International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2020; 8(1): 1497-1500

Received: 20-11-2019
Accepted: 26-12-2019

**Pushpendra Kumar**
Assistant Professor,
Department of Agriculture,
Roorkee College of Engineering,
Roorkee, Uttarakhand, India

**CN Ram**
Associate Professor,
Department of Vegetable Science, ANDUA&T,
Kumarganj, Ayodhya,
Uttar Pradesh, India

**MK Singh**
Assistant Professor
School of Agriculture,
Lovely Professional University,
Jalandhar (Punjab)

**Ajeet Singh**
Assistant Professor
Department of Agriculture,
Bindeshwari P. G. College,
Ambedkar Nagar,
Uttar Pradesh, India

**Corresponding Author:**
**Pushpendra Kumar**
Assistant Professor,
Department of Agriculture,
Roorkee College of Engineering,
Roorkee, Uttarakhand, India

# Studies on gene action involved in inheritance for yield and its attributing traits in tomato (*Solanum lycopersicum* L.)

**Pushpendra Kumar, CN Ram, MK Singh and Ajeet Singh**

**DOI:** https://doi.org/10.22271/chemi.2020.v8.i1u.8467

**Abstract**
The present study was carried out during *Rabi* seasons of 2016-17 and 2017-18 at Main Experiment Station of Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) India. The experimental materials of the study comprised of 54 treatments of tomato [40 $F_1$'s and 14 parental lines (10 lines *viz.*, NDT-1, NDT-2, NDT-3, NDT-4, NDT-5, NDT-6, NDT-7, NDT-8, Azad T-6, Arka Saurabh and 4 testers *viz.*, Pusa Ruby, Punjab Chhuhara, Arka Vikash and Arka Meghali]. The 14 parents were involved in a crossing programme to develop a line × tester set (10 lines + 4 testers + 40 $F_1$'s). The experimental materials (40 $F_1$'s and 14 parental lines) were evaluated in Randomized Complete Block Design (RBD) with three replication having each experimental unit with spacing of 60cm × 50cm with plot size of 1.2m ×3.0m. The observations were recorded on eighteen characters, *viz.*, days to 50 % flowering, days to first fruit set, days to first fruit harvest, plant height (cm), number of primary branches per plant, number of fruits per cluster, number of fruits per plant, fruit weight per plant (kg), average fruit weight (g), fruit length (cm), fruit girth (cm), number of locules per fruit, pericarp thickness (mm), total soluble solids (TSS), ascorbic acid (mg/100g fresh fruit) total fruit yield per plant (kg). Estimates of sca variance were higher than gca variances for most of the traits except plant height and ascorbic acid in both years and pooled. The value of sca variances were found significant and positive for all the characters except number of primary branches per plant and pericarp thickness in both years, total soluble solids in pooled. Likewise, positive and significant gca variances were also exhibited by almost all the characters except days to 50 % flowering, days to first fruit set, fruit length and total soluble solids in both the years and pooled. Average degree of dominance were more than unity (>1) for the characters like plant height, number of fruits per plant and ascorbic acid in both year and pooled, for number of primary branches per plant, pericarp thickness and total fruit yield per plant in both years except pooled. The predictability ratio was lesser than (<1) for all the characters under study in both the years and pooled. Estimate of high heritability in narrow-sense was recorded for plant height followed by ascorbic acid and number of fruits per plant in both years and pooled. Estimate of high genetic advance in per cent of mean (>20%) was observed for plant height in both years and pooled.

**Keywords:** Gene action involved in inheritance for yield and its attributing traits in tomato (*Solanum lycopersicum* L.)

## Introduction
Tomato (*Solanum lycopersicum* L.), 2n=2x=24, a member of the family Solanaceae is one of the most popular & extensively cultivated vegetable throughout the world.
It is originated from Peru Ecuador and Bolivia region of Andes of South America (Rick, 1969) [6]. India ranks third in terms of production after China and USA. In India, total area under tomato cultivation is 0.808 million hectares with production of 19.69 million tonnes and its productivity is 24.4 tonnes per hectare; In India the leading tomato growing states are, Karnataka, West Bengal, Maharashtra, Uttar Pradesh, Haryana, Punjab, Gujarat and Bihar. (Anonymous, 2017) [1].
The assessment of the parents for their ability to donate desirable genes to their offspring is an important pre-requisite for a systematic vegetable-breeding programme aimed at development of superior strains or varieties. The concept of combining ability analysis has been frequently used in numerous plant species for discriminating the parents for use in hybridization programmes and for understanding the nature and magnitude of gene action governing various

Characters. In biometrical genetics, two types of combining abilities considered i.e. general combining ability (GCA) and specific combining ability (SCA). General combining ability refers to the average performance of the genotype in a series of hybrid combinations and is a measure of additive gene action whereas; specific combining ability is the performance of a parent in a specific cross in relation to general combining ability. SCA is due to genes showing non-additive effects (Sprague and Tatum, 1942) [7]. The importance of combining ability studies lies in the assessment of parental lines and their hybrid combination showing significant additive and non-additive gene effects with respect to certain traits. Gene action refers to the mode of expression of genes in a breeding population. Modes of gene action provide guidelines in the selection of parents for utilization in hybridization programmes as well as choice of breeding procedures for genetic improvement of various quantitative traits of interest. Its main attributes include genetic components of variance that comprises the magnitude of combining ability variances and their relative effects. Based on genetic variance, gene action is being described in three different forms i.e., additive gene action, dominant and epistatic gene action, respectively. Latter two are collectively termed as non-additive gene action. Different factors affect the mode of gene action, which includes type of genetic material utilized, mode of pollination, pattern of inheritance, sample size, sampling methods, existence of linkages and methods of derivation on gene action. Various biometrical techniques for combining ability analysis such as line × tester, diallel, partial diallel and augmented partial diallel analysis have been developed for accomplishing the twin objectives of understanding the inheritance of characters and identification of genotypically superior parents and crosses.

**Materials and Methods**

The present study was carried out during *Rabi* seasons of 2016-17 and 2017-18 at Main Experiment Station of Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) India. The experimental materials of the study comprised of 54 treatments of tomato [40 $F_1$'s and 14 parental lines (10 lines *viz.*, NDT-1, NDT-2, NDT-3, NDT-4, NDT-5, NDT-6, NDT-7, NDT-8, Azad T-6, Arka Saurabh and 4 testers *viz.*, Pusa Ruby, Punjab Chhuhara, Arka Vikash and Arka Meghali]. The 14 parents were involved in a crossing programme to develop a line × tester set (10 lines + 4 testers + 40 $F_1$'s). The experimental materials (40 $F_1$'s and 14 parental lines) were evaluated in Randomized Complete Block Design (RBD) with three replication having each experimental unit with spacing of 60 cm × 50 cm with plot size of 1.2 m × 3.0 m. The observations were recorded on eighteen characters, *viz*., days to 50 % flowering, days to first fruit set, days to first fruit harvest, plant height (cm), number of primary branches per plant, number of fruits per cluster, number of fruits per plant, fruit weight per plant (kg), average fruit weight (g), fruit length (cm), fruit girth (cm), number of locules per fruit, pericarp thickness (mm), total soluble solids (TSS), ascorbic acid (mg/100g fresh fruit) total fruit yield per plant (kg). The analysis of variance was carried out as suggested by Panse and Sukhatme (1967).

**Result and Discussion**

The estimates of gca and sca variances, predictability ratio and average degree of dominance had given in Table 1.

In the year $Y_1$, estimates of sca variance were higher than gca variances for all the traits except plant height, pericarp thickness and ascorbic acid. The value of sca variances were found significant and positive for all the characters except number of primary branches per plant and pericarp thickness. Likewise, positive and significant gca variances were also exhibited by almost all the characters except days to 50 % flowering, days to first fruit set, fruit length, fruit girth and total soluble solids. The value of average degree of dominance was more than unity (1) and highest for plant height (12.84) followed by pericarp thickness (6.94), ascorbic acid (3.72), number of fruits per plant (1.80), number of primary branches per plant (1.54) and total fruit yield per plant (1.10) revealed over dominance. Less than unity (1) and lowest for total soluble solids (0.10), days to first fruit set (0.12), fruit length (0.13), days to 50 % flowering (0.15), fruit girth (0.31), days to first fruit harvest (0.34), average fruit weight (0.35), number of locules per fruit (0.39) and number of fruits per cluster (0.97) indicating partial dominance. The general predictability ratio was less than one for all the characters. $\sigma^2A$ greter then $\sigma^2D$ in plant height (721.63), number of primary branches per plant (0.04), number of fruits per plant (15.77), pericarp thickness (0.03) and ascorbic acid (59.53) then it repregent the preponderance of recessive effect and $\sigma^2D$ greter then $\sigma^2A$ in all traits except plant height (56.20), number of primary branches per plant (0.03), number of fruits per plant (8.74), pericarp thickness (0.01) and ascorbic acid (16.02) then it repregent the preponderance of dominance effect.

In the year $Y_2$, estimates of sca variance were higher than gca variances for all the traits except plant height, pericarp thickness and ascorbic acid. The value of sca variances were found significant and positive for all the characters except number of primary branches per plant and pericarp thickness. Likewise, positive and significant gca variances were also exhibited by almost all the characters except days to 50 % flowering, days to first fruit set, fruit length and total soluble solids. The value of average degree of dominance was more than unity (1) and highest for plant height (12.06) followed by pericarp thickness (7.53), ascorbic acid (2.56), number of fruits per plant (1.80), number of primary branches per plant (1.56) and total fruit yield per plant (1.53) revealed over dominance. Less than unity (1) and lowest for total soluble solids (0.10), days to first fruit set (0.12), fruit length (0.13), days to 50 % flowering (0.27), fruit girth (0.33), days to first fruit harvest (0.34), average fruit weight (0.36), number of locules per fruit (0.39) and number of fruits per cluster (0.93) indicating partial dominance. The general predictability ratio was less than one for all the characters. $\sigma^2A$ greter then $\sigma^2D$ in plant height (754.00), number of primary branches per plant (0.04), number of fruits per plant (15.77), pericarp thickness (0.03) and ascorbic acid (57.33) then it.

**Table 1:** Components of genetic variance, average degree of dominance, predictability ratio and heritability in narrow sense for 15 characters in tomato over two years and pooled

| Parameters/Characters | GCA variance ($\sigma^2g$) | | | SCA variance ($\sigma^2s$) | | | Average degree of dominance $\sqrt{\sigma^2s/2\sigma^2g}$ | | | Predictability ratio $2\sigma^2g/2\sigma^2g+\sigma^2s)$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | Pooled | $Y_1$ | $Y_2$ | Pooled | $Y_1$ | $Y_2$ | Pooled | $Y_1$ | $Y_2$ | Pooled |
| Days to 50 % flowering | 0.15 | 0.20 | 0.24 | 1.98** | 1.52** | 2.19** | 0.15 | 0.27 | 0.22 | 0.13 | 0.21 | 0.18 |
| Days to first fruit set | 0.08 | 0.08 | 0.17 | 1.28** | 1.28** | 1.90** | 0.12 | 0.12 | 0.17 | 0.11 | 0.11 | 0.15 |
| Days to first fruit harvest | 0.16* | 0.16* | 0.24 | 0.92* | 0.92* | 1.48** | 0.34 | 0.34 | 0.32 | 0.25 | 0.25 | 0.24 |
| Plant height (cm) | 360.82** | 377.00** | 368.98** | 56.20** | 62.50** | 59.64** | 12.84 | 12.06 | 12.37 | 0.93 | 0.92 | 0.92 |
| Number of primary branches per plant | 0.02** | 0.02** | 0.03 | 0.03 | 0.03 | 0.07** | 1.54 | 1.56 | 0.75 | 0.61 | 0.61 | 0.43 |
| Number of fruits per cluster | 0.04** | 0.04** | 0.05 | 0.09* | 0.09* | 0.14** | 0.97 | 0.93 | 0.72 | 0.49 | 0.48 | 0.42 |
| Number of fruits per plant | 7.89** | 7.89** | 7.93** | 8.74** | 8.74** | 9.07** | 1.80 | 1.80 | 1.75 | 0.64 | 0.64 | 0.64 |
| Average fruit weight (gm) | 8.36* | 8.38* | 8.45 | 47.10** | 47.06** | 47.63** | 0.35 | 0.36 | 0.35 | 0.26 | 0.26 | 0.26 |
| Fruit length (cm) | 0.01 | 0.01 | 0.02 | 0.18** | 0.18** | 0.23** | 0.13 | 0.13 | 0.17 | 0.12 | 0.12 | 0.14 |
| Fruit girth (cm) | 0.05 | 0.06* | 0.09 | 0.34* | 0.34* | 0.59** | 0.31 | 0.33 | 0.31 | 0.24 | 0.25 | 0.23 |
| Number of locules per fruit | 0.04* | 0.04* | 0.05 | 0.23** | 0.23** | 0.29** | 0.39 | 0.39 | 0.37 | 0.28 | 0.28 | 0.27 |
| Pericarp thickness (mm) | 0.02** | 0.02** | 0.02* | 0.01 | 0.00 | 005** | 6.94 | 7.53 | 0.90 | 0.87 | 0.88 | 0.47 |
| Total soluble solid (TSS) | 0.01 | 0.01 | 0.02 | 0.22** | 0.22** | 0.26** | 0.10 | 0.10 | 0.13 | 0.09 | 0.09 | 0.12 |
| Ascorbic acid (mg/100 g fresh fruit) | 29.76** | 28.66** | 29.02** | 16.02** | 22.37** | 17.82** | 3.72 | 2.56 | 3.26 | 0.79 | 0.72 | 0.76 |
| Total fruit yield per plant (kg) | 0.02** | 0.02** | 0.03** | 0.04** | 0.03** | 0.05** | 1.10 | 1.53 | 0.07 | 0.52 | 0.60 | 0.52 |

**Table 1:** Contd.....

| Parameters/Characters | $\sigma^2A$ | | | $\sigma^2D$ | | | Heritability ($h^2ns$ %) | | | Genetic advance in per cent of mean | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | Pooled | $Y_1$ | $Y_2$ | Pooled | $Y_1$ | $Y_2$ | Pooled | $Y_1$ | $Y_2$ | Pooled |
| Days to 50 % flowering | 0.30 | 0.40 | 0.48 | 1.98 | 1.52 | 2.19 | 9.59 | 14.42 | 22.44 | 0.35 | 0.50 | 0.68 |
| Days to first fruit set | 0.15 | 0.15 | 0.33 | 1.28 | 1.28 | 1.90 | 6.05 | 6.05 | 22.38 | 0.20 | 0.20 | 0.56 |
| Days to first fruit harvest | 0.31 | 0.31 | 0.48 | 0.92 | 0.92 | 1.48 | 13.11 | 13.11 | 46.34 | 0.42 | 0.42 | 0.97 |
| Plant height (cm) | 721.63 | 754.00 | 737.95 | 56.20 | 62.50 | 59.64 | 92.32 | 91.89 | 92.43 | 53.17 | 54.22 | 53.80 |
| Number of primary branches per plant | 0.04 | 0.04 | 0.06 | 0.03 | 0.03 | 0.07 | 27.64 | 27.58 | 76.03 | 0.22 | 0.22 | 0.42 |
| Number of fruits per cluster | 0.09 | 0.08 | 0.10 | 0.09 | 0.09 | 0.14 | 31.52 | 30.11 | 61.85 | 0.34 | 0.32 | 0.51 |
| Number of fruits per plant | 15.77 | 15.77 | 15.87 | 8.74 | 8.74 | 9.07 | 62.41 | 62.41 | 65.36 | 6.46 | 6.46 | 6.63 |
| Average fruit weight (gm) | 16.72 | 16.77 | 16.90 | 47.10 | 47.06 | 47.63 | 25.71 | 25.78 | 26.61 | 4.27 | 4.28 | 4.37 |
| Fruit length (cm) | 0.02 | 0.02 | 0.04 | 0.18 | 0.18 | 0.23 | 7.70 | 7.70 | 21.18 | 0.09 | 0.09 | 0.19 |
| Fruit girth (cm) | 0.11 | 0.11 | 0.18 | 0.34 | 0.34 | 0.59 | 11.42 | 12.15 | 43.41 | 0.23 | 0.24 | 0.58 |
| Number of locules per fruit | 0.09 | 0.09 | 0.11 | 0.23 | 0.23 | 0.29 | 20.53 | 20.53 | 35.64 | 0.28 | 0.28 | 0.40 |
| Pericarp thickness (mm) | 0.03 | 0.03 | 0.05 | 0.01 | 0.00 | 0.05 | 28.36 | 28.30 | 98.52 | 0.20 | 0.20 | 0.44 |
| Total soluble solid (TSS) | 0.02 | 0.02 | 0.04 | 0.22 | 0.22 | 0.26 | 6.75 | 6.75 | 16.12 | 0.08 | 0.08 | 0.16 |
| Ascorbic acid (mg/100 g fresh fruit) | 59.53 | 57.33 | 58.04 | 16.02 | 22.37 | 17.82 | 76.81 | 69.93 | 72.24 | 13.93 | 13.04 | 13.34 |
| Total fruit yield per plant (kg) | 0.05 | 0.05 | 0.05 | 0.04 | 0.03 | 0.05 | 40.64 | 44.69 | 68.89 | 0.28 | 0.31 | 0.39 |

$Y_1$=2016-17 and $Y_2$=2017-18

repregent the preponderance of recessive effect and $\sigma^2D$ greter then $\sigma^2A$ in all traits except plant height (62.50), number of primary branches per plant (0.03), number of fruits per plant (8.74), pericarp thickness (0.00) and ascorbic acid (22.37) then it repregent the preponderance of dominance effect.

In case of pooled, estimates of sca variance were higher than gca variances for all the traits, except plant height and ascorbic acid. The value of sca variances were found significant and positive for all the characters. Likewise, positive and significant gca variances were plant height, number of fruits per plant, pericarp thickness, ascorbic acid and total fruit yield per plant. The value of average degree of dominance was more than unity (1) and highest for plant height (12.37) followed by ascorbic acid (3.26) and number of fruits per plant (1.75) revealed over dominance. Less than unity (1) and lowest for total fruit yield per plant (0.07) followed by total soluble solids (0.13), days to first fruit set and fruit length (0.17), days to 50 % flowering (0.22), fruit girth (0.31), days to first fruit harvest (0.32), average fruit weight (0.35), number of locules per fruit (0.37), number of fruits per cluster (0.72), number of primary branches per plant (0.75) and pericarp thickness (0.90) indicating partial dominance. The general predictability ratio was less than one for all the characters. $\sigma^2A$ greter then $\sigma^2D$ in plant height (737.95), number of fruits per plant (15.87) and ascorbic acid (58.04) then it repregent the preponderance of recessive effect and $\sigma^2D$ greter then $\sigma^2A$ in all traits except plant height (59.64), number of fruits per plant (9.07) and ascorbic acid (17.82) then it repregent the preponderance of dominance effect. The combining ability analysis elucidated higher magnitude of variance due to sca ($\sigma^2s$) than variance due to gca ($\sigma^2g$) indicating preponderance of non-additive gene action for all the characters. Similar finding had also been reported by previous workers (Dhaliwal *et al*., 2000; Bhatt *et al.*, 2001; Mondal *et al*., 2009; Janaki *et al.*, 2011 and Srivastava *et al*., 2013) [3, 2, 5, 4, 8].

Average degree of dominance were more than unity (1) for all the characters under study, except for plant height, number of primary branches per plant, number of fruits per plant and ascorbic acid in both the years and pooled and pericarp thickness and total fruit yield per plant in $Y_1$ and $Y_2$ which indicated existence of over dominance and controlled by a preponderance of non-additive gene effects suggesting thereby scope of development of $F_1$'s as well as the recombinants within the segregating populations. Total soluble solids, days to first fruit set, fruit length, days to 50 % flowering, fruit girth, days to first fruit harvest, average fruit weight, number of locules per fruit and number of fruits per cluster which had less than one value of average degree of

dominance suggested existence of partial dominance. The predictability ratio was lesser than (<1) for all the characters under study in both the years. The importance of additive as well as non-additive gene effects with predominance of non-additive gene effects in inheritance of fruit yield and yield components of tomato has also been reported by earlier workers (Dhaliwal *et al*., 2000; Bhatt *et al*., 2001; Mondal *et al*., 2009 and Janaki *et al*., 2011) [3, 2, 5, 4].

**Acknowledgment**
The work on tomato reported in this paper has been supported by research and teaching faculties of Department of Genetics and Plant Breeding, N.D.U.A.T and We would also like to thank Late Mr. Murli Mohan Khetan for statistical analysis.

**References**

1. Anonymous. Data base Horticultural Statistics at a Glance India, 2017.
2. Bhatt RP, Biswas VR, Kumar N. Heterosis, combining ability and genetics for Vitamin C. total soluble at 1700 m altitude. Journal of Agricu. 2001; 137(1):71-75.
3. Dhaliwal MS, Singh S, Cheema DS. Estimating combining ability effects of the genetic male sterile lines of tomato for their use in hybrid breeding. Journal of Genetics and Plant Breeding. 2000; 54(3):41-44.
4. Janaki VP, Vishwanath TB, Parasanath YC, Shrinivasulu GV, Poornima G. Studies on combining abilty of promising lines for yield and its acomponents in tomato. Advance Research Journal of Crop Improvement. 2011; 2(1):46-50.
5. Mondal C, Sarkar S, Haza P. Line x tester analysis of combining ability in tomato *(Lycopersicon esculantum* Mill.). Journal of Crop and Weed. 2009; 5(1):53-57.
6. Rick CM. Origin of cultivated tomato, current status of the problem. International Botanical Congress, 1969, 180.
7. Sprague GF, Tautum LR. General *vs*. specific combining ability in single cross of corn. J Amer. Socity of Agronomy. 1942; 34:923-932.
8. Srivastava RK, Singh KNP, Vasistha NK, Singh RK, Singh MK. Combining ability analysis for yield and quality traits in tomato (*Solanum lycopersicum* L.). Journal of Agricultural Science. 2013; 5(2):213-218.