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Response of tomato hybrids to different growing media and fertigation on quality characters of tomato (*Solanum lycopersicum* Mill) under naturally ventilated Polyhouse

Shilpa Kaushal, Vinod Sharma and Vijay Singh

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 response of tomato hybrids to different growing media and fertigation on quality characters of tomato (*Solanum lycopersicum* Mill) under naturally ventilated polyhouse. The experiment was laid out in Randomized Block Design with treatments comprising three hybrids (Avtar, Rakshita and Naveen 2000 plus), three fertigation levels (NPK @ 20:20:20 g/m^2, NPK @ 25:25:25 g/m^2 and NPK @ 30:30:30 g/m^2) and two growing media (vermicompost and cocopeat: vermicompost). Hybrid Naveen 2000 plus registered significantly higher pericarp thickness, highest total soluble solids and highest titrable acidity over other two hybrids. Highest ascorbic acid was recorded in Hybrid Avtar which was significantly higher than Rakshita and Naveen 2000 plus. Maximum total soluble solids, ascorbic acid and titrable acidity were observed at NPK @ 30 g/m^2 which were significantly higher than NPK @ 25 g/m^2 and NPK @ 20 g/m^2. Growing media comprising cocopeat: vermicompost (1:1, v/v) registered maximum pericarp thickness, highest total soluble solids, titrable acidity. Growing media comprising vermicompost registered ascorbic acid which was significantly higher than growing medium containing cocopeat: vermicompost (1:1, v/v).

Keywords: Tomato, hybrids, growing media, fertigation, naturally ventilated polyhouse, and quality characters

Introduction
Tomato (*Solanum lycopersicum* Mill.), member of solanaceae family, is one of the most important vegetable crops grown throughout the world. Tomato is native to Central and South America and was introduced in India by the Portuguese in the middle of sixteenth century. Tomato has attained a status of high value crop in India in recent years and occupies a pride place among vegetables in Indian cuisine because of its delicacy and pleasant flavour. On the nutritional part, it is rich in Vitamin A and C, thiamine, riboflavin, nicotinic acid, vitamin C and carbohydrates and also has medicinal values. The pulp and juice is digestible, promoter of gastric secretion and blood purifier. In terms of value, it comes next only to potato and sweet potato in India, but as a processing crop, it ranks first among vegetable crops (Anonymous 2006) [1]. The area under tomato in India is 882 thousand ha with a production of 18735.9 thousand MT with a productivity of 21.2 MT/ha (Anonymous 2014) [2]. Important component of protected cultivation, which influences productivity and quality of tomato is application of fertilizers with the irrigation water called fertigation. Fertigation seems to incorporate desirable features, which can improve water as well as nutrient use efficiency. It is a well established fact that macro nutrients such as nitrogen, phosphorus and potassium have profound effect on crop productivity and quality.

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 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. The seeds of the three hybrids were 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 on 20th Feb 2013 and 2014 to get healthy and disease free seedlings of tomato. The seedlings were ready for transplanting after one month of sowing and were subsequently transplanted inside the naturally ventilated polyhouse equipped with drip irrigation system. Before transplanting, beds were prepared. These beds were thoroughly sterilized with 4 per cent formalin (1 litre of 40 per cent 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. Before transplanting, beds were prepared with growing media comprising of vermicompost alone and mixture of cocopeat and vermicompost (1:1, v/v) up to 15 cm depth. 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 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. After 30-35 days of transplanting, plants were trained to 2 stems and staked with the help of nylon threads connected to the wire inside the polyhouse. Other cultural practices and standard plant protection measures were also adopted from time to time to ensure good and healthy crop stand. There were eighteen treatment combinations comprising of three hybrids, two growing medium and three fertigation levels of NPK. Observations recorded were pericarp thickness (cm), total soluble solids (TSS %), ascorbic acid and titrable acidity.

Result and Discussion

Pericarp thickness (cm)

Hybrid Naveen 2000 plus registered significantly higher pericarp thickness (7.6 cm in 2013 and 7.8 cm in 2014) over other two hybrids. The pericarp thickness of fruits is expected due to their respective varietal characters. Singh and Gulshan (2003) [3] also reported the similar findings. Pericarp thickness was not significantly influenced by different levels of NPK. Growing media also had a significant influence on pericarp thickness. Growing media consisting of cocopeat: vermicompost (1:1, v/v) registered maximum pericarp thickness of 7.3 cm and 7.5 cm in the year 2013 and 2014, respectively which was significantly higher than growing media consisting of vermicompost during both the year. The higher pericarp thickness of the fruits obtained from the plants growing in the growing media consisting of cocopeat: vermicompost (1:1, v/v) may be due to higher physiological activity of the plants which resulted in more production and accumulation of photosynthates within the plant and ultimately increased the fruit size and pericarp thickness.

Total soluble solids (TSS %)

Total soluble solids were significantly influenced by different hybrids. Hybrid Naveen 2000 plus recorded the highest total soluble solids (5.16 in 2013 and 5.24 in 2014) which was significantly higher than hybrid Rakshita (4.73 in 2013 and 4.68 in 2014) and Avtar (4.32 in 2013 and 4.29 in 2014). Similar observations were reported by Kumar (2009) [4]. Different levels of fertigation also had significant influence on total soluble solids during both the years. Among different levels of NPK application, maximum total soluble solids (4.85 in 2013 and 2014 also) were observed at NPK @ 30 g/m^2 which were significantly higher than NPK @ 25 g/m^2 (4.72 in 2013 and 4.73 in 2014) and NPK @ 20 g/m^2 (4.64 in 2013 and 4.63 in 2014). The increase in total soluble solids with an increase in NPK level might be due to the fact that these nutrients particularly potassium is involved in sugar/carbohydrate metabolism by the plants. The present results confirm the findings of Patil *et al*. (2004) [5]. Total soluble solids also differed significantly by different growing media used. Growing media comprising cocopeat: vermicompost (1:1, v/v) recorded the highest total soluble solids of 4.83 during the year 2013 and 2014, respectively and was found significantly higher than other growing media. These results are in close line with the findings of Inden and Torres (2004) [6].

Ascorbic acid (mg/100g)

Ascorbic acid was significantly influenced by different hybrids. Hybrid Avtar recorded the highest ascorbic acid (26.8 mg in 2013 and 25.0 mg in 2014) which was significantly higher than hybrid Rakshita (23.6 mg in 2013 and 20.7 mg in 2014) and Naveen 2000 plus (22.0 mg in 2013 and 20.0 mg in 2014). Varietal differences for this character have also been reported by Singh and Gulshan (2003) [3]. Different levels of fertigation also had significant influence on ascorbic acid during both the years. Among different levels of NPK application, maximum ascorbic acid (25.2 mg in 2013 and 22.9 mg in 2014) were observed at NPK @ 30 g/m^2 which were significantly higher than NPK @ 25 g/m^2 (24.2 mg in 2013 and 21.9 mg in 2014) and NPK @ 20 g/m^2 (23.1 mg in 2013 and 20.9 mg in 2014). Minimum ascorbic acid was observed at NPK @ 20 g/m^2 during both the years. Similar observations have also been reported by Kanthasamy *et al*. (2004) [7] who observed a direct relationship of ascorbic acid content in fruits with increasing level of NPK fertilizers. Growing media had significant effect on ascorbic acid significantly. Growing media comprising vermicompost registered ascorbic acid of 24.6 mg in 2013 and 22.3 mg in 2014 which was significantly higher than growing medium containing cocopeat: vermicompost (1:1, v/v). The results are in agreement with those obtained by Inden and Torres (2004) [6].

Titrable acidity (%)

Hybrid Naveen 2000 plus recorded the highest titrable acidity (0.52 in 2013 and 0.54 in 2014) which was significantly higher than hybrid Rakshita (0.44 in 2013 and 0.46 in 2014) and Avtar (0.33 in 2013 and 0.34 in 2014). Similar observations were reported by Raghav (2000) [8]. Different levels of fertigation also had significant influence on titrable acidity during both the years. Among different levels of NPK application, maximum titrable acidity (0.45 in 2013 and 0.47 in 2014) was observed at NPK @ 30 g/m^2 which was significantly higher than NPK @ 25 g/m^2 (0.43 in 2013 and 0.45 in 2014) and NPK @ 20 g/m^2 (0.40 in 2013 and 0.42 in 2014). Similar observations have also been reported by Colla *et al*. (2003) [9]. Titrable acidity also differed significantly by

different growing media used. Growing media comprising cocopeat: vermicompost (1:1, v/v) recorded the highest titrable acidity of 0.44 and 0.46 during the year 2013 and 2014, respectively and was found significantly higher than other growing media.

Table 1: Quality parameters as influenced by different treatments

Treatments	Pericarp thickness (cm)		Total soluble solids (TSS %)		Ascorbic acid (mg/100 g of fruit)		Titrable acidity (%)	
	2013	2014	2013	2014	2013	2014	2013	2014
Hybrids								
Rakshita	7.0	7.1	4.73	4.68	23.6	20.7	0.44	0.46
Naveen 2000 plus	7.6	7.8	5.16	5.24	22.0	20.0	0.52	0.54
Avtar (7711)	6.3	6.5	4.32	4.29	26.8	25.0	0.33	0.34
S.Em+	0.2	0.2	0.04	0.03	0.2	0.2	0.00	0.00
CD (P=0.05)	0.5	0.6	0.11	0.09	0.5	0.4	0.01	0.01
Fertigation levels								
NPK @ 20 : 20 : 20 g/m^2	6.4	6.6	4.64	4.63	23.1	20.9	0.40	0.42
NPK @ 25 : 25 : 25 g/m^2	7.1	7.3	4.72	4.73	24.2	21.9	0.43	0.45
NPK @ 30 : 30 : 30 g/m^2	7.4	7.5	4.85	4.85	25.2	22.9	0.45	0.47
S.Em+	0.2	0.2	0.04	0.03	0.2	0.2	0.00	0.00
CD (P=0.05)	NS	NS	0.11	0.09	0.5	0.4	0.01	0.01
Growing media								
Vermicompost	6.6	6.8	4.64	4.64	24.6	22.3	0.42	0.43
Cocopeat: Vermicompost (1:1)	7.3	7.5	4.83	4.83	23.7	21.5	0.44	0.46
S.Em+	0.2	0.2	0.03	0.02	0.1	0.1	0.00	0.00
CD (P=0.05)	0.5	0.5	0.09	0.07	0.4	0.4	0.01	0.01

NS = non-significant

Conclusion

Hybrid Naveen 2000 plus recorded significantly higher pericarp thickness (7.6 cm in 2013 and 7.8 cm in 2014), highest total soluble solids (5.16 in 2013 and 5.24 in 2014) and highest titrable acidity (0.52 in 2013 and 0.54 in 2014) at NPK @ 30 g/m^2 comprising cocopeat: vermicompost (1:1, v/v) as growing media whereas Hybrid Avtar recorded the highest ascorbic acid (26.8 mg in 2013 and 25.0 mg in 2014) NPK @ 30 g/m^2 comprising vermicompost as growing media.

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