



E-ISSN: 2278-4136

P-ISSN: 2349-8234

[www.phytojournal.com](http://www.phytojournal.com)

JPP 2021; 10(1): 2795-2800

Received: 25-11-2020

Accepted: 27-12-2020

**Erra Ranjith Kumar**

Department of Horticulture,  
Naini Agricultural Institute,  
Sam Higginbottom University of  
Agriculture, Technology and  
Sciences, Prayagraj,  
Uttar Pradesh, India

**Vijay Bahadur**

Department of Horticulture,  
Naini Agricultural Institute,  
Sam Higginbottom University of  
Agriculture, Technology and  
Sciences, Prayagraj,  
Uttar Pradesh, India

## Evaluation of tomato (*Solanum lycopersicum* L.) genotypes for growth, yield and quality traits at different planting density

**Erra Ranjith Kumar and Vijay Bahadur**

**Abstract**

An experiment on Tomato Genotypes at different planting density was conducted during January to May 2020 in Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) India. The results of the present investigation, regarding the evaluation of four genotypes i.e. (AVTO – 1706, AVTO – 1707, Arka Samrat and Pusa Ruby) of tomato in four planting densities i.e. (0.2, 0.3, 0.4 and 0.5 m) for plant growth, fruit yield and quality of Tomato, have been discussed and interpreted in the light of previous research work done in India and abroad. The experiment was conducted in 4x4 Factorial Randomized block design with 4 Genotypes of Tomato obtained from different sources, were each genotype replicated thrice in different planting densities. From the present experimental findings it is found that the genotype G<sub>4</sub> (Pusa Ruby) followed by G<sub>3</sub> (Arka Samrat) and planting density D<sub>4</sub> (0.5 m) followed by D<sub>3</sub> (0.4 m) was found suitable in terms of growth, quality and yield per plant. In terms of yield/plot and per hectare, planting density D<sub>1</sub> (0.2 m) was best due to more number of plants per plot and per hectare area. In terms of economics maximum gross, net return and cost benefit ratio was recorded in genotype G<sub>4</sub> (Pusa Ruby) and minimum in G<sub>1</sub> (AVTO - 1706).

**Keywords:** tomato, genotypes, planting density, growth and yield

**Introduction**

Tomato (*Solanum lycopersicum* L.) Wettst., (2n = 2x = 24) is one of the most popular and widely grown vegetable crops of the world next to potato. The genus *Solanum* consists of annual or short lived perennial herbaceous, typical day neutral plant and warm season crops. Tomato is reasonably susceptible to frost as well as high temperature but it is grown in a variety of climatic conditions.

Tomato production is affected with various factors like insects, diseases, low yields, crop failures, heat complexes and salinity that need systematic breeding effort. Considering the importance of tomato as a potential vegetable both as domestic consumption as well as export market, it is important to increase its productivity along with desirable attributes through genetic manipulation (Iregna Tasisa *et al.*, 2011). In this context it is necessary to identify plant characters or traits important to the development programme.

The present research is conducted to assess the genotypes for growth, yield and quality components with different planting densities. Yield is a complex character controlled by a large number of contributing characters and their interactions. A study of genotypes with planting density between different growth and yield characters provides an idea of association that could be effectively exploited to formulate selection strategies for improving yield components. It would be desirable to consider the relative magnitude of association of various characters with yield, therefore proper understanding of the genotypes in different planting density helps in identifying the best genotypes with best suited density for benefiting the farmers.

**Materials and Methods**

The present Experiment was conducted in 4x4 Factorial Randomized Block Design (FRBD), with four genotypes i.e. (AVTO – 1706, AVTO – 1707, Arka Samrat and Pusa Ruby) of tomato in four planting densities i.e. (0.2, 0.3, 0.4 and 0.5 m) total 16 treatments, replicated thrice with, in the Research field, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during January to May, 2020.

**Corresponding Author:****Erra Ranjith Kumar**

Department of Horticulture,  
Naini Agricultural Institute,  
Sam Higginbottom University of  
Agriculture, Technology and  
Sciences, Prayagraj,  
Uttar Pradesh, India

### Climatic condition in the experimental site

The area of Prayagraj district comes under subtropical belt in the south east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46 °C- 48 °C and seldom falls as low as 4 °C- 5 °C. The relative humidity ranges between 20 to 94%. The average rainfall in this area is around 1013.4 mm annually. However, occasional precipitation is also not uncommon during winter months.

### Results and Discussion

The present investigation entitled "Evaluation of Tomato (*Solanum lycopersicum* L.) Genotypes for growth, yield and quality traits at different planting density" was carried out during January to May, 2020 in Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) India. The results of the present investigation, regarding the evaluation of genotypes of Tomato for growth, yield and quality parameters in different planting densities, have been discussed and interpreted in the light of previous research work done in India and abroad.

The results of the experiment are summarized below.

#### A. Growth Parameters

The data on growth parameters are given in table 1 it is clear from the table that all the treatment differed significantly for all growth parameters. Significantly maximum Plant height 60.15, was noticed in the interaction effect of D<sub>4</sub>G<sub>4</sub> (0.5 m x Pusa Ruby), followed by D<sub>3</sub>G<sub>4</sub> (0.4 m x Pusa Ruby) with 55.90 cm, whereas minimum plant height 43.21 cm, was recorded in, D<sub>1</sub>G<sub>2</sub> (0.2 m x AVTO - 1707). Similarly in for Number of branch maximum 12.90 branch, was recorded in D<sub>4</sub>G<sub>4</sub> (0.5 m x Pusa Ruby), followed by D<sub>4</sub>G<sub>3</sub> (0.5 m x Arka Samrat) with 11.44 branch, whereas minimum number of branch 8.12, was observed in, D<sub>2</sub>G<sub>1</sub> (0.2 m x AVTO - 1706). Maximum plant height and Number of branches in wider spacing is may be due to the availability of more space for plant growth, better light distribution and utilization pattern due to wider spacing. Significantly increase plant height with increased plant spacing previously also reported by Singh *et al.* (2005)<sup>[16]</sup> and Bhattarai *et al.* (2015)<sup>[4]</sup> in Tomato.

In earliness parameter i.e. Days to first flowering significantly, minimum days for first flowering 45.32 days, was recorded in interaction effect D<sub>4</sub>G<sub>3</sub> (0.5 m x Arka Samrat), followed by D<sub>4</sub>G<sub>1</sub> (0.5 m x AVTO - 1706) with 45.42 days, whereas maximum days for first flowering 58.51 days, was observed in, D<sub>1</sub>G<sub>4</sub> (0.2 m x Pusa ruby). Similarly in days to 50% flowering, minimum 50.43 days, was noticed in interaction effect D<sub>4</sub>G<sub>3</sub> (0.5 m x Arka Samrat), followed by D<sub>4</sub>G<sub>1</sub> (0.5 m x AVTO - 1706) with 51.60 days, whereas maximum 63.64 days, was observed in, D<sub>1</sub>G<sub>4</sub> (0.2 m x Pusa ruby).

The early flowering in wider spacing is may be attributed to better light distribution and utilization pattern due to wider spacing Ambroszczyk *et al.* (2008)<sup>[11]</sup> and availability of more nutrients per unit area Jiang *et al.* (2013)<sup>[8]</sup> in Tomato. In early fruit picking for minimum days for first fruit picking 65.46 days, was recorded in interaction effect D<sub>4</sub>G<sub>3</sub> (0.5 m x Arka Samrat), followed by D<sub>4</sub>G<sub>1</sub> (0.5 m x AVTO - 1706) with 67.01 days, whereas maximum 80.50 days, was observed in, D<sub>1</sub>G<sub>4</sub> (0.2 m x Pusa ruby). The early fruit picking in wider spacing is may be attributed to better light distribution and

utilization pattern due to wider spacing Ambroszczyk *et al.* (2008)<sup>[11]</sup> and availability of more nutrients per unit area Jiang *et al.* (2013)<sup>[8]</sup> in Tomato.

#### Yield Parameters

The data on growth parameters are given in table 2 and 3 it is clear from the table that all the treatment differed significantly for all yield parameters. Significantly maximum polar diameter 5.57 cm, was recorded in interaction effect D<sub>4</sub>G<sub>4</sub> (0.5 m x Pusa ruby), followed by D<sub>3</sub>G<sub>4</sub> (0.4 m x Pusa ruby) with 5.42 cm, whereas minimum diameter 4.22 cm, was observed in, D<sub>1</sub>G<sub>3</sub> (0.2 m x Arka Samrat). Similarly in maximum radial diameter 5.99 cm, was recorded in interaction effect D<sub>4</sub>G<sub>4</sub> (0.5 m x Pusa ruby), followed by D<sub>3</sub>G<sub>4</sub> (0.4 m x Pusa ruby) with 5.87 cm, whereas minimum radial diameter 4.62 cm, was observed in, D<sub>1</sub>G<sub>3</sub> (0.2 m x Arka Samrat) and in terms of fruit girth, maximum 14.50 cm, was recorded in interaction effect D<sub>4</sub>G<sub>4</sub> (0.5 m x Pusa ruby), followed by D<sub>3</sub>G<sub>4</sub> (0.4 m x Pusa ruby) with 13.59 cm, whereas minimum fruit girth 10.62 cm, was observed in, D<sub>1</sub>G<sub>2</sub> (0.2 m x AVTO - 1707). Maximum polar, radial diameter and fruit girth in wider spacing, is might be attributed to the genetic makeup of varieties that primarily dictate the characters and do not influenced by the environment. Similar results were obtained by Dasgan and Abak (2003)<sup>[6]</sup> in bell peppers and Bhabadur and Singh (2005)<sup>[2]</sup> in Tomato.

Interaction effect shows that statistically significant variation for average fruit weight, maximum fruit weight 82.06 g, was recorded in interaction effect D<sub>4</sub>G<sub>4</sub> (0.5 m x Pusa ruby), followed by D<sub>3</sub>G<sub>4</sub> (0.4 m x Pusa ruby) with 76.83 g, whereas minimum fruit weight 57.05 g, was observed in, D<sub>1</sub>G<sub>1</sub> (0.2 m x AVTO - 1706). The similar findings of increase average fruit weight and yield per plant with wider spacing was reported by Biradar *et al.* (2014)<sup>[3]</sup> in capsicum, Harish and Patil (2011)<sup>[7]</sup> and Sharma *et al.* (2011)<sup>[15]</sup> in tomato.

In terms of number of fruits, maximum significant number of fruits per cluster 5.51 fruits, was noticed in interaction effect, D<sub>4</sub>G<sub>4</sub> (0.5 m x Pusa ruby), followed by D<sub>3</sub>G<sub>4</sub> (0.4 m x Pusa ruby) with 5.08 fruit, whereas minimum 3.38 fruits, was recorded in, D<sub>2</sub>G<sub>2</sub> (0.3 m x AVTO - 1707). This might be due to more photosynthesis as it produces more plant height and more fruit setting at wider spacing. Similar findings have been reported by Mantur and Patil (2008)<sup>[11]</sup>, Bhattarai *et al.* (2015)<sup>[4]</sup> and Rajendra *et al.* (2013)<sup>[14]</sup> in tomato. Similarly for number of fruits per plant maximum 26.62 fruits, was recorded in interaction effect D<sub>4</sub>G<sub>4</sub> (0.5 m x Pusa ruby), followed by D<sub>3</sub>G<sub>4</sub> (0.4 m x Pusa ruby) with 25.04 fruits, whereas minimum 17.87 fruits, was recorded in, D<sub>1</sub>G<sub>1</sub> (0.2 m x AVTO - 1706). This might be due to more photosynthesis as it produces more plant height and more fruit setting at wider spacing. Similar findings have been reported by Mantur and Patil (2008)<sup>[11]</sup>, Bhattarai *et al.* (2015)<sup>[4]</sup> and Rajendra *et al.* (2013)<sup>[14]</sup> in tomato.

In fruit yield/plant maximum significant yield 2.10 kg, was noticed in interaction effect D<sub>4</sub>G<sub>4</sub> (0.5 m x Pusa ruby), followed by D<sub>3</sub>G<sub>4</sub> (0.4 m x Pusa ruby) with 1.90 kg, whereas minimum 1.01 kg, was recorded in, D<sub>1</sub>G<sub>1</sub> (0.2 m x AVTO - 1706).

Similarly in yield per plot maximum 90.20 kg, was noticed in interaction effect D<sub>1</sub>G<sub>4</sub> (0.2 m x Pusa ruby), followed by D<sub>1</sub>G<sub>3</sub> (0.2 m x Arka Samrat) with 65.45 kg, whereas minimum yield per plot 30.14 kg, was observed in, D<sub>4</sub>G<sub>1</sub> (0.5 m x AVTO - 1706). Similar trends in yield per hectare was noticed with

maximum yield 95.83 ton, was noticed in interaction effect, D<sub>1</sub>G<sub>4</sub> (0.2 m x Pusa ruby), followed by D<sub>1</sub>G<sub>3</sub> (0.2 m x Arka Samrat) with 69.53 ton, whereas minimum yield per hectare 32.02 ton, was observed in, D<sub>4</sub>G<sub>1</sub> (0.5 m x AVTO - 1706) This might be due to wider plant spacing found effective in utilization of land, nutrients and sunlight that has resulted in good quality of fruits and yield. The results are in conformity with findings of Dasgan and Abak (2003) [6] in sweet pepper and Mantur and Patil (2008) [11], Campillo *et al.* (2012) [5], Klaring and Krumbein (2013) [9] and Kumari *et al.* (2015) [10] in Tomato.

### B. Economics (Benefit: cost ratio)

The data on Economics (Benefit: cost ratio) are given in table 4 it is clear from the table that all the treatment differed significantly for all in gross, net return and benefit: cost ratio. In terms of Gross Return maximum Rs. 766640.00, Net Return Rs. 647430.00 and Cost Benefit Ratio 6.49 was recorded in Interaction effect G<sub>4</sub>D<sub>1</sub> (Pusa Ruby) Followed by G<sub>3</sub>D<sub>1</sub> (Arka Samrat) with Gross Return Rs. 5566240.00, Net Return Rs. 434530.00 and Cost Benefit Ratio 4.57 and minimum Gross Return Rs. 256160.00, Net Return Rs. 132450.00 and Cost Benefit Ratio 2.07 was recorded in G<sub>1</sub>D<sub>4</sub> (AVTO - 1706).

**Table 1:** Plant Height, Number of primary branches, days to first flowering, days to 50% flowering and polar diameter of different genotypes of Tomato in different planting density

| Genotypes      | Plant height 120 DAS |                |                |                |        |
|----------------|----------------------|----------------|----------------|----------------|--------|
|                | Planting density     |                |                |                | Mean G |
|                | D <sub>1</sub>       | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 43.81                | 45.73          | 46.17          | 48.74          | 46.11  |
| G <sub>2</sub> | 43.21                | 43.47          | 44.42          | 47.44          | 44.63  |
| G <sub>3</sub> | 44.86                | 46.92          | 48.84          | 50.92          | 47.88  |
| G <sub>4</sub> | 50.62                | 52.53          | 55.90          | 60.15          | 54.80  |
| Mean D         | 45.62                | 47.16          | 48.83          | 51.81          |        |
| Factors        |                      |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                      |                | S              | 0.273          | 0.561  |
| Factor(D)      |                      |                | S              | 0.273          | 0.561  |
| Factor(G X D)  |                      |                | S              | 0.547          | 1.122  |

| Genotypes      | Number of branches 120 DAS |                |                |                |        |
|----------------|----------------------------|----------------|----------------|----------------|--------|
|                | Planting density           |                |                |                | Mean G |
|                | D <sub>1</sub>             | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 8.50                       | 8.12           | 8.48           | 9.66           | 8.69   |
| G <sub>2</sub> | 8.48                       | 9.01           | 9.27           | 10.29          | 9.26   |
| G <sub>3</sub> | 9.28                       | 10.11          | 10.72          | 11.44          | 10.38  |
| G <sub>4</sub> | 9.86                       | 10.85          | 11.35          | 12.90          | 11.24  |
| Mean D         | 9.03                       | 9.52           | 9.95           | 11.07          |        |
| Factors        |                            |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                            |                | S              | 0.086          | 0.176  |
| Factor(D)      |                            |                | S              | 0.086          | 0.176  |
| Factor(G X D)  |                            |                | S              | 0.172          | 0.352  |

| Genotypes      | Days to first flowering |                |                |                |        |
|----------------|-------------------------|----------------|----------------|----------------|--------|
|                | Planting density        |                |                |                | Mean G |
|                | D <sub>1</sub>          | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 49.61                   | 48.29          | 47.11          | 45.42          | 47.60  |
| G <sub>2</sub> | 55.35                   | 53.92          | 52.27          | 50.42          | 52.99  |
| G <sub>3</sub> | 50.58                   | 49.44          | 47.79          | 45.32          | 48.28  |
| G <sub>4</sub> | 58.51                   | 56.94          | 55.53          | 53.41          | 56.09  |
| Mean D         | 53.51                   | 52.14          | 50.67          | 48.64          |        |
| Factors        |                         |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                         |                | S              | 0.665          | 1.365  |
| Factor(D)      |                         |                | S              | 0.665          | 1.365  |
| Factor(G X D)  |                         |                | S              | 1.330          | N/A    |

| Genotypes      | Days to 50% flowering |                |                |                |        |
|----------------|-----------------------|----------------|----------------|----------------|--------|
|                | Planting density      |                |                |                | Mean G |
|                | D <sub>1</sub>        | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 57.02                 | 54.87          | 53.22          | 51.60          | 54.17  |
| G <sub>2</sub> | 61.81                 | 60.09          | 58.31          | 56.37          | 59.14  |
| G <sub>3</sub> | 56.23                 | 54.92          | 53.01          | 50.43          | 53.64  |
| G <sub>4</sub> | 63.64                 | 62.58          | 61.31          | 58.55          | 61.52  |
| Mean D         | 59.67                 | 58.11          | 56.46          | 54.23          |        |
| Factors        |                       |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                       |                | S              | 0.668          | 1.370  |
| Factor(D)      |                       |                | S              | 0.668          | 1.370  |
| Factor(G X D)  |                       |                | NS             | 1.335          | N/A    |

| Genotypes      | Days to first fruit picking |                |                |                |        |
|----------------|-----------------------------|----------------|----------------|----------------|--------|
|                | Planting density            |                |                |                | Mean G |
|                | D <sub>1</sub>              | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 75.25                       | 72.29          | 69.37          | 67.01          | 70.98  |
| G <sub>2</sub> | 79.47                       | 76.57          | 73.79          | 71.40          | 75.30  |
| G <sub>3</sub> | 72.77                       | 71.14          | 68.66          | 65.46          | 69.50  |
| G <sub>4</sub> | 80.50                       | 78.46          | 77.06          | 73.41          | 77.35  |
| Mean D         | 76.99                       | 74.61          | 72.22          | 69.32          |        |
| Factors        |                             |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                             |                | S              | 0.667          | 1.369  |
| Factor(D)      |                             |                | S              | 0.667          | 1.369  |
| Factor(G X D)  |                             |                | NS             | 1.334          | N/A    |

**Table.2:** Polar diameter, Radial diameter, Fruit girth, avg. fruit weight, number of fruits/cluster and number of fruits/plant of different genotypes of Tomato in different planting density

| Genotypes      | Polar diameter (cm) |                |                |                |        |
|----------------|---------------------|----------------|----------------|----------------|--------|
|                | Planting density    |                |                |                | Mean G |
|                | D <sub>1</sub>      | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 5.01                | 5.17           | 5.22           | 5.36           | 5.19   |
| G <sub>2</sub> | 4.99                | 5.14           | 5.23           | 5.24           | 5.15   |
| G <sub>3</sub> | 4.22                | 4.43           | 4.56           | 4.88           | 4.52   |
| G <sub>4</sub> | 5.11                | 5.13           | 5.42           | 5.57           | 5.30   |
| Mean D         | 4.83                | 4.96           | 5.10           | 5.26           |        |
| Factors        |                     |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                     |                | S              | 0.058          | 0.120  |
| Factor(D)      |                     |                | S              | 0.058          | 0.120  |
| Factor(G X D)  |                     |                | NS             | 0.117          | N/A    |

| Genotypes      | Radial diameter (cm) |                |                |                |        |
|----------------|----------------------|----------------|----------------|----------------|--------|
|                | Planting density     |                |                |                | Mean G |
|                | D <sub>1</sub>       | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 5.33                 | 5.41           | 5.59           | 5.75           | 5.52   |
| G <sub>2</sub> | 5.12                 | 5.18           | 5.37           | 5.48           | 5.28   |
| G <sub>3</sub> | 4.62                 | 5.06           | 4.98           | 5.16           | 4.95   |
| G <sub>4</sub> | 5.26                 | 5.50           | 5.87           | 5.99           | 5.65   |
| Mean D         | 5.08                 | 5.28           | 5.45           | 5.59           |        |
| Factors        |                      |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                      |                | S              | 0.075          | 0.154  |
| Factor(D)      |                      |                | S              | 0.075          | 0.154  |
| Factor(G X D)  |                      |                | NS             | 0.150          | N/A    |

| Genotypes      | Fruit girth (cm) |                |                |                |        |
|----------------|------------------|----------------|----------------|----------------|--------|
|                | Planting density |                |                |                | Mean G |
|                | D <sub>1</sub>   | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 11.97            | 12.17          | 12.47          | 13.33          | 12.48  |
| G <sub>2</sub> | 10.62            | 11.63          | 12.10          | 12.61          | 11.74  |
| G <sub>3</sub> | 11.08            | 11.10          | 11.62          | 12.27          | 11.51  |
| G <sub>4</sub> | 12.22            | 12.71          | 13.59          | 14.50          | 13.25  |
| Mean D         | 11.47            | 11.90          | 12.44          | 13.17          |        |
| Factors        |                  |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                  |                | S              | 0.122          | 0.251  |
| Factor(D)      |                  |                | S              | 0.122          | 0.251  |
| Factor(G X D)  |                  |                | S              | 0.244          | 0.502  |

| Genotypes      | Avg. fruit weight (g) |                |                |                |        |
|----------------|-----------------------|----------------|----------------|----------------|--------|
|                | Planting density      |                |                |                | Mean G |
|                | D <sub>1</sub>        | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 57.05                 | 59.74          | 63.88          | 67.53          | 62.05  |
| G <sub>2</sub> | 57.34                 | 61.99          | 66.41          | 71.40          | 64.28  |
| G <sub>3</sub> | 59.97                 | 64.02          | 68.87          | 74.57          | 66.85  |
| G <sub>4</sub> | 69.01                 | 72.72          | 76.83          | 82.06          | 75.15  |
| Mean D         | 60.84                 | 64.61          | 68.99          | 73.89          |        |
| Factors        |                       |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                       |                | S              | 0.199          | 0.409  |
| Factor(D)      |                       |                | S              | 0.199          | 0.409  |
| Factor(G X D)  |                       |                | S              | 0.399          | 0.818  |

| Genotypes      | Number of fruit/cluster |                |                |                |        |
|----------------|-------------------------|----------------|----------------|----------------|--------|
|                | Planting density        |                |                |                | Mean G |
|                | D <sub>1</sub>          | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 3.73                    | 3.87           | 4.06           | 4.23           | 3.97   |
| G <sub>2</sub> | 3.78                    | 3.38           | 3.92           | 4.29           | 3.84   |
| G <sub>3</sub> | 4.18                    | 4.25           | 4.51           | 4.62           | 4.39   |
| G <sub>4</sub> | 4.56                    | 5.06           | 5.08           | 5.51           | 5.05   |
| Mean D         | 4.06                    | 4.14           | 4.39           | 4.66           |        |
| Factors        |                         |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                         |                | S              | 0.094          | 0.192  |
| Factor(D)      |                         |                | S              | 0.094          | 0.192  |
| Factor(G X D)  |                         |                | NS             | 0.187          | N/A    |

| Genotypes      | Number of fruit/plant |                |                |                |        |
|----------------|-----------------------|----------------|----------------|----------------|--------|
|                | Planting density      |                |                |                | Mean G |
|                | D <sub>1</sub>        | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 17.87                 | 19.12          | 19.76          | 20.43          | 19.29  |
| G <sub>2</sub> | 18.54                 | 19.19          | 19.43          | 21.09          | 19.56  |
| G <sub>3</sub> | 19.89                 | 20.55          | 21.11          | 21.62          | 20.79  |
| G <sub>4</sub> | 23.85                 | 23.14          | 25.04          | 26.62          | 24.66  |
| Mean D         | 20.03                 | 20.50          | 21.33          | 22.44          |        |
| Factors        |                       |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                       |                | S              | 0.280          | 0.574  |
| Factor(D)      |                       |                | S              | 0.280          | 0.574  |
| Factor(G X D)  |                       |                | NS             | 0.559          | N/A    |

**Table 3:** Yield/plant (kg), yield/plot and Yield/ha of different genotypes of Tomato in different planting density

**Table 4:** Total soluble solid, Ascorbic acid and benefit cost ratio of different genotypes of Tomato in different planting density

| Genotypes      | Yield/plant (kg) |                |                |                |        |
|----------------|------------------|----------------|----------------|----------------|--------|
|                | Planting density |                |                |                | Mean G |
|                | D <sub>1</sub>   | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 1.01             | 1.14           | 1.20           | 1.30           | 1.19   |
| G <sub>2</sub> | 1.06             | 1.18           | 1.20           | 1.50           | 1.25   |
| G <sub>3</sub> | 1.19             | 1.31           | 1.40           | 1.60           | 1.39   |
| G <sub>4</sub> | 1.64             | 1.68           | 1.90           | 2.10           | 1.85   |
| Mean D         | 1.22             | 1.32           | 1.40           | 1.65           |        |
| Factors        |                  |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                  |                | S              | 0.022          | 0.045  |
| Factor(D)      |                  |                | S              | 0.022          | 0.045  |
| Factor(G X D)  |                  |                | S              | 0.044          | 0.090  |

| Genotypes      | Total Soluble Solids (°Brix) |                |                |                |        |
|----------------|------------------------------|----------------|----------------|----------------|--------|
|                | Planting density             |                |                |                | Mean G |
|                | D <sub>1</sub>               | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 4.73                         | 4.54           | 4.84           | 5.06           | 4.79   |
| G <sub>2</sub> | 5.26                         | 5.24           | 5.31           | 5.44           | 5.31   |
| G <sub>3</sub> | 5.91                         | 5.51           | 5.78           | 5.87           | 5.76   |
| G <sub>4</sub> | 4.16                         | 4.16           | 4.22           | 4.32           | 4.21   |
| Mean D         | 5.01                         | 4.86           | 5.03           | 5.17           |        |
| Factors        |                              |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                              |                | S              | 0.103          | 0.212  |
| Factor(D)      |                              |                | S              | 0.103          | 0.212  |
| Factor(G X D)  |                              |                | NS             | 0.206          | N/A    |

| Genotypes      | Yield/plot (kg)  |                |                |                |        |
|----------------|------------------|----------------|----------------|----------------|--------|
|                | Planting density |                |                |                | Mean G |
|                | D <sub>1</sub>   | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 55.55            | 39.90          | 35.28          | 30.14          | 40.21  |
| G <sub>2</sub> | 58.18            | 41.30          | 49.02          | 33.00          | 45.37  |
| G <sub>3</sub> | 65.45            | 45.85          | 40.60          | 35.42          | 46.83  |
| G <sub>4</sub> | 90.20            | 58.80          | 53.76          | 47.96          | 62.68  |
| Mean D         | 67.34            | 46.46          | 44.66          | 36.63          |        |
| Factors        |                  |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                  |                | S              | 0.726          | 1.489  |
| Factor(D)      |                  |                | S              | 0.726          | 1.489  |
| Factor(G X D)  |                  |                | S              | 1.451          | 2.978  |

| Genotypes      | Ascorbic acid (mg/100g) |                |                |                |        |
|----------------|-------------------------|----------------|----------------|----------------|--------|
|                | Planting density        |                |                |                | Mean G |
|                | D <sub>1</sub>          | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 20.19                   | 21.59          | 22.86          | 21.48          | 21.53  |
| G <sub>2</sub> | 20.34                   | 21.57          | 22.52          | 24.07          | 22.12  |
| G <sub>3</sub> | 23.74                   | 24.59          | 24.64          | 25.71          | 24.67  |
| G <sub>4</sub> | 24.14                   | 25.87          | 24.91          | 26.22          | 25.28  |
| Mean D         | 22.10                   | 23.40          | 23.73          | 24.37          |        |
| Factors        |                         |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                         |                | S              | 1.215          | 2.482  |
| Factor(D)      |                         |                | S              | 1.215          | 2.482  |
| Factor(G X D)  |                         |                | NS             | 2.430          | N/A    |

| Genotypes      | Yield/ha (tonnes) |                |                |                |        |
|----------------|-------------------|----------------|----------------|----------------|--------|
|                | Planting density  |                |                |                | Mean G |
|                | D <sub>1</sub>    | D <sub>2</sub> | D <sub>3</sub> | D <sub>4</sub> |        |
| G <sub>1</sub> | 59.02             | 42.39          | 37.48          | 32.02          | 42.72  |
| G <sub>2</sub> | 61.93             | 43.87          | 52.08          | 35.06          | 48.23  |
| G <sub>3</sub> | 69.53             | 48.71          | 43.13          | 37.63          | 49.75  |
| G <sub>4</sub> | 95.83             | 62.47          | 57.12          | 50.95          | 66.59  |
| Mean D         | 71.57             | 49.36          | 47.45          | 38.91          |        |
| Factors        |                   |                | F-Test         | SE(d)          | C.D.   |
| Factor(G)      |                   |                | S              | 0.771          | 1.583  |
| Factor(D)      |                   |                | S              | 0.771          | 1.583  |
| Factor(G X D)  |                   |                | S              | 1.543          | 3.166  |

| Treatments                    | B:C ratio | Treatments                    | B:C ratio |
|-------------------------------|-----------|-------------------------------|-----------|
| G <sub>1</sub> D <sub>1</sub> | 3.33      | G <sub>3</sub> D <sub>1</sub> | 4.57      |
| G <sub>1</sub> D <sub>2</sub> | 2.49      | G <sub>3</sub> D <sub>2</sub> | 3.31      |
| G <sub>1</sub> D <sub>3</sub> | 2.31      | G <sub>3</sub> D <sub>3</sub> | 3.03      |
| G <sub>1</sub> D <sub>4</sub> | 2.07      | G <sub>3</sub> D <sub>4</sub> | 2.74      |
| G <sub>2</sub> D <sub>1</sub> | 3.49      | G <sub>4</sub> D <sub>1</sub> | 6.43      |
| G <sub>2</sub> D <sub>2</sub> | 2.58      | G <sub>4</sub> D <sub>2</sub> | 4.32      |
| G <sub>2</sub> D <sub>3</sub> | 3.21      | G <sub>4</sub> D <sub>3</sub> | 4.09      |
| G <sub>2</sub> D <sub>4</sub> | 2.26      | G <sub>4</sub> D <sub>4</sub> | 3.77      |



## Conclusion

From the present experimental findings it is concluded that the genotype G<sub>4</sub> (Pusa Ruby) followed by G<sub>3</sub> (Arka Samrat) and planting density D<sub>4</sub> (0.5 m) followed by D<sub>3</sub> (0.4 m) was found suitable in terms of growth, quality and yield per plant. In terms of yield/plot and per hectare, planting density D<sub>1</sub> (0.2 m) was best due to more number of plants per plot and per hectare area. In terms of economics maximum gross, net return and cost benefit ratio was recorded in genotype G<sub>4</sub> (Pusa Ruby) and minimum in G<sub>1</sub> (AVTO - 1706).

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