b. Highest heritability was found in total titrable acidity (100%) and Total Antioxidant Capacity (100%). Moreover for other biochemical traits like lycopene content (98%) and ascorbic acid content (96%) also expressed high broad sense heredity. The lowest heritability found in Total Soluble Solids (84%) and in Total phenolics content

(90%) [13], [14], [15] and [16] observed similar findings. Such high values of heritability for all characters imply that it may be due to environment influence and selection based on phenotypic performance would be reliable.

**Table 2** Mean performance of 29 genotypes of tomato for biochemical traits

| **Genotypes** | **A.A(mg/100g Fw)** | **TCC(mg/100g Fw)** | **LC(mg/100g Fw)** | **TAC(µ Mol/Te/G)** | **TA(%)** | **TPC(mg Catechol Equivalent /100g Fw)** | **TSS(%)** |
|---|---|---|---|---|---|---|---|
| Pusa Rohin×H-86 | 24.98 | 3.34 | 2.85 | 2.58 | 0.35 | 56.45 | 4.77 |
| Pusa Rohin×CLNB | 32.91 | 4.44 | 4.11 | 3.95 | 0.44 | 70.51 | 5.50 |
| Pusa Rohin×Arka Ahuti | 29.98 | 4.02 | 2.90 | 1.34 | 0.36 | 56.29 | 5.07 |
| Pusa Rohin×ArkaVikas | 26.95 | 3.60 | 2.52 | 2.93 | 0.29 | 62.19 | 4.67 |
| Pusa Rohin×Arka Abha | 35.94 | 3.15 | 3.49 | 3.16 | 0.42 | 51.73 | 5.10 |
| PusaRohin×*S.pimpinellifolium* | 23.06 | 2.81 | 2.66 | 1.25 | 0.41 | 63.41 | 5.40 |
| H-86×CLNB | 35.07 | 2.18 | 2.67 | 3.09 | 0.53 | 75.24 | 5.43 |
| H-86×Arka Ahuti | 32.85 | 3.13 | 3.11 | 3.54 | 0.55 | 67.74 | 4.67 |
| H-86×Arka Vikas | 29.95 | 3.00 | 2.52 | 2.03 | 0.47 | 65.92 | 4.70 |
| H-86×Arka Abha | 28.40 | 3.42 | 2.50 | 3.34 | 0.34 | 59.08 | 4.57 |
| H-86×*S.pimpinellifolium* | 30.67 | 2.38 | 2.12 | 3.58 | 0.30 | 53.64 | 4.90 |
| CLNB×Arka Ahuti | 35.21 | 3.13 | 3.57 | 1.67 | 0.25 | 69.77 | 5.10 |
| CLNB×ArkaVikas | 33.41 | 3.33 | 3.28 | 3.94 | 0.40 | 65.88 | 5.00 |
| CLNB×Arka Abha | 34.74 | 3.02 | 4.16 | 3.73 | 0.30 | 73.73 | 5.37 |
| CLNB×*S.pimpinellifolium* | 35.15 | 2.82 | 2.34 | 2.93 | 0.43 | 52.02 | 5.30 |
| Arka Ahuti×ArkaVikas | 25.71 | 2.02 | 2.79 | 1.65 | 0.44 | 68.06 | 5.00 |
| Arka Ahuti×Arka Abha | 30.20 | 3.21 | 3.28 | 2.36 | 0.44 | 61.24 | 5.27 |
| Arka Ahuti×*S.pimpinellifolium* | 28.20 | 2.10 | 3.10 | 2.97 | 0.45 | 57.21 | 5.50 |
| Arka Vikas×Arka Abha | 42.70 | 4.36 | 3.73 | 3.35 | 0.28 | 58.07 | 5.60 |
| ArkaVikas×S.pimpinellifolium | 32.00 | 3.40 | 2.47 | 4.83 | 0.47 | 61.89 | 4.37 |
| ArkaAbha×S.pimpinellifolium | 34.09 | 2.58 | 3.64 | 3.95 | 0.47 | 55.25 | 5.00 |
| Pusa Rohini | 31.51 | 3.55 | 2.69 | 2.73 | 0.37 | 52.06 | 4.83 |
| H-86 | 28.48 | 2.14 | 2.28 | 2.35 | 0.42 | 61.99 | 4.73 |
| CLNB | 34.09 | 2.95 | 3.17 | 3.53 | 0.40 | 57.75 | 5.07 |
| Arka Ahuti | 29.06 | 2.09 | 2.88 | 1.16 | 0.40 | 50.87 | 4.50 |
| Arka Vikash | 28.32 | 3.28 | 3.68 | 3.57 | 0.32 | 56.82 | 4.33 |
| Arka Abha | 26.73 | 3.32 | 3.38 | 3.54 | 0.34 | 57.78 | 4.77 |
| *Solanum pimpinellifolium* | 32.94 | 2.29 | 2.32 | 3.93 | 0.42 | 49.53 | 5.37 |
| BSS-488 | 25.77 | 4.03 | 2.74 | 1.15 | 0.46 | 50.49 | 5.10 |
| Mean | 31.00 | 3.07 | 3.00 | 2.90 | 0.40 | 60.09 | 5.00 |
| C.V. | 2.84 | 4.35 | 2.82 | 1.47 | 1.03 | 3.86 | 3.01 |
| S.E. | 0.51 | 0.08 | 0.05 | 0.02 | 0.00 | 1.34 | 0.09 |
| C.D. 5% | 1.44 | 0.22 | 0.14 | 0.07 | 0.01 | 3.80 | 0.25 |

**Characters:** Ascorbic acid content (AA), Total carotenoids content (TCC), lycopene content (LC), Total antioxidant capacity (TAC), Titrable acidity (TA), Total phenol content (TPC), Total soluble solid (TSS).

**Table 3**: Genetic performance of 29 genotypes of tomato

| **Characters** | **General Mean** | **GCV (%)** | **PCV (%)** | **$h^2$ (Broad sense) %** | **Gen. Adv as % of Mean 5%** |
|---|---|---|---|---|---|
| TSS (°brix) | 5.00 | 6.84 | 7.48 | 84 | 12.90 |
| Titratable Acidity (%) | 0.40 | 18.58 | 18.61 | 100 | 38.22 |
| Ascorbic Acid Content (mg/100g Fw) | 31.00 | 13.36 | 13.66 | 96 | 26.93 |
| Total Phenolics Content (mg Catechol Equivalent | 60.09 | 11.75 | 12.37 | 90 | 23.00 |

| | | | | | |
|---|---|---|---|---|---|
| /100g Fw) | | | | | |
| Total Antioxidant Capacity (µ Mol/Te/G) | 2.90 | 33.98 | 34.01 | 100 | 69.93 |
| Lycopene Content (mg/100g Fw) | 3.00 | 18.36 | 18.58 | 98 | 37.39 |
| Total Carotenoids Content (mg/100g Fw) | 3.07 | 21.94 | 22.07 | 96 | 43.70 |

**Character:** GCV = Genotypic coefficient of variation, PCV= Phenotypic coefficient of variation, H= Heritability, Gen. Adv. = Genetic Advance

The maximum genetic advance (%) was recorded for Total antioxidant capacity (69.93%) followed by Total carotenoids content (43.70%) and medium genetic advance was found in TSS (12.90%). Similar result found by [17], [18] and in general, the degree of success in selection depends upon the magnitude of the heritability. Furthermore, the progress in the selection is also directly proportional to the amount of genetic advance. Therefore, the effect of selection is realized more quickly in those characters which have high heritability as well as high genetic advance perusal of data (Table 3), high heritability along with high genetic advance have also been reported for most of the quality and quality attributing traits by [19].

## Conclusion

The information generated from this study can be exploited for further breeding programme in tomato, on heritability and genetic advance revealed that high heritability coupled with high genetic advance (>20%) were recorded for all traits except for TSS (12.90%) Thus, these traits which exhibited high heritability in broad sense and high expected genetic advance as percent of mean may be considered to be largely governed by additive gene action therefore; it could be effectively improved through selection.

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