*Available online at* www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2808

**ISSN: 2320 – 7051**

*Int. J. Pure App. Biosci.* **5 (2):** 908-912 (2017)

*Research Article*

International Journal of Pure & Applied Bioscience

OPEN ACCESS

# Studies on Genetic Variability, Heritability and Genetic Advance in Tomato [*Solanum lycopersicon* (Mill.) Wettsd.]

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Received: 7.04.2017 | Revised: 15.04.2017 | Accepted: 16.04.2017

**ABSTRACT**

*Thirty-five genotypes of tomato were evaluated for yield and yield attributing characters at the Main Experiment Station, Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) during winter 2013-2014. Observations were recorded on nine quantitative characters viz., days to 50 per cent flowering, plant height (cm), number of primary branches per plant, number of locules per fruit, pericarp thickness (mm), average fruit weight (g), total soluble solids, number of fruits per plant and fruit yield per plant (g). High magnitude of phenotypic as well as genotypic coefficients of variation were observed in case of fruit yield per plant followed by average fruit weight, number of locules per fruit, number of fruits per plant, plant height and number of primary branches per plant. Days to 50 per cent flowering exhibited low level of variability. High heritability coupled with high genetic advance were estimated for all the traits except days to 50 per cent flowering indicating opportunity for selection response.*

***Key words:*** *Tomato, Colour, Flavour, Genetic variability, Phenotypic, Genotypic*

## INTRODUCTION

Tomato [*Solanum lycopersicon* (Mill.) Wettsd] is one of the most important solanaceous vegetable crop having diploid chromosome number 2n=2x=24. It is herbaceous, annual to perennial, prostrate and sexually propagated crop plant with bisexual flowers. There are four to eight flowers in each compound inflorescence. There is a light protective anther cone surrounding the stigma leading to self-pollination. Considering the potentiality of this crop, there is a need for improvement and to develop varieties suited to specific agro-ecological conditions and also for specific use. Since, it is used as fresh vegetable and it also in processing industry for preparations of various value added products such as soup, ketchups, sauces, concentrates, purees, juices etc. It contributes as an important source of lycopene (an antioxidant), ascorbic acid and ß-carotene.

**Cite this article:** Singh, A.K., Ram, C. N., Yadav, G.C., Srivastava, R.K., Deo, C., Gautam, D.K., Kumar, P. and Kumar, P., Studies on Genetic Variability, Heritability and Genetic Advance in Tomato [*Solanum lycopersicon* (Mill.) Wettsd.], *Int. J. Pure App. Biosci.* **5(2):** 908-912 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2808

In view of above facts, present investigation was carried out among thirty-five promising genotypes to study the existing genetic variability, heritability and genetic advance for further utilization in genetic/varietal improvement programme.

## MATERIALS AND METHODS

The experiment was conducted to evaluate 35 genotypes of tomato at the Main Experiment Station, Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) during 2013-2014. Seeds were sown in nursery bed one month old healthy seedlings were transplanted in the experimental plot in two row of 3 m length with inter and intra row spacing of 60 and 45 cm, respectively. Three check varieties (Punjab Chhuhara, NDT-8 and Angoorlata) along with 32 genotypes were planted in two rows, maintaining eight plants in each row. The experiment was conducted in Randomized Block Design with three replications. All recommended cultural practices were followed to maintain proper plant stand and growth. Observations were recorded for nine characters *viz.*, days to 50 per cent flowering, plant height (cm), number of primary branches per plant, number of locules per fruit, pericarp thickness (mm), average fruit weight (g), total soluble solids, number of fruits per plant, fruit yield per plant (g) and subjected to suitable statistical analysis.

## RESULTS AND DISCUSSION

All the characters were highly significant in analysis of variance of experiment (Table 1). The mean performance of 35 genotypes of tomato for nine characters had been presented in Table-2. A very wide range of variations in mean performance of genotypes were observed for all the characters. The comparison of mean performance of thirty-five genotypes for nine traits using critical differences revealed existence of very high level of variability in the used genotypes. Eight genotypes produced significantly higher fruit yield per plant in case of determinate group, while only one genotype NDT-472 (1.23g) produced significantly higher fruit yield per plant than the best check NDT-4 (1.024g) in case of indeterminate group. The highest fruit yield per plant (2791.93g) was recorded with NDT-472 and lowest fruit yield per plant (310.16g) was recorded from variety NDT-2. Genotypes NDT-472(2791.93g), NDT-471(2242.86g), H-86 (2090.16g), NDT-7 (1433.10g), NDT-511(1381.00g) and NDT-1(1317.03g) were highly significant than the best check NDT-8 (1164.66g).

### Coefficient of variation

The genotypic and phenotypic coefficients of variation were computed to assess the exiting variability in the germplasm (Table-3). The estimates of highest phenotypic as well as genotypic coefficient of variation were observed for fruit yield per plant while lowest magnitude of variability was exhibited for days to 50 per cent flowering. The high estimates of PCV and GCV for these characters were also reported by Dar and Sharma[1] and Rani and Anitha[8]. Moderate variations were noted in case of pericarp thickness, total soluble solids (TSS) and diameter of fruits. While, low GCV and PCV were observed for days to 50 per cent flowering. Moderate and low variability were also reported by Sahanur *et al*[10]., and Madhurina and Paul[4].

### Heritability and genetic advance

The highest estimates of heritability were observed in case of number of locules per fruit. Highest genetic advance in per cent of mean was observed for fruit yield per plant. The high estimates of heritability, genetic advance and genetic advance in per cent of mean for these characters were also reported earlier by several workers[2,6,11,12]. Heritability in broad sense ranged from 57.00 (50% flowering) to 98.00 per cent (Fruit yield per plant (g)) and average fruit weight (g). Higher estimates of heritability (>75) were recorded for eight characters *viz*. fruits yield per plant (98.00%), average fruit weight (98.00%), number of locules per fruit (91.00%), plant height (88.00%), primary branches per plant (92.00%), T.S.S. (89.00%), pericarp thickness (91.00%) and number of fruit per plant (97.00%) while medium (75>50%) estimates for days to 50 per cent flowering (57.00%). Higher value of genetic advance was recorded for fruits yield per plant (1147.70) followed by average fruit weight (39.04).

**Table 1: Analysis of variance (mean squares) for nine quantitative characters in tomato**

| S. No. | Characters | Source of variation | | |
|---|---|---|---|---|
| | | Replications | Treatments | Error |
| | Degree of freedom | 2 | 34 | 68 |
| 1. | Days to 50 per cent flowering | 0.08 | 42.42** | 8.49 |
| 2. | Plant height (cm) | 27.64 | 1268.17** | 54.77 |
| 3. | Number of primary branches per plant | 0.05 | 2.82** | 0.07 |
| 4. | Number of locules per fruit | 0.01 | 2.47** | 0.07 |
| 5. | Pericarp thickness (mm) | 0.00 | 2.08** | 0.06 |
| 6. | Average fruit weight (g) | 0.55 | 1105.99** | 7.29 |
| 7. | Total Soluble Solids ($^{o}$Brix) | 0.08 | 4.39** | 0.16 |
| 8. | Number of fruits per plant | 1.63 | 515.16** | 4.66 |
| 9. | Fruits yield per plant (g) | 1780.57 | 959671.47** | 7239.03 |

**- Significant at 1 per cent probability level

**Table 2: Mean performances of 35 genotypes of tomato**

| S. No. | Character / Genotypes | Days to 50% Flowering | Number of primary branches/ plant | Plant Height (cm) | Average Fruit Weight (g) | Number of Fruits /Plants | Pericarp Thickness (mm) | Number of Locules/ Fruit | Fruits Yield/ Plant (g) | Total Soluble Solids ($^{o}$Brix) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Angoorlata (C) | 55.06 | 4.12 | 92.3 | 33.83 | 25.00 | 4.00 | 4.27 | 750.63 | 5.23 |
| 2. | H-7 | 55.26 | 4.24 | 107.8 | 15.48 | 30.23 | 2.60 | 2.10 | 411.66 | 4.76 |
| 3. | NDTG-501 | 55.96 | 4.32 | 111.8 | 14.08 | 34.18 | 1.73 | 2.29 | 409.36 | 5.01 |
| 4. | NDTG-502 | 60.83 | 4.17 | 74.7 | 32.23 | 22.39 | 2.75 | 4.35 | 617.75 | 4.74 |
| 5. | NDTG-503 | 64.33 | 4.66 | 65.2 | 21.73 | 26.23 | 4.63 | 3.23 | 410.70 | 4.46 |
| 6. | Pusa Ruby | 55.46 | 4.65 | 73.5 | 42.88 | 24.06 | 3.65 | 3.70 | 877.06 | 5.07 |
| 7. | Navodaya -1 | 56.50 | 3.32 | 86.4 | 40.18 | 23.71 | 3.61 | 4.51 | 809.78 | 5.99 |
| 8. | NDTG-504 | 54.32 | 4.14 | 59.7 | 30.61 | 21.52 | 4.16 | 3.22 | 561.18 | 5.47 |
| 9. | Navodaya-2 | 54.35 | 3.00 | 67.1 | 30.00 | 27.61 | 4.64 | 4.45 | 702.90 | 5.50 |
| 10. | Azad T-1 | 64.23 | 3.00 | 62.0 | 22.62 | 18.11 | 3.12 | 4.28 | 350.02 | 5.36 |
| 11. | Azad T-6 | 60.84 | 3.62 | 39.5 | 30.08 | 28.75 | 3.99 | 5.56 | 735.26 | 5.39 |
| 12. | Arka Ahuti | 59.33 | 2.93 | 36.9 | 18.75 | 24.74 | 3.30 | 3.25 | 393.83 | 4.28 |
| 13. | H-86 | 58.15 | 4.24 | 74.7 | 67.60 | 36.36 | 2.98 | 3.81 | 2090.16 | 5.68 |
| 14. | H-24 | 54.51 | 5.04 | 54.4 | 38.07 | 35.18 | 3.41 | 3.58 | 1139.67 | 5.85 |
| 15. | NDT-471 | 54.04 | 5.33 | 92.2 | 38.63 | 68.28 | 3.45 | 3.54 | 2242.86 | 5.93 |
| 16. | NDT-472 | 55.29 | 5.86 | 83.0 | 44.68 | 74.98 | 3.48 | 3.81 | 2791.93 | 5.97 |
| 17. | NDTG-505 | 55.63 | 3.49 | 62.4 | 51.90 | 16.17 | 3.52 | 3.43 | 727.31 | 7.21 |
| 18. | NDTG-506 | 56.58 | 4.65 | 56.8 | 28.59 | 17.09 | 4.14 | 4.60 | 415.44 | 7.46 |
| 19. | NDTG-507 | 56.99 | 6.05 | 128.8 | 51.78 | 14.81 | 4.94 | 3.26 | 652.69 | 7.29 |
| 20. | NDTG-508 | 56.34 | 4.74 | 58.4 | 62.61 | 16.31 | 3.60 | 2.82 | 869.00 | 7.37 |
| 21. | NDTG-509 | 55.60 | 3.22 | 73.9 | 29.18 | 14.30 | 3.72 | 5.00 | 354.79 | 7.43 |
| 22. | NDTG-510 | 60.06 | 4.50 | 89.0 | 49.35 | 16.99 | 5.86 | 2.31 | 623.13 | 8.06 |
| 23. | Punjab Chhuhara (C) | 54.60 | 3.70 | 75.76 | 30.44 | 19.38 | 5.04 | 2.30 | 406.90 | 7.21 |
| 24. | NDT-1 | 52.40 | 3.29 | 73.8 | 76.79 | 18.65 | 4.55 | 2.70 | 1317.03 | 6.99 |
| 25. | NDT-2 | 52.10 | 5.22 | 58.5 | 56.45 | 17.10 | 4.28 | 2.42 | 310.16 | 7.27 |
| 26. | NDT-3 | 54.62 | 5.66 | 57.2 | 34.61 | 16.33 | 4.48 | 3.32 | 498.13 | 7.13 |
| 27. | NDT-4 | 53.76 | 6.34 | 91.8 | 78.21 | 17.42 | 3.24 | 5.50 | 1155.21 | 6.66 |
| 28. | NDT-5 | 56.45 | 4.42 | 88.6 | 61.90 | 18.60 | 3.29 | 4.38 | 979.03 | 6.20 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 29. | NDT-6 | 55.41 | 3.40 | 73.2 | 58.96 | 16.69 | 3.20 | 4.63 | 837.33 | 5.63 |
| 30. | NDT-7 | 55.03 | 6.38 | 67.4 | 77.33 | 21.81 | 3.54 | 3.57 | 1433.10 | 6.86 |
| 31. | NDT-8 (C) | 55.21 | 4.53 | 59.7 | 74.91 | 18.31 | 2.76 | 3.00 | 1164.66 | 6.26 |
| 32. | NDTG-511 | 58.65 | 3.16 | 54.9 | 79.06 | 18.30 | 3.90 | 2.47 | 1381.00 | 7.49 |
| 33. | Pant T-5 | 71.11 | 3.81 | 53.0 | 40.09 | 17.20 | 2.19 | 3.79 | 580.66 | 2.14 |
| 34. | NDTG-512 | 57.29 | 4.49 | 48.2 | 34.46 | 26.15 | 3.68 | 3.38 | 743.13 | 5.59 |
| 35. | NDTG-513 | 55.10 | 3.49 | 41.4 | 29.25 | 23.99 | 3.01 | 4.20 | 630.66 | 6.20 |
| | **Mean** | **56.89** | **4.32** | **71.30** | **43.64** | **24.77** | **3.67** | **3.63** | **867.83** | **6.03** |
| | C.V. | 5.12 | 6.49 | 10.38 | 6.18 | 8.72 | 7.13 | 7.60 | 9.80 | 6.76 |
| | S.E. | 1.68 | 0.16 | 4.27 | 1.55 | 1.24 | 0.15 | 0.15 | 49.12 | 0.23 |
| | C.D. 5% | 4.74 | 0.45 | 12.05 | 4.40 | 3.52 | 0.42 | 0.45 | 138.62 | 0.66 |
| | Range Lowest | 52.10 | 2.93 | 36.91 | 14.08 | 14.30 | 1.73 | 2.10 | 310.16 | 2.14 |
| | Range Highest | 71.11 | 6.38 | 128.82 | 79.06 | 74.98 | 5.86 | 5.56 | 2791.93 | 8.06 |

**Table 3: Estimates of range, grand mean, phenotypic (PCV), genotypic (GCV), environmental (ECV) coefficient of variation, heritability in broad sense, genetic advance (Ga) and Ga (in per cent of mean) for nine characters in tomato germplasm**

| S. No. | Genetic parameters / Characters | Range | | Grand mean | PCV | GCV | ECV | Heritability broad sense (%) ($h^2_{bs}$) | Genetic advance | Genetic advance in per cent of mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lowest | Highest | | | | | | | |
| **1.** | **Days to 50 % flowering** | 52.10 | 71.11 | 61.60 | 7.82 | 5.91 | 5.12 | 57 | 5.24 | 9.20 |
| **2.** | **Plant height (cm)** | 36.91 | 128.82 | 82.86 | 30.06 | 28.21 | 10.38 | 88 | 38.88 | 54.53 |
| **3.** | **Number of primary branches/ plant** | 2.93 | 6.38 | 4.65 | 23.05 | 22.12 | 6.50 | 92 | 1.89 | 43.71 |
| **4.** | **Number of locules / fruit** | 2.10 | 5.56 | 3.83 | 25.76 | 24.61 | 7.61 | 91 | 1.76 | 48.33 |
| **5.** | **Pericarp thickness (mm)** | 1.73 | 5.86 | 3.79 | 23.41 | 22.30 | 7.14 | 91 | 1.61 | 43.75 |
| **6.** | **Average fruit weight (g)** | 14.08 | 79.06 | 46.57 | 44.29 | 43.85 | 6.19 | 98 | 39.04 | 89.45 |
| **7.** | **Total Soluble Solids ( $^o$Brix )** | 2.14 | 8.06 | 5.10 | 20.81 | 19.68 | 6.77 | 89 | 2.31 | 38.34 |
| **8.** | **Number of fruits / plant** | 14.30 | 74.98 | 44.64 | 53.40 | 52.68 | 8.72 | 97 | 26.52 | 107.06 |
| **9.** | **Fruits yield pe/ plant (g)** | 310.16 | 2791.93 | 1551.04 | 65.66 | 64.93 | 9.80 | 98 | 1147.70 | 132.25 |

The degree of success in selection depends upon the magnitude of the heritability value. 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) on heritability and genetic advance revealed that high heritability coupled with high genetic advance (>75%) were recorded for all the traits except days to 50% flowering. Thus, these traits which exhibited high heritability in broad sense and high expected genetic advance as per cent of mean may be considered to be largely governed by additive gene action and therefore, could be effectively improved through selection. High heritability along with high genetic advance have also been reported for most of the yield and yield attributing traits by Mahesha *et al*[5]., Kumari *et al*[3]., Saeed *et al*[9]., Prema *et al*[7]., Tasisa *et al*[12]., Madhurina and Paul[4] and Sahanur *et al*[10].

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