



Effect of soilless media on nutrient uptake and yield of tomato (*Solanum lycopersicum*)

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ABSTRACT

Soilless culture provides an alternative to soil culture when serious soil problems (i.e. soil borne pests, soil salinity, chemical residues in soil, lack of fertile soil) create difficulties in traditional soil-based production. Soilless culture includes growing media, like cocopeat, vermiculite, perlite etc. or hydroponics system. The study was conducted during 2016 and 2017 to standardize growing media for soilless tomato (*Solanum lycopersicum* L.) production at Department of Soil Science and Water Management, Dr Y S Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh, India. The treatments consisted of different growing media, viz. cocopeat alone (control), cocopeat + vermicompost (70:30) and vermiculite + vermicompost (70:30). Plants were irrigated and fertigated with equal amount of Hoagland nutrient solution for meeting nutrient requirement. Treatment containing cocopeat + vermicompost (70:30) increased the nutrient uptake of N, P and K which was evident by the increased yield *vis-à-vis* control, i.e. cocopeat, alone. The results indicate that growing media consisting of cocopeat + vermicompost (70:30) enhances the quality and yield of tomato over the generally preferred growing media i.e. cocopeat, alone. The findings of the study will be helpful for the growers for enhancing the quality and yield of tomato under protected conditions to escape the problems faced in soil-based production system.

Key words: Cocopeat, Nutrient uptake, Soilless cultivation, Vermicompost

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops grown widely all over the world. The world's total area under tomato cultivation is 47.82 M ha with the production of 1770.93 MT (Anonymous 2016). It is an important off-season crop of Himachal Pradesh with annual production of 489.96 thousand MT from an area of 11.08 thousand ha (Anonymous 2017). Cultivation of tomato is generally done under open field conditions where the crop is prone to attack of biotic and abiotic factors, most important being the soil health that limits its growth, production and quality. Therefore, production under protected condition is an alternative for increasing yield and quality of tomato. In Himachal Pradesh, protected cultivation is being adopted by the farmers and the total area of polyhouse in Himachal Pradesh is 223.18 ha, out of which 150 ha is under vegetables (Spehia 2015).

Soil is the least expensive medium for plant growth, when having required amount of available nutrients, but can be biggest hurdle if deficient in nutrients and infested with pathogens. Soilless culture through growing media provides an alternative to soil culture. There are different growing

media (cocopeat, perlite, vermiculite, etc.) available in the market; cocopeat being the most easily available and hence, mostly used. Cocopeat increases the water holding capacity of the potting mix and is free from soil borne pathogens with a pH of 5.7-6.5 (slightly acidic) that is ideal for plant growth while vermiculite is used as a moisture retention media for growing plants (Awang *et al.* 2009). Vermicompost is rich in nutrients like N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B, the uptake of which has a positive effect on plant nutrition and other activities (Dominguez 2004). The effect of different growing media has been well documented but the exact impact of mixing readily and locally available vermicompost with cocopeat or vermiculite is relatively undocumented. Hence, the present study was undertaken to compare the influence of readily available growing media like cocopeat and vermiculite in conjunction with vermicompost on nutrient uptake and its effect on yield of tomato under protected conditions.

MATERIALS AND METHODS

The experiment was conducted from February to October, during 2016-17, at the Research Farm of Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP). The experimental site is located at 30° 51' N latitude and 76° 11' E longitude at an elevation of 1175

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amsl having average slope of 7-8%. The study area falls in sub-temperate, sub-humid agro-climatic zone of Himachal Pradesh (Zone-2). The area receives an annual rainfall of 1100 mm and about 75% of it is received during the monsoon period (mid-June to mid-September). Winter rains are meagre and received during the months of January and February. The experiment was laid out in 200 m² naturally ventilated polyhouse with following treatments consisting of growing media, viz. T₁ (vermiculite+ vermicompost (70:30)), T₂ (cocopeat + vermicompost (70:30)) and T₃ (cocopeat- control) under Complete Randomized Block design. During the growing period, average temperature minimum temperature ranged between 16°C (February) to maximum average of 37°C (June). Plants were irrigated daily through drip irrigation and fertigated every third day with equal amount of Hoagland nutrient solution for meeting nutrient requirement. Vermicompost was procured from the Department of Soil Science and Water Management, UHF, Nauni, Solan, while cocopeat and vermiculite were procured from the market.

The seeds of Solan Lalima tomato were sown at the experimental farm in protrays in cocopeat in protected condition. Healthy and uniform sized seedlings of 34 days old were transplanted in each grow bag accommodating one plant per bag. The seedlings were uprooted carefully from protrays to avoid any damage to the root system. To minimize root damage of the seedlings protrays were watered one hour before uprooting the seedlings. Transplanting was done in the afternoon. Total Soluble solids, titratable acidity and vitamin C contents were estimated by following the standard procedure (Ranganna 1995). Nutrient content of leaf and media were estimated by standard procedure (Jackson 1973). The data generated from present investigation were subjected to statistical analysis using the statistical package SPSS (20.0) and Microsoft Excel. Critical difference (CD) at 5% level was used for testing the significant difference among the treatment means.

Table 1 Effect of soilless media on biochemical characters of tomato

Treatment	TSS (°B)	Titratable acidity (%)	Vitamin C (mg/100g)
T ₁	4.78	0.71	18.42
T ₂	4.84	0.75	19.66
T ₃ (Control)	4.75	0.68	17.36
CD _{0.05}	0.05	0.03	1.37

RESULTS AND DISCUSSION

Total soluble solids, titratable acidity and vitamin C content were found to be significantly affected by the growing media. Maximum TSS (4.84 °B), titratable acidity (0.75 %) and vitamin C (19.66 mg/100g) were observed under the treatment T₂ which were 1.89, 10.29 and 13.25% higher, respectively, over control (Table 1). Higher TSS and vitamin-C were reported by Ghehsareh *et al.* (2011) in tomato with combination of different growing media as compared to cocopeat alone. Kowalczyk *et al.* (2011) and Mazur *et al.* (2012) also reported higher titratable acidity in 'cherry' tomato fruits obtained from coconut fibre and mineral wool cultivated plants. El Sunafawi *et al.* (2005) also reported high TSS content due to the addition of vermicompost. Vitamin C of fruit juice increased with increasing vermicompost added to the media (Truong and Wang (2015) and Truong *et al.* (2018)).

Leaf nutrient content of the plants were significantly affected by the growing media in which they were grown. Maximum leaf nitrogen (2.83%), phosphorus (1.97%) and potassium (1.97%) were recorded under T₂ whereas, minimum leaf nitrogen (2.68%), phosphorus (1.85%) and potassium (1.80%) were recorded under T₃ (Table 2). The increased availability of macro nutrients in tomato leaves with the addition of vermicompost + cocopeat might be due to acceleration of microbial nitrogen fixation, improved physical condition of media, more moisture retention and thus increased absorption of water and nutrient. These results are in line with the Sezen *et al.* (2010) and Soltani and Naderi (2016). The findings are in line with those of Truong and Wang (2015) who reported significant increase in the contents of N, and P in both stem and leaf by increasing proportion of vermicompost in growing media. The high total N and P concentrations in stem and leaf might be due to higher mineral N and P contents in the medium. The level of K decreases with increasing vermicompost in the media, this could be due to high proportion of vermicompost which may reduce root growth and K uptake.

Nutrient uptake in the growing media of tomato under UV stabilized polybags under polyhouse revealed that it was significantly influenced by different growing media. T₂ reported higher N (57.74 kg/ha), P (12.30 kg/ha) and K (48.45 kg/ha) uptake compared to T₃ which recorded lower N (37.41 kg/ha), P (9.10 kg/ha) and K (32.23 kg/ha) uptake (Table 2). Treatment having cocopeat + vermicompost recorded highest nutrient uptake of N, P and K by tomato crop. Generally, lowest uncredited nutrient content is considered better (meaning more uptakes by plants) but

Table 2 Effect of soilless media on leaf nutrients and nutrient uptake in tomato

Treatment	Leaf nitrogen (%)	Leaf phosphorus (%)	Leaf potassium (%)	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)
T ₁	2.71	1.89	1.88	47.85	10.20	37.34
T ₂	2.83	1.97	1.97	57.74	12.30	48.45
T ₃ (Control)	2.68	1.85	1.80	37.41	9.10	32.23
CD _{0.05}	0.06	0.09	0.08	2.55	0.96	1.34

Table 3 Effect of soilless media on plant and yield parameters of tomato

Treatment	Plant height (cm)	No. of fruits/plant	Fruit weight (g)	Yield (kg/plant)
T ₁	139.59	81.43	69.58	5.97
T ₂	144.53	82.97	72.31	6.27
T ₃ (Control)	135.97	78.48	67.45	5.69
CD _{0.05}	3.13	2.59	1.33	0.24

two treatments having vermicompost showed better nutrient credit due to availability of some percentage of nutrients in vermicompost. The findings are in line with report of Xiong *et al.* (2017), Truong and Wang (2015) and Truong *et al.* (2018).

Plant height is an important biometric parameter related to growth and development of the crop. Growing media had significant effect on plant height of tomato crop during both the years and maximum plant height (144.53 cm) was reported in T₂ while, minimum (135.97 cm) was observed in the T₃ (Table 3). Maximum plant height under T₂ may be due to better physico-chemical properties of the medium as also reported by Ten and Kirienko (2002) and Arancon *et al.* (2003) where all the vermicompost growing media recorded higher plant height. Truong and wang (2015) and Truong *et al.* (2018) supported our findings as they have reported that the plant height of tomato was maximum in the medium containing mixture of vermicompost, cocopeat and rice husk as the physico-chemical properties of media were optimal for the root growth development. According to Atiyeh *et al.* (1999) addition of 20% vermicompost in either peat/perlite or cocopeat also improved plant growth and yield per plant significantly over unamended medium.

Number of fruits per plant and fruit weight was observed to be significantly affected by growing media. Maximum number of fruits per plants (82.97) and fruit weight (72.31 g) were observed under T₂ while minimum number of fruits (78.48) and fruit weight (67.45 g) were recorded in T₃ (Table 3). Due to combination of all the above factors, yield was also reported to be maximum (6.27 kg/plant) under T₂, whereas minimum yield (5.69 kg/plant) was recorded under T₃ (Table 3). Higher number of fruits under T₂ might be due to the combined effect of vermicompost (due to its rich nutrient content) and good aeration and water holding capacity. Similar results were obtained by Alaoui *et al.* (2014), Abak and Çelikel (1994) and Raviv *et al.* (2004). The present results are also in-line with the findings of Lopez *et al.* (2014) and Arancon *et al.* (2003) where they reported positive response of vermicompost on average fruit weight which may be due to vital role played by the nutrient status and better moisture conservation through cocopeat. Higher yielding attributes and yield of tomato through media supplemented with vermicompost could be the result of regulated liberalization and balanced supply of nutrients, tilting microbial dynamics in favour of growth and creation of salutary environmental conditions

for crop growth. Comparable results were reported by El-Sanafawi *et al.* (2005), Ten and Kirienko (2002) and Joseph and Muthuchamy (2014). Ghehsareh *et al.* (2011) reported that media with cocopeat, alone, had lower yield compared to other growing media.

The study concluded that the growing media significantly affected growth, fruit production and quality in tomato. Addition of vermicompost to the growing media further helped in enriching the media with nutrient contents that might have helped in improving the quality and yield of the crop. Further, the water holding capacity and inertness, or the media is an important benefit in utilizing the available water. Moreover, the combination of growing media with vermicompost is an added advantage as both are easily available to the farmers all over the world and provides better growing conditions to the plant, as well. In general, it can be concluded that the media consisting of cocopeat + vermicompost (70:30) is an efficient combination for enhancing the quality and yield of tomato in polybags under protected conditions to escape the problems of soil-based production system.

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