I J T A
© Serials Publications
National Academy of Agricultural Science (NAAS) Rating : 3.03

# Evaluation of tomato (*Lycopersiconesculentum*Mill.) genotypes on the basis of physiological and biochemical characteristics

**JitendraDhruve[1*] andPoonam Choudhary[2]**

***ABSTRACT:*** *A field experiment was conducted to characterize the tomato genotypes on the basis of physiological and biochemical parameters.During this investigation yield attributes, plant protection and fruit quality measures were evaluated: Days to first picking, Primary branches/ plant, Plant height at harvest (cm), Fruit yield (t/ha), No. of seeds/fruit, Fruit length (cm), Fruit girth (cm), Fruit weight (g), Fruit volume (cm$^3$), protection parameters* viz., *Leaf curl disease (%),Fruit borer disease (%) and Early blight infestation (%). While quality parameters; moisture per cent, TSS (Brix), Lycopene content (mg/100g), Ascorbic acid content (mg/100g), Titratable acidity (%), Total soluble sugars (%), Reducing sugar (%), pH of juice and EC of Juice at two different harvesting stage (5$^{th}$ and 10$^{th}$ picking). Among the eight genotypes evaluated, Shaktiman yielded highest fruits per hectare (37.44 t/ha) followed by HeemShikhar (33.40 t/ha). The highest fruit yielding hybrid Shaktiman also exhibited maximum lycopene (3.31 mg/100g) and total soluble sugar (3.18 %) contents as well as moderate total soluble solid content (4.00 brix). As far as disease and insect resistance concern Shaktiman and HeemShikhar hybrid were found tolerant against leaf curl and fruit borer and moderately tolerant against early blight disease.*

***Key words:*** Ascorbic acid, disease and insect resistance, lycopene,tomato, total soluble solids

## INTRODUCTION

Tomato (*Lycopersiconesculentum*Mill.) is the world's largest vegetable crops next to potato and sweet potato, cultivated all over the world for its fleshy fruits. It belongs to genus *Lycopersicon*and family *solanaceae*. The cultivated tomatoes originated as wild forms in the Peru-Ecuador-Bolivia area of South America (Rick, 7) . It is often referred to as *'the poor man's orange'* because of its high nutraceutical components such as, vitamin, malic acid, and citric acid contents and it serves as a fine appetizer.

Tomato is considered as protective as well as productive food because of its special nutraceutical value and also wide spread production. The fruits are used directly as raw vegetable in sandwiches, salad, etc. Several processed items like paste, puree, syrup, juice, ketchup, drinks etc. are prepared on a large scale. Hence, there is a great demand of tomato fruits in the market throughout the year.

The most important antioxidants in tomatoes are carotenes. Among the carotenes, lycopene and β-carotene dominates. The attractive red colour of tomato is due to presence of pigment lycopene and carotene imparts the yellow colour to the tomato fruits. Epidemiological studies suggested role for lycopene in the protection against cancers of the lung, bladder, cervix, skin, prostate, breast and atherosclerosis, prevention of cardiovascular disease, macular degeneration and serum lipid oxidation (Di Mascio *et al.,* (4) ; Clinton, (3) ; Rao and Agarwal, (6). According to Arias *et al.,* (1) and Brandt *et al.,* (2) the amount of carotenes as well as their antioxidant activity is significantly influenced by tomato variety and maturity.

Therefore, the present study was carried out with the following objectives

1. To evaluate the public and private sector varieties/hybrids of tomato cultivated in Gujarat for fruit yield, disease and insect resistance as well as for biochemical composition and other quality parameters.
2. To collect the tomato samples of different varieties cultivated by the farmers and

1&* Associate Professor, 2 PhD Research Scholar, *E-mail: jitendra_dhruve@yahoo.com*
Department of Biochemistry, Anand Agricultural University, Anand- 388 110 Gujarat, India

evaluate for its biochemical composition and other quality parameters.

3. To identify the varieties suitable for higher yield, disease resistance and fulfil the criteria for processing purpose.

## MATERIAL AND METHODS

The present study was carried out in the Quality Control Laboratory of the main vegetable research station, Anand Agricultural University, Anand during 2009-10. Eight tomato cultivars were grown in the field following the package of practices, for cultivation. Unblemished tomato fruits of eight tomato cultivars ('AT-3 ', 'Abhinav', 'Alankar, 'Heemsona', 'Heemsikhar' 'NS-2535', 'Jewel' and 'Shaktiman' of uniform size at two different stages, i.e., middle and last picking stages were harvested from the field. The fruits were cleaned and their peduncles were removed. Fruits at two different stages ($5^{th}$and $10^{th}$ picking) were collected for estimation of various parameters. TSS was determined by Abbe's hand refractometer and results were expressed in °Brix. Juice pH and EC of the fruits were determined using a pH meter and EC meter, respectively. Ascorbic acid and lycopene content content was determined using 2,6-dicholorophenol indophenol dye method of Thimmaih, (9). Titratable Acidity was determined by Mazumdar and majmudar (5). Moisture, total soluble sugars and reducing sugars were determined by Sadasivam and Manikam (8). The fruit borer data were analyzed by using square root transformations. The analysis for other traits was done by adopting standard statistical procedures prescribed for each one.

## RESULT AND DISCUSSION

### Days to Fruit Picking

Days to fruit picking indicate the earliness of the genotypes. The data related to the days to fruit picking were given in Table 1. The hybrids Jewel, HeemShikhar, HeemSona, NS 2535 andshaktiman had early fruit picking about 75 days after transplanting than AT-3, Abhinav and Alankar that had fruits about 82 days after transplanting.

**Table 1**
**Fruit yield and its related character of different varieties of tomato**

| *Varieties* | *Days to first picking* | *Primary branches/plant* | *Plant height (cm)* | *Fruit yield (q/ha)* | *No. of Seeds/ fruit* |
|---|---|---|---|---|---|
| AT-3 | 82 | 7.37 | 101.30 | 21.33 | 112.50 |
| Abhinav | 82 | 7.10 | 111.17 | 30.12 | 65.83 |
| Alankar | 82 | 8.90 | 109.11 | 30.36 | 24.17 |
| Jewel | 75 | 6.40 | 83.67 | 25.06 | 61.83 |
| HeemShikhar | 75 | 9.20 | 213.68 | 33.40 | 93.44 |
| HeemSona | 75 | 7.80 | 163.25 | 29.57 | 98.17 |
| NS 2535 | 75 | 6.00 | 67.88 | 23.94 | 60.00 |
| Shaktiman | 75 | 8.90 | 101.00 | 37.44 | 38.00 |
| S.Em.± | | 0.47 | 7.46 | 2.478 | 3.62 |
| CD at 5% | | 1.41 | 22.63 | 7.515 | 10.97 |
| CV% | | 10.46 | 10.87 | 14.847 | 9.04 |

### Primary Branches Per plant

This is also important fruit yield component trait which generally related with plant height (Table 1, Plate 1). The minimum and maximum number of branches observed in NS 2535 and HeemShikhar, respectively. The second highest branches per plant (8.9) were recorded for the semi-determinate hybrids Alankar and Shaktiman.

### Plant Height

Plant height ranged from 67.88 (NS 2535) to 213.68 (HeemShikhar) cm (Table 1). According to the growth habit, tomato varieties are divided in three groups*viz*. determinate, semi-determinate and indeterminate types. Out of eight genotypes evaluated, Jewel and NS 2535 catagorized as determinate types, whereas AT 3, Abhinav, Alankar and Shaktiman designated as semideterminate types. The hybrids HeemShikhar and HeemSona developed by Syngenta I Pvt. Ltd., Pune were found to be indeterminate types. The plant height is also important to finalizing the transplanting distance. If the plant height is more, then it should be transplanted at wider space or to be used telephone or stacking method. The determinate type varieties are planted at narrow spacing and generally found for early picking with short life span with concentrated fruit yield.


**Plate 1: Plant type of different genotypes of tomato**

**Fruit Yield**

The minimum and maximum fruit yield was recorded for AT 3 (21.33 t/ha) and Shaktiman (37.44 t/ha), respectively (Table 1). The significantly highest yielding Shaktiman gave at par fruit yield with HeemShikhar (33.40 t/ha), Alankar (30.36 t/ha) and Abhinav (30.12 t/ha).

**Number of Seeds Per Fruit**

For processing purpose less number of seeds in tomato fruits is desirable. The significantly lowest number of seeds per fruit was obtained in Alankar (24.17) as compared to other varieties (Table 1, Plate. 2). Whereas, significantly the highest number of seeds per fruit was observed in open pollinated variety AT 3 (112.50). The seeds per fruit ranged from 60 to 70 in the NS 2535 (60.00), Jewel (61.83) and Abhinav (65.83). While in HeemShikhar and HeemSona, it was observed 93.44 and 98.17, respectively.

**Fruit Characters**

The fruit characters like length, girth, weight and volume were recorded at middle (5$^{th}$ picking) and last picking (10$^{th}$ picking). The character wise results are presented as under.

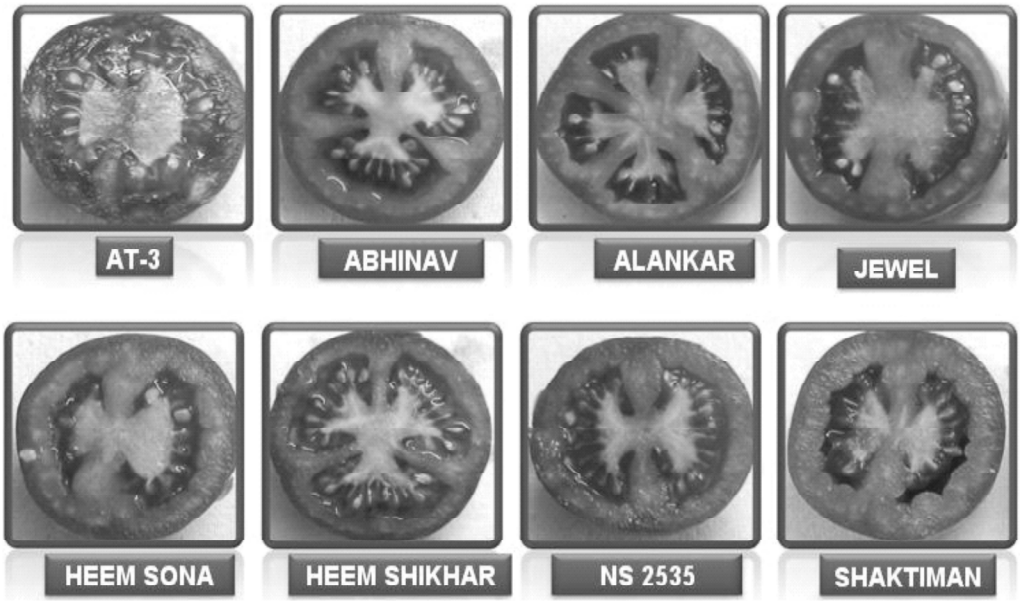


**Plate 2: Cross section of different genotypes of ripen tomato**

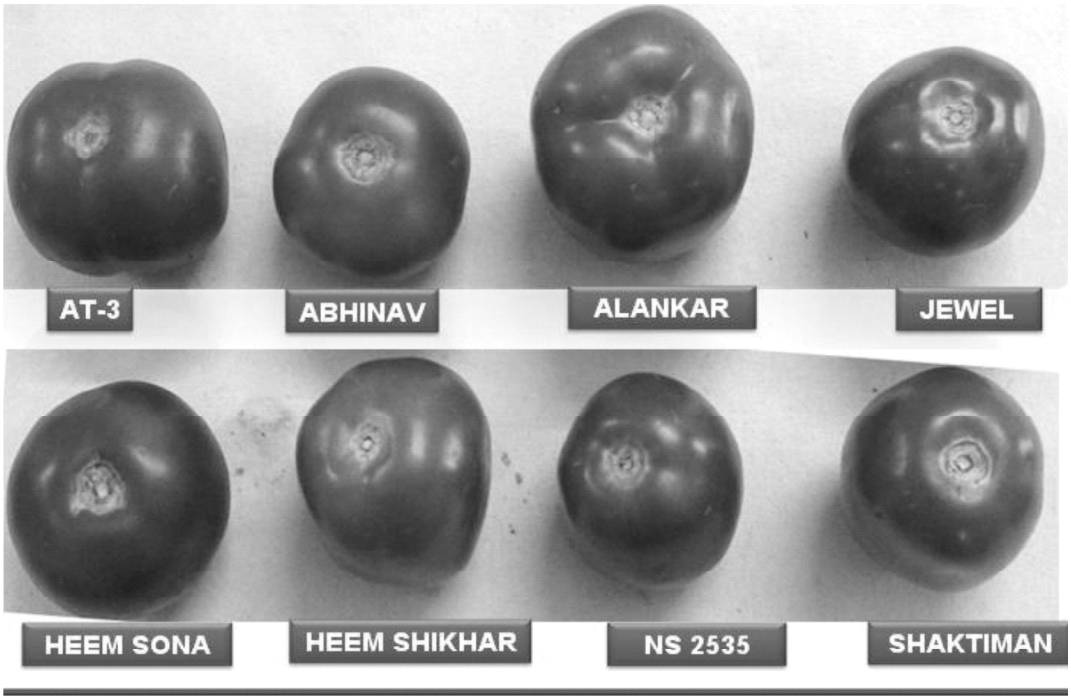


**Plate 3: Ripen fruits of different tomato genotypes**

### Fruit length

The fruit length in middle picking was minimum and maximum for the HeemSona (8.53 cm) and Alankar (10.20 cm), whereas it was observed for AT 3 (6.43 cm) and Abhinav (8.80 cm) in last picking, respectively (Table 2).

### Fruit girth

For this trait, the range was 16.07 (Abhinav) to 19.70 (Alankar) cm in middle picking (Table 2), while during last picking it was from 13.33 (AT 3) to 16.03 (Alankar) cm. The hybrid Alankar had its maximum fruit girth during both the picking. This is also important to fetch the higher price during later picking.

### Fruit weight

This is the most important fruit yield contributing character in tomato crop. During middle picking, the fruit weight ranged from 93.63 (HeemShikhar) to 128.48 (Alankar) cm while during last picking it ranged from 42.43 (AT 3) to 75.37 (Abhinav) cm (Table 2). The hybrids Alankar, Jewel and Abhinav had maintained its higher fruit weight from middle to last picking.

### Fruit volume

The fruit volume is directly related with its size. The higher volume indicates the higher fruit size. It was ranged from 61.67 (Abhinav) to 108.33 (Jewel) $cm^3$ in middle picking and from 52.33 (HeemSona) to 89.00 (Alankar) $cm^3$ in last picking (Table 2).

**Table 2**
**Fruit characters of different varieties of tomato**

| *Varieties* | *Length (cm)* | | *Girth (cm)* | | *Weight (g)* | | *Volume ($cm^3$)* | |
|---|---|---|---|---|---|---|---|---|
| | *Middle* | *Last* | *Middle* | *Last* | *Middle* | *Last* | *Middle* | *Last* |
| AT-3 | 9.00 | 6.43 | 16.50 | 13.33 | 103.72 | 42.43 | 91.67 | 87.33 |
| Abhinav | 10.10 | 8.80 | 16.07 | 15.47 | 100.53 | 75.37 | 61.67 | 72.33 |
| Alankar | **10.20** | 8.63 | **19.70** | 16.03 | **128.48** | 73.52 | 85.00 | 89.00 |
| Jewel | 9.57 | 8.20 | 17.50 | 15.03 | 115.67 | 66.57 | **108.33** | 71.67 |
| HeemShikhar | 8.83 | 7.20 | 17.67 | 14.67 | 93.63 | 44.44 | 103.33 | 67.67 |
| HeemSona | 8.53 | 8.23 | 17.97 | 15.43 | 97.35 | 61.50 | 80.00 | 52.33 |
| NS-2535 | 9.70 | 7.83 | 17.17 | 14.77 | 105.47 | 56.13 | 95.00 | 53.00 |
| Shaktiman | 9.97 | 7.43 | 17.30 | 13.83 | 102.22 | 45.23 | 88.33 | 62.67 |
| **S.Em.±** | 0.37 | 0.29 | 0.63 | 0.52 | 5.91 | 3.07 | 4.58 | 3.49 |
| **CD at 5%** | 1.12 | 0.88 | 1.93 | 1.60 | 17.95 | 9.32 | 13.89 | 10.61 |
| **CV%** | 6.75 | 6.41 | 6.32 | 6.17 | 9.68 | 9.15 | 8.89 | 8.72 |

**Disease and insect observations**

Tomato crop is highly prone to leaf curl disease caused by different virus complexes and early blight caused by fungus (*Altenariasolani*). Of these, leaf curl virus disease damaging to the crop depending upon the resistant genes incorporated in the varieties, environmental condition and vector population prevailing in the field. While, early blight was related with the resistance of the variety and environmental conditions. Among the different insects, fruit borer is the main to damage the fruits which reduce the marketable fruit yield. The results obtained on these biotic stresses are presented as under.

**Leaf curl**

The leaf curl ranged from 8.33 to 77.33 per cent. According to the disease severity, varieties were classified in three groups viz; resistant, moderately resistant and susceptible (Table 3). The hybrids Alankar (8.33%), Heemshikhar (10.00%) and Abhinav (12.67%); Shaktiman (32.00%) and HeemSona (45.33%); and NS 2535 (66.00%), Jewel (70.0%) and AT 3 (77.33%) were grouped as resistant; moderately resistant; and susceptible, respectively.

**Table 3**
**Disease and insect infestation in different genotypes of tomato**

| | *Insect Pest Disease* | | |
|---|---|---|---|
| *Variety* | *Leaf Curl (%)* | *Blight (%)* | *Fruit Borer (%)* |
| AT-3 | 77.33 | 44.33 (2) | 17.17(8.77) |
| Abhinav | 12.67 (3) | 35.56 (1) | 12.04(4.37) |
| Alankar | 8.33 (1) | 45.56 | 10.62(3.51) |
| Jewel | 70.00 | 68.89 | 17.09(8.74) |
| HeemShikhar | 10.00 (2) | 48.89 | 10.66(3.46) |
| HeemSona | 45.33 | 44.44 (3) | 12.56(4.76) |
| Namdhari | 66.00 | 73.33 | 12.65(4.80) |
| Shaktiman | 32.00 | 52.22 | 10.67(3.46) |
| SEm ± | 1.16 | 2.40 | 0.91(0.73) |
| CD at 5% | 3.52 | 7.29 | 2.763(2.22) |
| CV% | 5.00 | 8.06 | 12.19(24.25) |

**Early blight**

For this disease NS 2535 (73.33%) and Jewel (68.89%) found to be susceptible, while Shaktiman (52.22%), HeemShikhar (48.89%), Alankar (45.56%), AT 3 (44.33%) and Abhinav (35.50) were categorized as moderately resistant(Table 3).

**Fruit borer**

For this trait, about 10 per cent fruit borer infestation was observed for the varieties, Alankar, HeemShikhar and Shaktiman; 12 per cent for Abhinav, HeemSona and NS 2535; and 17 per cent for AT 3 and Jewel respectively (Table 3).

**Fruit Quality traits**

**Moisture per cent**

The significant differences among the treatments were found for this trait during both the pickings. Out of the eight genotypes, Alankar exhibited maximum moisture content in fruits during both the pickings (Table 4). While, it was observed minimum for AT 3 and HeemShikhar during middle and last pickings, respectively.

**Total soluble solids (brix)**

Total soluble solids (TSS) content in fruits is the most important quality criterion for tomato processing and serves as the base for fixing the price to be paid to the producer.

For this trait, significant differences were observed among the varieties. However, the highest TSS was recorded in Abhinav at middle and last picking. While, minimum TSS was recorded for HeemSona ($3.60^0$) and Shaktiman ($2.40^0$) at middle and last picking, respectively. (Table 4).

**Lycopene (mg/100g)**

The membrane associated antioxidant lycopene, which is responsible for the reddening of the fruits. Due to the differentiation of the chloroplasts and chromoplasts, lycopene is very important with regard to the final nutritional and marketable quality of tomato.

Significant differences were observed among the varieties. Significantly the highest and lowest lycopene content was recorded for the variety Shaktiman (3.31mg/ 100 g) and HeemSona (2.00mg/ 100 g), respectively at middle picking (Table 4). However, the same content was observed maximum for HeemSona (1.98 mg/100g) and minimum for AT 3 (1.05 mg/100g) at last picking.

**Ascorbic acid (mg/100g)**

The most impor-tant vitamin in fruits and vegetables is vitamin C i.e. ascorbic acid. The ascorbic acid usually acts as an antioxidant by being available for energetically favourable oxidation. Significantly the highest ascorbic acid content was recorded for AT 3(8.22 mg/100g) at middle picking (Table 4). The same content was recorded significantly lowest in Shaktiman (5.65 mg/100g) at middle picking. While in case of last picking, it was recorded highest and lowest in Abhinav (6.09 mg/100g) and NS 2535 (4.18 mg/100g), respectively.

**Table 4**
**Biochemical character of different varieties of tomato fruit**

| *Varieties* | *Moisture (%)* | | *TSS (brix)* | | *Lycopene (mg/100g)* | | *Ascorbic acid (mg/100g)* | |
|---|---|---|---|---|---|---|---|---|
| | *Middle Picking* | *Last Picking* | *Middle Picking* | *Last Picking* | *Middle Picking* | *Last Picking* | *Middle Picking* | *Last Picking* |
| AT-3 | 95.02 | 94.77 | 3.93 | 3.60 | 2.44 | 1.05 | 8.22 | 5.75 |
| Abhinav | 96.04 | 94.86 | 4.27 | 4.00 | 2.67 | 1.46 | 7.31 | 6.09 |
| Alankar | 96.15 | 96.39 | 4.07 | 2.70 | 2.01 | 1.86 | 5.87 | 5.64 |
| Jewel | 95.73 | 95.25 | 4.13 | 2.50 | 2.03 | 1.93 | 5.89 | 4.46 |
| HeemShikhar | 95.04 | 94.73 | 3.73 | 2.90 | 2.80 | 1.79 | 6.33 | 5.73 |
| HeemSona | 95.18 | 95.45 | 3.60 | 2.40 | 2.00 | 1.98 | 6.36 | 5.67 |
| NS 2535 | 95.70 | 94.79 | 3.80 | 3.10 | 2.39 | 1.86 | 6.23 | 4.18 |
| Shaktiman | 95.22 | 96.03 | 4.00 | 2.50 | 3.31 | 1.96 | 5.65 | 4.56 |
| **SEm±** | 0.09 | 0.05 | 0.10 | 0.08 | 0.08 | 0.06 | 0.18 | 0.07 |
| **CD at 5%** | 0.27 | 0.15 | 0.30 | 0.25 | 0.24 | 0.19 | 0.57 | 0.22 |
| **CV%** | 0.16 | 0.09 | 4.44 | 3.60 | 5.67 | 6.45 | 5.04 | 2.47 |

**Titratable acidity (%)**

For this trait, significant differences were observed among the varieties. However, the highest acidity was recorded in Abhinav at middle and in Heemsona at last picking (Table 5). While minimum acidity was recorded for Alankar (0.83%) and Jewel (0.46%) at middle and last picking respectively.

**Total Soluble sugar (%)**

For this trait significant differences were observed among the varieties during both the pickings (Table 5). In middle picking, the highest total soluble sugar was observed for NS 2535 (3.00%), while it was lowest for Abhinav (2.01%). On the other hand, during last picking it was highest and lowest for Jewel (4.06%) and Heemsona (2.68%), respectively.

**Reducing sugar (%)**

During middle picking, highest reducing sugar was found in Jewel (1.14%) followed by Heemsona (1.11%), whereas, during last picking it was highest (Table 5). in Abhinav (2.91%) followed by Jewel (2.83%) ansAlankar (2.61%).

**pH of Juice**

The range of pH during middle picking was shown 4.32 (Heemsona) to 4.64 (NS 2535), whereas during last picking (Table 5), it was from 4.63 (Heemshikhar) to 4.91 (Abhinav). For this trait narrow range of variability was observed for both the picking.

**EC of Juice**

For this trait, significant differences were observed among the varieties. However, the highest EC was recorded in HeemShikhar at middle and last picking. While, minimum EC was recorded for HeemSona and Jewel at middle and last picking, respectively (Table 5).

**Table 5**
**Biochemical character of different varieties of tomato fruit**

| *Varieties* | *Acidity (%)* | | *Total Soluble Sugar (%)* | | *Reducing Sugar (%)* | | *pH of juice* | | *EC of juice* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Middle Picking* | *Last Picking* | *Middle Picking* | *Last Picking* | *Middle Picking* | *Last Picking* | *Middle Picking* | *Last Picking* | *Middle Picking* | *Last Picking* |
| AT-3 | 1.31 | 0.95 | 2.04 | 2.97 | 2.36 | 0.63 | 4.53 | 4.71 | 6.53 | 7.30 |
| Abhinav | 1.66 | 0.96 | 2.01 | 3.64 | 2.91 | 0.70 | 4.59 | 4.91 | 6.41 | 7.05 |
| Alankar | 0.83 | 0.57 | 2.07 | 3.41 | 2.61 | 0.89 | 4.63 | 4.87 | 6.20 | 6.88 |
| Jewel | 1.06 | 0.46 | 2.82 | 4.06 | 2.83 | 1.14 | 4.50 | 4.78 | 4.93 | 6.71 |
| HeemShikhar | 1.50 | 1.07 | 2.78 | 3.31 | 2.37 | 1.02 | 4.52 | 4.63 | 6.87 | 7.48 |
| HeemSona | 1.31 | 1.16 | 2.60 | 2.68 | 2.13 | 1.11 | 4.32 | 4.73 | 5.34 | 7.31 |
| NS 2535 | 0.85 | 0.85 | 3.00 | 3.30 | 2.59 | 0.88 | 4.64 | 4.79 | 5.71 | 6.28 |
| Shaktiman | 1.63 | 0.67 | 3.18 | 2.58 | 2.50 | 0.67 | 4.63 | 4.66 | 5.36 | 6.63 |
| **SEm±** | 0.03 | 0.03 | 0.09 | 0.05 | 0.08 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| **CD at 5%** | 0.10 | 0.11 | 0.29 | 0.17 | 0.25 | 0.10 | 0.09 | 0.10 | 0.09 | 0.09 |
| **CV%** | 4.59 | 7.77 | 5.21 | 3.90 | 5.77 | 6.94 | 1.14 | 1.26 | 0.90 | 0.76 |

## CONCLUSION

Among the eight genotypes evaluated, Shaktiman yielded highest fruit per hectare (37.44 t/ha) followed by HeemShikhar (33.40 t/ha) and Alankar (30.30 t/ha). The highest fruit yielding hybrid Shaktiman also exhibited maximum lycopene (3.31 mg/100g) and total soluble sugar (3.18%) contents as well as moderate total soluble solid content (4.00 brix). Whereas, hybrid HeemShikhar ranked second for fruit yield along with high lycopene.

As far as disease and insect resistance concern Shaktiman and HeemShikhar hybrid were found tolerant against leaf curl and fruit borer and moderately tolerant against early blight disease.

## REFERENCES

Arias, R., Lee, T. C., Logendra, L. &Janes, H. (2000), Correlation of lycopene measured by HPLC with the L*, a*, b* colour readings of a hydroponic tomato and the relationship of maturity with colour and lycopene content. *Food Chem.*, **48**: 1697–1702.

Brandt, S., Pek, Z. and Barna, E. (2006), Lycopene content and colour of ripening tomatoes as affected by environmental conditions. *J. Sci. Food Agri.,* **86**: 568–572.

Clinton, S. K. (1998), Lycopene: chemistry, biology, and implications for human health and disease. *Nutr. Rev.*, **56:** 35–51.

Di, Mascio, P., Murphy, M. C. and Sies, H. (1991), Antioxidant defense systems, the role of carotenoid, tocopherol and thiols. *Am. J. Clinical Nutr.Suppl.,***53**: 194-200.

Mazumdar, B. C. and Majumder K. (2003), Methods on physico-chemical analysis of fruits, Daya Publ. House, Delhi, India: pp. 93-139.

Rao, A. V. and Agarwal, S. (2000), Role of antioxidant lycopene in cancer and heart disease. *J. Am. Coll. Nutri.,***19**: 563–569.

Rick, C. M. (1969), Origin of cultivated tomato, current status and the problem. *International Botonical Congress, Abstract* **11**: 180.

Sadasivam, S. and Manickam, A. (1996), Biochemical methods. II ed. New Age International Publishers, New Delhi, pp. 184-185.

Thimmaih, S. K. (1999), Standard methods of biochemicalanalysis. Kalyani Publications, New Delhi. pp. 278, 306.