Genetic Variability, Heritability and Genetic Advance for Yield and Yield Attributes in Tomato (*Solanum lycopersicum* L.)

B. Anuradha¹*, P. Saidaiah¹, K. Ravinder Reddy¹, S. Harikishan² and A. Geetha³

¹College of Horticulture, Rajendranagar, SKLTSHU, Hyderabad, India
²International Crops Research Institute for the Semi-arid Tropics, Patancheru-502 324 Hyderabad, India
³Regional Agricultural Research Station, Palem, Nagarkurnool, India

*Corresponding author

**Abstract**

The present research programme, Genetic variability, heritability and genetic advance for yield and yield attributes in tomato (*Solanum lycopersicum* L.) was carried out at experimental farm of college of horticulture, Department of vegetable science, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad, Telangana, kharif, 2017-18. Forty tomato genotypes were evaluated in Randomized Block Design with three replications. Significant differences among genotypes were noticed in all characters. In the present investigation the high genetic variability observed for the characters number of primary branches per plant, number of fruits per plant, average fruit weight, fruit yield per plant and yield per hectare reveal the significance of these characters to be used for selecting superior genotypes. High heritability coupled with high genetic advance as per cent of mean shows operation of additive gene action which was observed in character’s plant height, number of primary branches per plant, days to 50% flowering, days to fruit set, number of fruits per plant, average fruit weight, fruit yield per plant, yield per hectare, ascorbic acid content, TSS, beta carotene and lycopene content which may be exploited for improvement through phenotypic selection for yield improvement.

**Keywords**

Genetic Variability, Heritability, Genetic advance as per cent of mean, Yield and Yield attributes, Tomato

**Article Info**

Accepted: 17 October 2020
Available Online: 10 November 2020

**Introduction**

Tomato (*Solanum lycopersicum* L.), originated from South America, is one of the most important and widely grown crop in Solanaceae family. Tomato is also called Love apple, Poor man’s orange and it is universally treated as Protective food. It is rich in Vit-C and it is an important source of lycopene, which is a powerful antioxidant and it prevents certain types of cancer.

The magnitude of variability and its genetic components are the most pivotal aspects of breeding material. Variability in tomato is anticipated to be immense as the fruits vary greatly in shape and size (Dixit and Dubey, 1985; Bhardwaj and Sharma, 2005). Studies
on genetic parameters and character associations provide to choose and help to develop optimum breeding procedure. Many researchers (Kamruzzahan et al., 2000) have noticed different genetic parameters in tomato based on few traits. As yield is the prime object of a breeder, it is essential to know the relationship between various characters that have direct and indirect effect on yield. Generally, genotypic coefficient of variability (GCV) and phenotypic coefficient of variability (PCV) are measured to study the variability.

Heritability and genetic advance are important selection parameters. However, the character showing high heritability needs not exhibit high genetic advance (Johnson et al., 1955). High heritability coupled with high genetic advance indicates that the improvement could be made for a character by simple selection.

Materials and Methods

The experimental material comprised of forty germplasm lines, of tomato 34 genotypes and 6 released varieties as checks (Arka Vikas, Pusa Ruby, PKM-1, Marutham, Arka Meghali, Arka Alok) which were obtained from NBPGR, Regional Station, Hyderabad, IARI, New Delhi, IIHR, Bengaluru which were evaluated systematically during the research period.

The research was carried out at the experimental farm of college of horticulture, Department of vegetable science, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad, Telangana, kharif, 2017-18. The experiment was laid out with forty genotypes of tomato in Randomized Block Design (RBD) with three replications. Each germplasm line was grown in a plot of 1.8 m × 3.15 m (5.67 Sq. meters) accommodating 21 plants per plot, 7 plants per row with spacing of 60×45 cm² per replication. Broad sense heritability was calculated as per Lush (1940) and genetic advance assessed by the method of Johnson et al., (1955).

Genotypic and phenotypic coefficients of variation were deliberated by using the formulae of Burton (1952). Categorization of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) and genetic advance (GA) were done as per Sivasubramanian and Menon (1973) and heritability categorized as by Johnson et al., (1955).

Results and Discussion

Plant growth characters

The data regarding plant height showed very high phenotypic and genotypic variances (994.66 and 961.95) which were combined with high PCV (28.78%) and GCV (28.30%) respectively (Table 1). This trait exhibited high heritability (96.70%) with high genetic advance (62.83) and high GA as per cent mean (57.34).

The outcome for the trait plant height are in proof with the results of Sajjan et al., (2016), Somraj et al., (2017), Vijay Bahadur et al., (2017), Kumar Nitish et al., (2018) and Sritama Kundu et al., (2018).

The data regarding number of primary branches per plant revealed low phenotypic and genotypic variances of 4.83 and 4.71 respectively with high PCV (37.30%) and GCV (36.86%). The high heritability (97.70%), low genetic advance (4.42) and high GA as per cent mean (75.05) were also noticed for this trait. Comparable results were reported by Mehta and Asati (2008), Anitha et al., (2013), Arun et al., (2016), Shankar et al., (2016), Kumar Manish et al., (2017) and Somraj et al., (2017).
Table 1: Estimation of variability, heritability and genetic advance as % of mean for thirteen characters in forty genotypes of tomato

| S. No | Characters                                      | Range          | Mean      | Variance    | PCV (%) | GCV (%) | $h^2_{bs}$ (%) | Genetic Advance | GA as % of mean |
|-------|------------------------------------------------|----------------|-----------|-------------|---------|---------|---------------|-----------------|-----------------|
| 1     | Plant height (cm)                              | 68.60-191.56   | 109.56    | 994.66-961.95 | 28.78   | 28.30   | 96.70         | 62.83           | 57.34           |
| 2     | Number of primary branches per plant           | 2.43-9.83      | 5.89      | 4.83-4.71   | 37.30   | 36.86   | 97.70         | 4.42            | 75.05           |
| 3     | Days to first flowering                        | 21.26-43.86    | 31.62     | 22.45-14.26 | 14.98   | 11.94   | 63.50         | 6.20            | 19.61           |
| 4     | Days to 50% flowering                          | 29.00-52.00    | 37.13     | 26.94-21.85 | 13.98   | 12.59   | 81.10         | 8.67            | 23.35           |
| 5     | Days to fruit set                              | 37.60-63.13    | 45.40     | 44.20-29.38 | 14.64   | 11.94   | 66.50         | 9.10            | 20.05           |
| 6     | Number of fruits per plant                     | 10.58-323.00   | 54.45     | 6038.11-6026.12 | 142.69 | 142.54  | 99.80         | 159.75          | 293.35          |
| 7     | Average fruit weight (g)                       | 0.96-194.44    | 53.87     | 1645.41-1625.22 | 75.29 | 74.82   | 98.80         | 82.53           | 153.19          |
| 8     | Fruit yield/plant (kg)                         | 0.26-2.28      | 1.17      | 0.28-0.27   | 45.30   | 44.82   | 97.90         | 1.07            | 91.38           |
| 9     | Yield /ha (t)                                  | 9.66-85.96     | 43.44     | 385.61-379.12 | 45.20 | 44.81   | 98.30         | 39.77           | 91.54           |
| 10    | Ascorbic acid content (mg/100g)                | 11.76-59.43    | 31.25     | 103.27-101.00 | 32.51 | 32.16   | 97.80         | 20.47           | 65.51           |
| 11    | TSS (°Brix)                                    | 2.96-8.16      | 4.31      | 1.35-1.31   | 26.92   | 26.57   | 97.40         | 2.33            | 54.03           |
| 12    | Beta-carotene (mg/100g)                        | 1.06-2.63      | 1.70      | 0.19-0.18   | 25.87   | 25.50   | 97.20         | 0.88            | 51.79           |
| 13    | Lycopene content (mg/100g)                     | 0.00-6.12      | 3.31      | 1.61-1.59   | 38.37   | 38.07   | 98.50         | 2.58            | 77.83           |

PCV and GCV: Phenotypic and genotypic coefficient of variation, $h^2_{bs}$: Heritability in broad sense, GA: Genetic Advance
Moderate phenotypic and genotypic variances (22.45 and 14.26 respectively) with moderate PCV (14.98%) and GCV (11.94%), high heritability (63.50%), low genetic advance (6.20) and moderate GA as per cent mean (19.61) were revealed for the character days to first flowering.

The data regarding days to 50 per cent flowering exhibited high phenotypic and genotypic variances (26.94 and 21.85 respectively) with moderate PCV (13.98%) and GCV (12.59%). High heritability (81.10%), moderate genetic advance (8.67) and high GA as per cent mean (23.35) estimates were noticed for this trait. The results are similar with findings of Anitha et al., (2013), Arun et al., (2016) and Shankar et al., (2016).

High phenotypic and genotypic variance values of 44.20 and 29.38 with moderate PCV and GCV of 14.64 % and 11.94 %, very high heritability (66.50%), moderate genetic advance (9.10) and high GA as per cent mean (20.05) respectively were noticed for the days to fruit set.

The data regarding number of fruits per plant exhibited very high phenotypic and genotypic variances of (6038.11 and 6026.12 respectively) were recorded with very high PCV and GCV of 142.69% and 142.54%. Very high heritability (99.80%), very high genetic advance (159.75) and very high GA as per cent mean (293.53) were recorded for this trait. The results are similar with findings of Kumari and Sharma (2013), Vinod Kumar et al., (2013), Sajjan et al., (2016), Bhandari et al., (2017), Dixit and Pandey et al., (2017), Vijay Bahadur et al., (2017), Kumar Nitish et al., (2018) and Sritama Kundu et al., (2018).

The data regarding average fruit weight revealed high phenotypic and genotypic variances (1645.41 and 1625.22) along with high PCV (75.29%) and GCV (74.82%), very high heritability (98.80%), high genetic advances (82.53) as well as high GA as per cent mean (153.19) were recorded for this trait. Comparable results are noticed by Lal et al., (1991), Brar and Singh (1998), Mohanty (2002), Sharma et al., (2006), Islam et al., (2012) and Mohamed et al., (2012), Rahaman et al., (2012), Sajjan et al., (2016), Bhandari et al., (2017), Somraj et al., (2017), Vijay Bahadur et al., (2017) and Kumar Nitish et al., (2018).

The data regarding yield per hectare showed high phenotypic and genotypic variances (385.61 and 379.12) with high PCV (45.20%) and GCV (44.81%), high heritability (98.30%) coupled with high genetic advance (39.77) and high GA as per cent mean (91.54).

Quality characters

Very high phenotypic (103.27) and genotypic (101.00) variances and high PCV (32.51%) and GCV (32.16%) were noted for ascorbic acid. High heritability (97.80%), high genetic advance (20.47) and high GA as per cent mean (65.51) estimates were noticed for this trait. The results are in line with the findings of Singh et al., (1973), Kumari et al., (1980), Supe (1985) and Sharma et al., (2006), Ranjodh et al., (2005), Anoop et al., (2013), Meena and Bahadur (2014), Umesh et al., (2015), Arun et al., (2016) and Shankar et al (2016), and Dixit and Pandey et al., (2017).
With regards to total soluble solids, low phenotypic and genotypic variances (1.35 and 1.31), moderate PCV (26.92%) and GCV (26.57%), high heritability (97.40%), low genetic advance (2.33), and high GA as per cent mean (54.03) estimates were noted. The results are in similar with the findings of Arun and Veeraraghavatham et al., (2005), Kumar and Thakur (2007), Anitha et al., (2013), Shankar et al., (2013), Arun et al., (2016) and Shankar et al., (2016). The data regarding beta carotene showed very low phenotypic and genotypic variances (0.19 and 0.18), moderate PCV (25.87%) and GCV (25.50%), high heritability (97.20%), very low genetic advance (0.88), and high GA as per cent mean (51.79) estimates were noted. With regards to lycopene, low phenotypic and genotypic variances (1.61 and 1.59), high PCV (38.37%) and GCV (38.07%), high heritability (98.50%), low genetic advance (2.58), and high GA as per cent mean (77.83) which are in line with the findings of Kumar et al., (2006), Anitha et al., (2013), Shankar et al., (2013), Arun et al., (2016) and Shankar et al., (2016).

Thus, it may be concluded that high genetic variability demonstrated directional selection could be essential for desired genetic improvement. High heritability coupled with high genetic advance as per cent of mean specify the significance so, that these characters can be utilized for choosing superior genotypes. Moderate genetic advance as per cent of mean with high heritability suggests the action of both additive and non-additive genes and favorable influence of environment in the expression. The same was reported in case of days to first flowering. Therefore, the breeder should adopt suitable breeding methodology to utilize both additive and non-additive gene effects simultaneously, since varietal and hybrid development will go a long way in the breeding programmes.

References

Anitha P. (2013). Studies on genetic diversity, screening and identification of parents and hybrids for drought tolerance in tomato (Solanum lycopersicum L.). Ph.D. (Horti.) thesis. Dr. Y. S. R. Horticultural University Venkataramannagudem, India.

Anoop Shetty, A. (2013). Line x tester analysis in tomato (Solanum lycopersicum L.). Ph.D. (Horti.) thesis. G.B. Pant University of Agriculture & Technology Pantnagar 263 145, (U.S. Nagar), Uttarakhand, India.

Arun Kumar P, Ravinder reddy K, RVSK Reddy, Pandravada, SR. and Saidaiah, P. (2016). Genetic divergence studies in tomato genotypes. The Bioscan. An international quarterly journal of life sciences. 11(4):30713074.

Bhandari, H. R, Kartikeya Srivastava and Eswar Reddy, G. (2017). Genetic Variability, Heritability and Genetic Advance for Yield Traits in Tomato (Solanum lycopersicum L.). International Journal of Current Microbiology and Applied Sciences. 6(7): 4131-4138.

Bhardwaj, N. V. and Sharma, M.K. (2005). Genetic parameters and character association in tomato. Bangladesh Journal of Agricultural Research. 30 (1) :49-56.

Brar, P.S. and Singh Hari (1998). Variability and correlation studies in different varieties of tomato (Lycopersicon esculentum Mill.). Punjab vegetable Grower. 33:23-26.

Burton, J.W. (1952). Quantitative inheritance in grasses. Proceeding of 6th International Grassland Congress. 1: 277-283.

Dixit, P. and Dubey, D.K. (1985). Heritability and genetic advance in induced mutant in lentil. Ind. J. Genet. 45 (3): 520-524.

Dixit, S. and Pandey, V.R. (2017). Genetic variability, heritability and genetic advance in tomato [Solanum lycopersicon (Mill.) Wettsd]. The Asian Journal of Horticulture. 12(1): 75-78.
Islam, M.S, Mohanta, H.C, Rafii, M.Y. and Malek, M.A.(2012). Genetic variability and trait relationship in cherry tomato (Solanum lycopersicum L.). Bangladesh Journal of Botany. 41(2): 163-167.

Johnson, H.W, Robinson, H.F. and Comstock, R.E. (1955). Estimation of genetic and environmental variability in soybean. Agronomy journal. 47: 314-318.

Kamruzzahan M, Hossain M, Islam, R. and Alam, M.F. (2000). Variability and correlation studies in tomato (Lycopersicon esculentum Mill.). Bangladesh J Genet Biotech. 1(1): 21-26.

Kaushik, S.K, Tomar, D.S. and Dixit, A.K. (2011). Genetics of fruit yield and it’s contributing characters in tomato (Solanum lycopersicom L.). Journal of Agricultural Biotechnology and Sustainable Development. 3(10): 209 - 213.

Kumar manish, Yadav, R. K, Yadav Rajeev, K, Behera, T.K. and Talukdar Akshay (2017). Estimates of genetic variability, heritability and genetic advance for yield and yield component traits in thermo tolerant tomato (Solanum lycopersicum L.) genotypes. International Journal of Agriculture Sciences. 9(2):3640-3642.

Kumar Nitish, Kumar Santosh, Sharma Ankita (2018). Studies on genetic variability, heritability and genetic advance in tomato. Journal of Hill Agriculture. 8(4):361-365.

Kumar, R. and Thakur, M.C. (2006). Genetic variability, heritability, genetic advance, correlation coefficients and path analysis in tomato. Haryana Journal of Horticultural Science. 34(3-4):370-373.

Kumar, N, Muthukrishnan, C.R. and Iruilappa, I. (1980). Genetic variability, heritability and coheritability in the segregating generation of tomato (Lycopersicon esculentum Mill.). South Indian Horticulture. 28(1): 105-108.

Kumari, S. and Sharma, M.K. (2013). Genetic variability in tomato (Solanum lycopersicum L.). Journal of Vegetable Science. 40(1): 83-86.

Lal, G, Singh, D.K. and Tiwari, R.P. (1991). Performance of some tomato cultivars during summer in Tarai region. Vegetable Science. 18: 99-101.

Lush, J.L. (1949) Intro-site correlation and regression of off spring on corn as a method of estimating heritability of characters. Proceedings of the American Society of Animal Production. 33: 293-301.

Meena, O.P. and Bahadur, V. (2014). Breeding potential of indeterminate tomato (Solanum lycopersicum L.) accessions using d² analysis. SABRAO journal of breeding and genetics. 47(1):49-59.

Mehta, N. and Asati, B.S. (2008). Genetic relationship of growth and development traits with fruit yield in tomato (Lycopersicon esculentum Mill.). Karnataka Journal of Agriculture Science. 21(1):92-96.

Mohamed, S.M, Ali, E.E. and Mohamed, T.Y. (2012). Study of heritability and genetic variability among different plant and fruit characters of tomato (Solanum lycopersicon L.). International Journal of science. 1(2): 55-58.

Mohanty, B.K. (2002). Variability, heritability and path coefficient analysis in tomato. (Lycopersicon esculentum Mill.). Haryana Journal of Agricultural Sciences. 2(1): 65-79.

Rahaman, S, Lakshman, S.S. and Maitra, N.J. (2012). Genetic variability and heritability in tomato (Lycopersicon esculentum Mill.). International Journal of Plant Science. 7(1): 58-62.

Rakesh Kumar Meena, Sanjay Kumar, Meena, M.L. and Shashank Verma (2018). Genetic variability, heritability and genetic advance for yield and quality attributes in tomato (Solanum lycopersicum L.). Journal of Pharmacognosy and Phytochemistry. 7(1): 1937-1939.

Ranjodh Singh, Surjan Singh, Cheema, D.S. and Dhaliwal, M.S. (2005). Screening for heat tolerance in tomato (Solanum lycopersicum L.). Veg. Sci. 32(1):90-91.
Rick, C.M. (1969). Origin of cultivated tomato, current status of the problem. Abstract XI International Botanical Congress, p.180.

Sajjan, A.M, Lingaiah, H.B, Fakrudin, B. (2016). Studies on Genetic Variability, Heritability and Genetic Advance for Yield and Quality Traits in Tomato (Solanum lycopersicum L.). International Journal of Horticulture. 6 (18):1-15.

Shankar, A. (2016). Studies on heterosis, combining ability and stability for yield and its components in tomato (Solanum lycopersicum L.). Ph.D. (Horti.) thesis. Dr. Y. S. R. Horticultural University. Venkataramannagudem, India.

Shankar, A, RVSK Reddy, Sujatha, M. Pratap, M. (2013). Genetic association analysis for yield and quality traits in tomato (Solanum lycopersicum L.). International Journal of Innovative Horticulture. 2(1):70-77.

Sharma, J.P, Sanjeev Kumar, Singh, A.K and Anil Bhushan (2006). Variability and interrelationship studies in tomato (Lycopersicon esculentum Mill.). Journal of Research. 5 (1): 100-104.

Singh, R.R, Mital, R.K. and Singh, H.N. (1973). Note on variability studies on some intervarietal crosses in tomato. Progressive Horticulture. 5 (2): 55-60.

Sivasubramanian, S. and Madhava Menon, P. (1973). Genotypic and phenotypic variability in rice. Madras Agricultural Journal. 60: 1093-1096.

Somraj, B, RVSK Reddy, Ravinder Reddy, K, Saidaiah, P. and Thirupathi Reddy, M. (2017). Genetic variability, heritability and genetic advance for yield and quality attributes in heat tolerant exotic lines of tomato (Solanum lycopersicum L.). Journal of Pharmacognosy and Phytochemistry. 6(4): 1956-1960.

Sritama Kundu, D.L, Savithramma, K. Mallikarjun and Madhu, S.V. (2018) Estimation of Genetic Parameters for Fruit Yield, Yield Related Traits and Traits Related to WUE in F5 Generation of the Inter-Specific Cross between EC 771612 × LA 2657 in Tomato. International Journal of Current Microbiology and Applied Sciences. 7(1): 466-471.

Supe, V.S. (1985). Genetic variability and correlation studies in tomato. M. Sc. thesis (Unpub.), Dr. PDKV, Akola.

Umesh, S, Pradeep, K.P., Amit, K.S., Vivek, Rajesh, K. and Rai, N. (2015). Screening of tomato genotypes under high temperature stress for reproductive traits. Veg. Sci. 42(2):52-55.

Vijay Bahadur, Priyanka Parappa Ligade, and Pushpa Gudadinni (2017). Study on Genetic Variability, Heritability, Genetic Advance in Tomato (Solanum lycopersicum L.). International Journal of Current Microbiology and Applied Sciences. 6(11): 1775-1783.

Vinod Kumar, R, Nandan, K, Srivastava, S.K., Sharma, Ravindra Kumar and Anuj Kumar (2013). Genetic parameters and correlation study for yield and quality traits in tomato (Solanum Lycopersicum L.). Plant Archives. 13 (1): 463-467.

How to cite this article:

Anuradha, B., P. Saidaiah, K. Ravinder Reddy, S. Harikishan and Geetha, A. 2020. Genetic Variability, Heritability and Genetic Advance for Yield and Yield Attributes in Tomato (Solanum lycopersicum L.). Int. J. Curr. Microbiol. App. Sci. 9(11): 2385-2391. doi: https://doi.org/10.20546/ijcmas.2020.911.286