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Effect of Date of Transplanting, Spacing and Training System on Quality Characters of Tomato (*Solanum lycopersicum* Mill) Under Naturally Ventilated Polyhouse

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ABSTRACT

An experiment was conducted in naturally ventilated polyhouse during summer-season (March to August) in the year 2013 and 2014 at the Research Farm of the Himachal Pradesh Krishi Vishvavidyalaya, Palampur, to study the effect of date of transplanting, spacing and training system on quality characters of tomato (*Solanum lycopersicum* Mill) under naturally ventilated poyhouse. The experiment was laid out in randomized block design with three replications, consisting of twelve treatments *i.e.* three dates of transplanting (15th March , 30th March and 15th April), two spacings (60 cm x 30cm and 75 cm x 30 cm) and two training systems (two shoots and three shoots). Plants transplanted on 15th March recorded significantly higher pericarp thickness (7.1 cm in 2013 and 7.5 cm in 2014), maximum TSS (5.33% in 2013 and 5.50% in 2014), higher ascorbic acid (24.4 mg/100g in 2013 and 22.7 mg/100g in 2014), maximum titrable acidity (0.50% in 2013 and 0.51% in 2014). It was observed that plant spacing of 75 cm x 30 cm resulted in higher pericarp thickness (7.1 cm in 2013 and 7.3 cm in 2014), maximum TSS (4.83% in 2013 and 5.11% in 2014), maximum titrable acidity (0.44% in 2013 and 0.46% in 2014) except ascorbic acid which was recorded higher in 60 cm x 30 cm spacing whereas, training plant to two shoots recorded significantly higher pericarp thickness (6.9 cm in 2013 and 7.2 cm in 2014) other characters were not affected significantly with different treatments.

1. Introduction

Tomato (*Solanum lycopersicum* Mill.), a member of Solanaceae family, is one of the most important vegetable crops grown throughout the world. In India, tomato has become an important vegetable crop and occupies an area of 882 thousand ha with a production of 18735.9 thousand MT with a productivity of 21.2 MT/ha (Anonymous, 2014) whereas, in Himachal Pradesh, it is grown in about 10.37 thousand ha area with a production of about 430.79 thousand MT with a productivity of 41.5 MT/ha (Anonymous 2014). Although, India has a wide range of diverse agro-climatic conditions, but vegetable cultivation practices have generally been restricted to regional and seasonal needs. In general, protected structures are used to overcome low temperature in temperate regions or high temperature in the countries having tropical climate. Protected cultivation has tremendous potential in increasing production, productivity and quality of vegetable crops like tomato, cherry tomato, coloured capsicum, cucumbers, muskmelon and summer squash, some rare vegetables, medicinal and ornamental plants even under adverse agro-climatic conditions. Among vegetables, tomato is one of the crops grown in polyhouses worldwide. Time of transplanting is one of the important factors as optimum date of transplanting brings about proper growth and development of plants resulting in maximum yield of the crop and economic use of land (Islam et al. 2010).

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Training the plants to two shoots or three shoots will not only facilitate easy training operation, but also permit closer planting, early ripening of fruits and get higher yields of larger sized fruits. Training methods vary with different growth habits of tomato cultivars and for different plant densities. The quality of tomato is profoundly influenced by the other cultural practices especially spacing and fertigation. Hence, the present study is investigated to know the optimum date of transplanting, spacing and training system for quality parameters of tomato under mid hill conditions of Himachal Pradesh in naturally ventilated poyhouse.

2. Material and Methods

The experiment was conducted in naturally ventilated polyhouse during summer-season (March to August) in the year 2013 and 2014 at the Research Farm of the Himachal Pradesh Krishi Vishvavidyalaya Palampur. The experimental site is located at $32^0 6'$ N latitude, $76^0 3'$ E longitude with an elevation of 1290.8 meters above mean sea level. The area represents the sub-humid mid hill zone of Himachal Pradesh and is characterized by the sub-tropical climate. Mild summer and cool winter characterized the climate of Palampur. May and June are the hottest months, whereas, December and January are the coldest. Annual rainfall ranges between 2000 to 2500 mm of which 80% is received during June to September and rest is received during remaining period of the year. Mean maximum temperature inside the polyhouse during the crop years 2013 and 2014 ranged from 32.6 to 44.2^0C and 27.6 to 42.3^0C, respectively. The mean minimum temperature during the corresponding years ranged from 15.3 to 26.2^0C and 14.8 to 25^0C. The average relative humidity inside polyhouse ranged between 32.1 and 97.4% and 26.2 and 79.3% during the growth period of the crop in 2013 and 2014, respectively. A total rainfall of 2231.8 and 1346.0 mm was received outside the polyhouse during the crop season of 2013 and 2014, respectively. The seeds of Naveen 2000 plus was sown in plastic plug trays by using soilless media having cocopeat, perlite and vermiculite in the ratio of 3:1:1, respectively inside the naturally ventilated polyhouse to get healthy and disease free seedlings of tomato. 25-35 days old seedlings were transplanted inside the naturally ventilated polyhouse equipped with drip irrigation system on different dates. Before transplanting, beds were prepared. These beds were thoroughly sterilized with 4% formalin (1 litre of 40% commercial formalin in 7 litre of water). Beds were covered with black polyethylene sheet for 7 days after formalin application. Then polyethylene sheet was removed and soil raked well for a week in order to remove the fumes of formalin. The basal dose of N, P and K @ 100 kg/ha from straight fertilizers was applied in the form of urea (21.5 g/m^2), single super phosphate (62.5 g/m^2) and muriate of potash (16.5 g/m^2). Remaining dose of 150:150:150 kg/ha NPK was applied with water soluble fertilizer (polyfeed 19:19:19) starting from 3rd week after transplanting and up to 15 days prior to final harvest. Fertigation was done twice a week. The plants were irrigated daily with drip irrigation system, one dripper was provided for each plant. Plants were watered regularly before 12 noon or late evening. Other cultural practices and standard plant protection measures were also adopted from time to time to ensure healthy crop stand. The experiment comprising three dates of transplanting (15th March , 30th March and 15th April), two spacings (60 cm x 30cm and 75 cm x 30 cm) and two training systems (two shoots and three shoots) was laid out in a randomized block design with three replications. Observations recorded were pericarp thickness (cm), total soluble solids (TSS %), ascorbic acid and titrable acidity.

3. Results and Discussion

3.1 Pericarp thickness (cm)

Transplanting of tomato plants on 15th March registered significantly higher pericarp thickness (7.1 cm in 2013 and 7.5 cm in 2014) over other two dates of transplanting (Table 1 and 2). Among the latter two dates of transplanting, 15th April transplanting produced the fruits with lowest pericarp thickness (6.4 cm in 2013 and 6.6 cm in 2014). Pericarp thickness was also significantly influenced by the spacing. Plant spacing of 75 cm x 30 cm registered significantly higher pericarp thickness (7.1 cm in 2013 and 7.3 cm in 2014) over 60 cm x 30 cm spacing. This could be due to bigger size of fruits at wider spacing of 75 cm x 30 cm. Training systems also had a significant influence on pericarp thickness. Training the plants to two shoots recorded significantly higher pericarp thickness than plants trained to three shoots and this increase was 6.15% in 2013 and 7.46% in 2014. Similar were the results of Singh and Gulshan (2003) and Uppal et al. (1997).

3.2 Total soluble solids (TSS %)

Maximum TSS (5.33% in 2013 and 5.50% in 2014) was obtained when crop was transplanted on 15th March which was significantly higher than 30th March (4.67% in 2013 and 5.08% in 2014) and 15th April plantings (3.83% in 2013 and 4.25% in 2014). The study indicated that total soluble solids content (Table 1 and 2) was significantly influenced by plant spacing during both the years and it was observed that with the increase in

Table 1. Quality characters as influenced by different treatments (2013)

Treatment	Pericarp thickness (cm)	Total soluble solids (TSS %)	Ascorbic acid (mg/100 g of fruit)	Titrable acidity (%)
Date of transplanting				
15th March	7.1	5.33	24.4	0.50
30th March	6.6	4.67	21.0	0.41
15th April	6.4	3.83	18.8	0.34
SEm±	0.1	0.06	0.5	0.01
CD (P=0.05)	0.3	0.18	1.5	0.03
Spacing				
60 cm X 30 cm	6.4	4.39	22.4	0.39
75 cm X 30 cm	7.1	4.83	20.4	0.44
SEm±	0.1	0.05	0.4	0.01
CD (P=0.05)	0.2	0.15	1.2	0.02
Training systems				
Two shoot	6.9	4.78	21.0	0.42
Three shoot	6.5	4.44	21.8	0.41
SEm±	0.1	0.05	0.4	0.01
CD (P=0.05)	0.2	NS	NS	NS

NS = non-significant

Table 2. Quality characters as influenced by different treatments (2014)

Treatment	Pericarp thickness (cm)	Total soluble solids (TSS %)	Ascorbic acid (mg/100 g of fruit)	Titrable acidity (%)
Date of transplanting				
15th March	7.5	5.50	22.7	0.51
30th March	6.8	5.08	20.1	0.43
15th April	6.6	4.25	18.4	0.35
SEm±	0.1	0.06	0.5	0.01
CD (P=0.05)	0.3	0.18	1.4	0.03
Spacing				
60 cm X 30 cm	6.6	4.78	21.3	0.41
75 cm X 30 cm	7.3	5.11	19.5	0.46
SEm±	0.1	0.05	0.4	0.01
CD (P=0.05)	0.2	0.15	1.2	0.02
Training systems				
Two shoot	7.2	5.06	20.1	0.44
Three shoot	6.7	4.83	20.7	0.42
SEm±	0.1	0.05	0.4	0.01
CD (P=0.05)	0.2	NS	NS	NS

plant spacing the total soluble solids (5.33% in 2013 and 5.50% in 2014) increased significantly. Training system could not influence the total soluble solids (%) significantly in any of the years under study. These results are in conformity of Singh and Parmar (2004).

3.3 Ascorbic acid (mg/100g)

Transplanting the crop on 15th March registered significantly higher ascorbic acid than 30th March and 15th April transplanting. Plant spacing had significant effect o n ascorbic acid in fruits. Plant spacing of 60 cm x 30 cm registered significantly higher ascorbic (22.4 mg in 2013 and 21.3 mg in 2014) over 75 cm x 30 cm spacing. Ascorbic acid was not affected significantly by training system during both the years. Smaller the fruit size more is the ascorbic acid Singh and Gulshan (2003), Raghav (2000) and Kumar (2001).

3.4 Titrable acidity (%)

Titrable acidity (Table 1 and 2) indicted that different dates of transplanting differed significantly in respect of titrable

acidity in both the years. Maximum titrable acidity (0.50% in 2013 and 0.51% in 2014) was obtained when crop was transplanted on 15th March which was significantly higher than 30th March (0.41% in 2013 and 0.43% in 2014) and15th April plantings (0.34% in 2013 and 0.35% in 2014). Fruits produced by the plants spaced at 75 cm x 30 cm recorded titrable acidity of 0.44% in 2013 and 0.46% in 2014 which was significantly higher than 60 cm x 30 cm spacing (0.39% in 2013 and 0.41% in 2014). Training system could not influence the titrable acidity (%) significantly in any of the years under study. These results are supported by the work of Singh et al. (2004)

Conclusions

Transplanting of tomato on 15th March, plants trained to two shoots and spaced at 75 cm x 30 cm apart were found to be the best for better quality of produce than 30th March and 15th April, plants trained to three shoots and spaced at 75 cm x 30 cm.

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