Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 2652-2656
Received: 03-07-2020
Accepted: 21-08-2020

Mukesh Kumar
Department of Vegetable Science, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

JC Chandola
Subject Matter Specialist Horticulture (Fruit Science), Krishi Vigyan Kendra, Saran, Dr. Rajendra Prasad Central Agricultural University, Pusa

Durvesh Kumar Singh
Department of Vegetable Science, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Yashpal Bisht
Department of Vegetable Science, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Dinesh Kumar Singh
Department of Vegetable Science, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Corresponding Author:
JC Chandola
Subject Matter Specialist Horticulture (Fruit Science), Krishi Vigyan Kendra, Saran, Dr. Rajendra Prasad Central Agricultural University, Pusa

Effect of different environment and their interactions on quality characters of Tomato cultivars (*Solanum lycopersicum* L.)

Mukesh Kumar, JC Chandola, Durvesh Kumar Singh, Yashpal Bisht and Dinesh Kumar Singh

Abstract
A field experiment was conducted at Vegetable Research Centre, G.B. Pant University of Agriculture and Technology Pantnagar, U.S. Nagar Uttarakhand, during winter season of 2016-17 to study performance in and outside of poly-house to find out the most suitable and best cultivar, environment and interactions for growth and quality characters of tomato fruits. The experiment was laid out in factorial randomized block design (R.B.D.) with three replications. Each replication consisted of eight treatment combinations *viz.* two tomato cultivars i.e. Pant Poly-house Tomato-2 (V1) and Pant Poly-house Hybrid Tomato -1 (V2), four environments (viz. E4- poly-house + spray of 2, 4-D), E3 (open + sprayof 2, 4-D), E2 (poly-house without spray) and E1 (open field without spray). Foliar spray of 2, 4-D @ 5 ppm concentration was applied as whole plant spray at 30, 45 and 60 days after transplanting of tomato seedlings. The cultivar V1 produced highest fruit yield of 648.52 (q/ha) which was 12.13% higher over V2. Among the environment (treatment) E4 produced greater fruit yield (1009.79 q/ha) followed by E3 (606.85 q/ha) and E2 (565.26 q/ha). The treatment E4 produced 66.39% higher fruit yield over treatment E3, 78.64% higher fruit yield (q/ha) over E2 and 271.39% higher fruit yield over treatment E1, respectively. Whereas, treatment E3 gave 7.36% higher over E2 and 123.19% over treatment E1, respectively. Similarly, treatment E2 produced 107.90% greater fruit yield over E1 (271.89 q/ha).Among the interactions, treatment V1E4 performed better for 10 characters whereas, V2E4 was better for 3 characters, V2E3 for 3 characters and treatment V1E2 only for one character as compared to rest of the interactions. The treatment V1E4 gave 37.75% higher fruit yield than V2E4 and 84.44% over treatment V2E3 and 119.67% over V1E2. On the other hand, V2E4 produced 42.09% higher over V2E2 and 266.52% higher fruit yield over V2E1.Treatment V2E4 gave 33.89% higher over V2E3.

Keywords: Treatments, foliar spray, tomato, cultivars, interactions

Introduction
Tomato (*Solanum lycopersicum* L. 2n = 2x = 24) is one of the most widely grown vegetable crop in the world including tropical, sub-tropical and temperate regions. It is one of the most important 'protective food' because of the presence of the vitamin A and C, minerals and lycopene. It is a rich source of minerals particularly potassium. It also contains organic acids particularly citric acid and malic acid. Ascorbic acid content ranges from 16 to 75 mg per 100g of edible part. It occupied 774 thousand hectare area and having production of 18,732 thousand metric tons with the productivity of 24.20 tons per hectare. As per 3rd estimate of 2016-17 tomato occupied an area of 799 thousand hectare and produce 19,542 thousand metric tons of fruits with the productivity of 24.46 tons per hectare. (N.H.B, 2015-16).The efforts are continuously being made by researchers to develop high yielding cultivars for growers. Although, there are number of cultivars available for cultivation in the country. But very less numbers of cultivars are recommended for poly-house cultivation. Recently two new cultivars such as PPT-2, PPHT-1 has been released at state level for commercial cultivation to the farmers of the country for poly-house cultivation by the Pantnagar Researchers. The poly-house cultivation has distinct advantages of quality, productivity and favourable market price to the growers. Plant growth regulators play an important role in vegetable production by improving fruit setting, size, reduce flower and fruit drop, number and weight in several crops. Plant growth regulators are also known as plant exogenous hormones and these are synthetic substances that are similar to natural plant hormones. They are used to regulate the growth of the plants and are important measure to enhance and ensure horticulture production. By the use of the plant growth regulators, the fruit set can be improved by delaying the abscission of the flowers.

Materials and Methods

A field experiment was conducted at GBPUA & T Pantnagar, (29^0 N, 79.3^0 E, 243.84m MSL), U.S. Nagar, Uttarakhand, during winter season of 2016-17to study performance in and outside of poly-house to find out the most suitable and best cultivar, environment and interactions for quality characters of tomato fruits. Two tomato cultivars i.e. Pant Poly-house tomato-2 and Pant poly-house hybrid tomato-1 were grown under both the environments such as open field as well as under poly-house conditions. The recommended cultural practices for the crop were followed in the experimental field such as irrigation, weeding and plant protection measures. The observations were recorded on five tagged plants from each treatment and in each replication for various vegetative and reproductive characters.

The data were analysed according to the method of analysis for two factorial Randomized block design given by Snedecor and Cochran (1968). The significance of variance among the treatments was observed by applying F test and Least Significant Difference (LSD) at 5% level of significance was calculated to compare the mean values of treatments for all the characters under study.

Results and Discussions

1. Equatorial fruit diameter

Equatorial fruit diameter was significantly influenced by cultivars and environments (Table 1). The highest value was recorded in cultivar V1 (5.23cm) than V2 (4.91cm). The results of present trial were indicated that V1 was superior in respect of equatorial diameter of tomato fruit as compare to V2. It may be because of the genetic constitution of the cultivar and it may also be happen due to varietal variation of tomato cultivars as also reported by Nandi (1992) and Kanneh *et al. (*2017) [4]. They also reported variable response for this character among the tomato cultivars due to the genetic factor of the cultivar.

Among the environments, maximum value was recorded in E4 (6.01 cm) followed by E2 (5.02 cm) and E3 (4.75 cm) in open condition along with 2, 4-D. The results indicated that foliar spray of 2, 4-D increased the equatorial diameter of fruit in tomato in E3 (open along with 2, 4- D spray than E1 without 2, 4-D spray in open field condition. These results are in accordance with the findings of Tiwari and Singh (2014) [14] who had also found that application of 2, 4-D significantly increased the equatorial diameter of tomato fruits in open field condition. Similarly, in poly-house condition, foliar spray of 2, 4-D significantly increase equatorial diameter of tomato fruits in E4 (poly-house with 2, 4- D spray) as compare to E2 (poly-house without 2, 4- D) environment. It may be due to the better and congenial conditions available in the poly-house for better growth and development of the fruits and plant also received better conditions in poly-house as compare to the open field. Thus, due to better absorption of the nutrients and higher synthesis of photosynthates in the plant which may moves from the plant leaves towards the fruits. Therefore, the size of the fruits may increased due to application of 2, 4-D which provide better results for this character in open field as well as in poly-house conditions. The minimum value was recorded in treatment E1 (4.51 cm).

Among the interactions, maximum value was recorded in V1E4 (6.16 cm) followed by V2E4 (5.58 cm) and V1E2 (5.14 cm) as compare to other interactions. The minimum value was recorded in V2E1 (4.26 cm) and V2E3 (4.61cm) than rest of the interactions.

2. Polar diameter of tomato fruits

The data showed significant differences between the environments and their interactions, and it was found non-significant for this character between cultivars (Table 1). However, the highest was recorded in cultivar V1 (5.19cm) than V2 (5.18cm). Cultivar V1 was superior as compare to V2 may be because of the genetic variation of the cultivars. Similar, findings have also been found by Nandi (1992) [6] and Kanneh *et al.* (2017) [4]. They also reported that cultivars may vary for this character due to the varietal differences between the cultivars.

Among the environments, maximum value was recorded in E4 (6.34cm) followed by E2 (5.09cm) and E3 (5.02cm). The data indicated that foliar spray of 2, 4-D increased the polar diameter of tomato fruits in E3 (open field along with 2, 4-D) than E1 in open field condition without 2, 4-D. The present studies are similar to the results of Singh and Singh (1993) [9]. They found that application of 2, 4-D significantly increased the polar diameter of fruits in open field condition. Similarly, in poly-house condition, foliar spray of 2, 4-D significantly increased polar diameter of tomato fruits in E4 (poly-house along with 2, 4-D) as compare to E2 (poly-house without 2, 4-D). The increased polar diameter of tomato fruit was also found in poly-house by receiving the favourable conditions for better growth and development of the plant as well as for fruit size improvement. The minimum value was recorded in treatment E1 (4.28cm).

Among the interactions the highest value was recorded in V1E4 (6.81cm) followed by V2E4 (5.88 cm) and V2E3 (5.60cm) over rest of the interactions. The polar fruit diameter was higher in E4 in both the cultivars in poly-house with spray of 2, 4-D than open field without spray of 2, 4-D. Data indicated that V1 showed better response in poly-house with spray of 2, 4-D than V2 cultivar, whereas, V2 perform better in open field without 2, 4-D spray may be due to varietal differences. Rest of the interactions showed intermediate results for this character. The lowest value was recorded in V1E1 (4.12 cm) followed by V2E1 (4.44 cm) as compare to other interactions.

3. Shape index of tomato fruit

The data showed significant difference between the cultivars, environments and their interactions for shape index of tomato fruits (Table 1), data indicated that the highest value was recorded in cultivar V2 (1.02cm) than cultivar V1 (0.98cm). Cultivar V2 was superioras compare to V1 may be due to the genetic constitution of the cultivar. The cultivar V2 has shape index value more than one. It mean, it bears oval / pear shape of the fruits. These results are in accordance with the findings of Ngullie and Biswas (2014) [7] who had reported that pear shaped fruits of Punjab Chhuhara have more than 1 value of shape index. In general, round cultivars have shape index of either one or less than one but pear shape have value more than one due to varietal and genetic differences.

Among all the environments, the maximum value was recorded in E3 (1.06 cm) followed by E4 (1.03 cm) and E2 (0.98 cm). The data indicated that foliar spray of 2, 4-D increased the shape index of tomato fruits in E3 (open with 2, 4-D) than E1 (in open field condition without 2, 4-D). These results are in accordance with the findings of Singh and Singh (1993) [9]. They found that application of 2, 4-D significantly increased the shape index of tomato fruits in open field condition. Similarly, in poly-house condition, foliar spray of 2, 4-D significantly increased the shape index of tomato fruits in E4 as compare to E2. It may be due to attain better and

favourable temperature and other congenial condition available in the poly-house. Thus, plant received more nutrients from the soil as also mentioned by Singh and Singh (1996) [11]. The increased shape index of tomato fruits may be due to better response of 2, 4-D to the plants in this respect. The minimum value for this character was found in E1 (0.93cm).

Among the interactions, that maximum value was recorded in V2E3 (1.15 cm) followed by V1E4 (1.10 cm) and V1E2 (1.04 cm) than rest of the interactions. The minimum value was recorded in V1E1 (0.83 cm) and V2E2 (0.93 cm) than rest of the interactions.

4. Number of locules per fruit

Significant differences between the cultivars, environments and their interactions for number of locules per fruit was found (Table 1). The data revealed that more number of locules per fruit was recorded in cultivar V1 (3.09) than cultivar V2 (2.53). These results indicated that V1was superior as compare to V2 may be because of the varietal variation and genetic constitution of the cultivar which was also reported by Singh *et al.* (1992) [10] who had found more number of locules per fruit in tomato cultivar Pusa Sel-8 followed by Sel-1. Similarly, Biswas*et al*. (2015) [2] noted more locules per fruit in cultivar BARI Tomato-7. Thus, the number of locules per fruit may vary according to the cultivar. In general, round cultivars has more number of locules per fruit than the oval and pear shaped cultivars as also mentioned by Singh *et al.* (1995) [12]; reported more locules in round cultivars than the oval and pear shaped cultivars. They noted more locules per fruit in Pusa Ruby than Pant T-3. Similarly, Singh and Lal (2005) and Ahmad *et al*. (2007) reported more locules in round cultivar than the pear shaped cultivars.

Among all the environments, more number of locules per fruit was recorded in treatment E4 (3.13) followed by E2 (3.0) and E3 (2.70). Data indicated that foliar spray of 2, 4-D increased the number of locules per fruit in treatment E3 than E1 in open field conditions. The present results of investigation are in accordance with the findings of Singh (1986-87). They found that application of 2, 4-D significantly increased the number of locules per fruit in open field condition. Similarly, in poly-house condition foliar spray of 2, 4-D significantly increased the number of locules per fruit in treatment E4 as compare to E2 in poly-house without spray of 2, 4-D. Tiwari and Singh (2014) [14] also reported that 2, 4-D @ 5 ppm increased the number of locules per fruit in tomato cv. Pant T-3. Similarly, the increased number of locules per fruit were also found in poly-house condition may be due to favourable conditions. The minimum locules per fruit was found in treatment E1 (2.45). It may be due to without spray of 2, 4-D in open field.

Among the interactions, more number of locules per fruit in tomato was recorded in treatment V1E4 (3.27) followed by V1E2 (3.20) and V1E3 (3.20) as compare to other interactions. It may be due to better and favourable response of 2, 4-D in V1 than V2 (in poly-house). The minimum number of locules per fruit was noted in V2E1 (2.10) followed by V2E3 (2.20) and V1E2 (2.80) than rest of the interactions.

5. Pericarp thickness of tomato fruits

The data showed significant differences in cultivars, environments and it was found non-significant with respect to pericarp thickness among the interactions (Table 1). The data revealed that highest value was recorded in cultivar V1 (0.66mm) than V2 (0.62mm). The data indicated that V1 was superior as compare to V2 may be because of the genetic constitution of the cultivar. These findings of present investigation are similar to the findings of Kanneh *et al.* (2017) [4] who had also reported that different cultivars has variable thickness of pericarp due to the variable differences in the cultivars. In general, round cultivars have thin and pear shape cultivars have thick pericarp as also mentioned by Singh and Lal (2005) who have also reported more thickness of pericarp in Pearson Local, Punjab Chhuhara and Pusa Gaurav. Spaldon and Hussain (2017) [13] also found maximum pericarp thickness in Anand cultivar.

Among all the environments, maximum value was recorded in treatment E4 (0.75 mm) followed by E2 (0.69 mm) and E3 (0.59 mm). The data indicated that foliar spray of 2, 4-D increased the pericarp thickness of tomato fruits in E3 than E1 (in open field condition). These results are in accordance with the findings of Gelmesa *et al. (*2010) [3]. They found that application of 2, 4-D significantly increased the pericarp thickness of tomato fruits in open field condition, as well as in poly-house condition. It may be because of better growth and development of the fruits in open field and by the use of 2, 4-D in poly-house by receiving good environment for better growth and development of the plant in favourable conditions. The minimum pericarp thickness was recorded in treatment E1 (0.52 mm) and E3 (0.59 mm).

Among the interaction, maximum pericarp thickness was recorded in treatment V1E4 (0.82 mm) and V1E2 (0.73 mm) as compared to other interactions. The minimum pericarp thickness was recorded in treatment V2E1 (0.50 mm) than V1E3 (0.52 mm) than rest of the interactions.

6. Total Soluble Solids of tomato fruits

Significant differences between the cultivars, environments and their interactions for total soluble solids of tomato fruits was found (Table 1). The data showed that highest value for T.S.S of tomato fruits was recorded in cultivar V1(4.34^0B) than cultivar V2(4.0^0B).The data indicated that V1 was superior in respect of total soluble solids of tomato fruits as compare to V2 may be because of the genetic constitution of the cultivar and may be due to the varietal differences in the cultivars as also mentioned by Spaldon and Hussain (2017) [13]. They have reported that ArkaVikas fruits have higher amount of T.S.S. than other cultivars. Among all the environments, maximum value for total soluble solids was recorded in treatment E3 (4.63^0B) followed by E4 (4.53^0B) and E2 (4.07^0B).

The data indicated that foliar spray of 2, 4-D increased the total soluble solids in tomato fruits in treatment E3 than E1 (in open field conditions). The results of present studies are in accordance with the findings of Mehrotra *et al.* (1970) [5]. They found that application of 2, 4-D significantly increased the total soluble solids of tomato in open field condition as well as in poly-house condition. It may because of plants get better and favourable temperature and other factors in poly-house and open field condition due to spray of 2, 4-D. However, response in respect to T.S.S. was better in open field than poly-house. The minimum value for this character was recorded in treatment E1 (3.45^0B).

Among the interactions highest total soluble solids was recorded in V2E3 (5.0^0B) followed by V1E4 (4.90^0B) and V1E2 (4.50^0B) than rest of the interactions. The lowest T.S.S. was recorded in V2E1 (3.20^0B) in open field without spray of 2, 4-D, and V2E2 (3.63^0B) was better than V2E1 in respect of T.S.S. content of the fruits.

7. Vitamin C content of tomato fruit juice

Significant differences for environments and it was found non-significant (Table 1) for cultivars, and their interactions for vitamin C content (mg/100ml of tomato fruit juice). The highest value for vitamin C content of tomato fruit juice was recorded in cultivar V1(31.80 mg/100ml) than cultivar V2(31.60 mg/100ml) (PPHT-1). CultivarV1 was superior as compare to V2 may be because of the genetic constitution of the cultivar. These findings are in accordance with the findings of Spaldon and Hussain (2017) [13] who had reported variable content of ascorbic acid in tomato cultivars due to varietal variations.

Among all the environments, maximum vitamin C content was recorded in E4 (35.60 mg/100ml) followed by E3 (34.35 mg/100ml) and E2 (31.0 mg/100ml). The data indicated that Vitamin C content was significantly influenced by 2, 4-D application in poly-house as well as in open conditions. The data showed that application of 2, 4-D significantly increased the vitamin C content in E4 than E2 (poly-house) as well as in E3 than E1 in open field. These results are in accordance with the findings of Gelmesa *et al.* (2010) [3]. They found that application of 2, 4-D significantly increased vitamin C content (mg/100ml) of tomato fruits juice in open field condition. Similarly, the increased vitamin C content of tomato fruits juice was also found in poly-house condition. It may be due to the better and favourable conditions available for quality improvement in poly-house by spray of 2, 4-D. The minimum vitamin C content was found in treatment E1 (25.80 mg/100ml) fruit juice.

Among the interactions, the highest value for vitamin C content was obtained in V1E4 (36.0 mg/100ml) followed by V2E4 (35.20 mg/100ml) in poly-house as compared to other interactions. The lowest vitamin C content was recorded in V2E1 (25.20 mg/100ml) followed by V1E1 (26.40 mg/100ml) than rest of the interactions due to unfavourable environment in open field in both the cultivars.

Table 1: Response of cultivars, environment and their interactions on quality characters

Treatments/characters	Equatorial diameter (cm)	Polar diameter (cm)	Shape index (cm)	Number of locules per fruit	Thickness of pericarp of fruit (mm)	Total soluble solids (^{0}B)	Vitamin C (mg/100ml of fruit juice)
V1	5.24	5.19	0.98	3.11	0.66	4.34	31.80
V2	4.91	5.18	1.02	2.53	0.62	4.00	31.60
$LSD_{(0.05)}$	1.06	NS	0.03	0.15	0.06	0.20	NS
E1	4.51	4.28	0.93	2.45	0.52	3.45	25.80
E2	5.02	5.10	0.99	3.00	0.69	4.07	31.00
E3	4.75	5.03	1.06	2.70	0.59	4.63	34.40
E4	6.01	6.34	1.03	3.13	0.75	4.53	35.60
$LSD_{(0.05)}$	1.50	0.53	0.05	0.21	0.09	0.29	4.42
V1E1	4.76	4.12	0.83	2.80	0.54	3.70	26.40
V1E2	5.14	5.40	1.04	3.20	0.73	4.50	30.40
V1E3	4.89	4.45	0.96	3.20	0.52	4.27	34.40
V1E4	6.16	6.81	1.10	3.27	0.82	4.90	36.00
V2E1	4.27	4.45	1.03	2.10	0.50	3.20	25.20
V2E2	4.91	4.80	0.93	2.80	0.65	3.63	31.60
V2E3	4.61	5.60	1.15	2.20	0.67	5.00	34.40
V2E4	5.85	5.88	0.96	3.00	0.69	4.17	35.20
$LSD_{(0.05)}$	NS	0.74	0.06	0.30	NS	0.42	NS

Acknowledgement

It is proud privilege to express my most sincere and profound sense of gratitude to my advisor and chairman of my advisory committee Dr. Durvesh Kumar Singh, Department of vegetable science, GBPUA & T Pantnagar, Uttarakhandfor her inspiring, nobel guidance, untiring help, keen interest, constant painstaking efforts, constructive criticism, constant encouragement and in carrying out the research and preparation of this manuscript also for providing necessary facilities to carry out the research work in an effective manner, which has made orientation of this memory of my life.

References

1. Ahmad F. Khan O, Sarwar S, Hussain A, Ahmad S. Performance of tomato cultivars at high altitude. Sarhad J Agric. 2007; 23(3).
2. Biswas M, Sarkar DR, Asif MI, Sikder SK, Mehraj H, Jamal Uddin AFM. Comparison of Growth and Yield Characteristics of BARI Tomato Varieties. Journal of Bioscience and Agriculture Research. 2015; 03(01):01-7.
3. Gelmesa D, Abebie B, Desalegn L. Effects of Gibberellic acid and 2, 4-Dichlorophenoxy acetic acid spray on fruit yield and quality of tomato (*Lycopersicon esculentum* Mill.). Journal of Plant Breeding and Crop Science 2010; 2(10):316-324.
4. Kanneh SM, Quee DD, Ngegba PM, Musa PD. Evaluation of Tomato (*Solanum lycopersicum* L.) Genotypes for Horticultural Characteristics on the Upland in Southern Sierra Leone. Journal of Agricultural Science. 2017; 9(6).
5. Mehrotra PM, Garg RG, Singh, Ist, Growth, fruiting and quality of tomato (*Lycopersicum esculentum* Mill.) as influenced by growth regulators. Prog. Hort. 1970; 2(1):57-64.
6. Nandi A. Evaluation of tomato (*Lycopersicon esculentum* Mill.) varieties for autumn crop. Orissa Journal of Agricultural Research 1992; 5(1, 2):116-118.
7. Ngullie, Renbomo, Biswas PK. Performance evaluation of tomato varieties under mid-altitude of Mokokchung district of Nagaland. International Journal of Farm Sciences. 2014; 4(3):19-23.
8. Singh, Durvesh K. Effect of 2, 4-D formulation and methods of application on growth, yield and quality of tomato (*Lycopersicumesculentum* Mill) cultivar. Ph.D thesis submitted to GBPUA&T., Pantnagar, 1988.
9. Singh DK, Singh RP. Varietal response to 2, 4-Dichloro Phenoxy acetic acid and method of its application on

Summer tomato. Indian Journal of Agri. Science. 1993; 63(5):276-282.
10. Singh DK, Lal G, Rai PN. Performance of determinate tomato (*Lycopersicon esculentum* Mill.) grown during summer season. Annual Agric. Res. 1992; 13(3):287-289.
11. Singh DK, Singh RP. Effect of 2, 4-D on seed, yield and quality characters of tomato. Advances in Horticultre and Forestry. 1996; 5:87-96.
12. Singh DK, Lal G, Tiwari RP, Jain SK. Effect of methods of planting on tomato cultivars during spring summer. Annuals Agriculture Research. 1995; 16(1):116-118.
13. Spaldon S, Hussain S. Performance of Tomato (*Solanumlycopersicum* L.) Genotypes for Yield and Quality Traits under Jammu Subtropical Condition. International Journal of Agriculture Innovations and Research. 2017, 6.
14. Tiwari AK, Singh DK. Use of Plant Growth Regulators in Tomato (*Solanum lycopersicum* L.) under Tarai Conditions of Uttar hand. Indian Journal of Hill farming 2014; 27(2):38-40.