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Effect of Potting Media and Pot Size on Yield and Fruit Quality Attributes of Cherry Tomato (*Solanum lycopersicum* var. *cerasiforme*)

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ABSTRACT

This research aimed to evaluate the effects of different potting media and pot sizes on yield and quality attributes (TSS%, Vitamin C, pH) of cherry tomato in the winter season under field conditions. Cherry tomato was cultivated in four different size pots by using four types of potting media. Plastic pots ranged in capacity (2L, 6L, 10L and 14L). Each treated pot was filled with air dried field loamy soil without fertilizer (control) and organic fertilizers, namely, cow dung (1:1), poultry litter (1:1) and vermicompost (1:1) which were used as treatments. In total, 16 treatment combinations were arranged in a randomized complete block design. The highest total number of fruits and fruit yield per plant of cherry tomato was obtained from the plants raised in pots with cow dung mixture soil (1:1). Organic fertilizers in pot soil significantly affected the TSS% and pH value of ripened fruits. The pot size affected the total fruit yield per plant significantly, and the best yield was 2.2 times higher than that of plants in the smallest pots. The highest total number of fruits per plant (108.75), fruit yield per plant (504.25g) and yield per hectare (20.17t) was obtained from plants in 14L size pots by using cow dung mixture soil (1:1). It was concluded that the 14L pot and cow dung mixture soil (1:1) were the best treatments for the cultivation of cherry tomato in homestead gardening.

Introduction

Tomato (*Solanum lycopersicum* L.) belongs to the family Solanaceae and is one of the most important, popular and nutritious vegetable crops in the world. It can be cultivated in almost all home gardens and in field conditions for its adaptability to a wide range of soil and climates in Bangladesh (Islam et al., 2016). It is one of the most important vegetables in terms of economic output (Lahoz et al., 2016) while constituting an important part of human diets. It contains about 94% water, 2.5% total sugars, 2% total fiber, 1% proteins, and other nutritional compounds (Koh et al., 2012). It is the main vegetable crop in terms of volume consumed fresh worldwide, one of the major sources of natural lycopene, an important antioxidant and anticancer compound, vitamin C and traces of potassium, phosphorus and iron (Monteiro et al., 2008). The popularity of tomato and its product has been established throughout history. It is a nutritious and delicious vegetable used in salad, soups and can be processed into stable products like ketchup, sauce, pickles paste, chutney and juice (Islam et al., 2016).

Cherry tomato [*Solanum lycopersicum* L. var. *cerasiforme* (Dunal) A. Gray] is a small variety of tomato. It is generally grown as a winter crop in fields and in pots. Soil plays an important role in

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pot plant cultivation. Physical and chemical properties determine the nutritional status, water holding capacity, and aeration status of potting media to sustain better plant growth (Younis et al., 2008). It has become more popular all over the world because of a good source of vitamins A and C, solids content, good taste and fruit set even at high temperature (Prema et al. 2011). Its fruits are consumed more as a fruit rather than as a vegetable (Islam et al., 2012). The yield and quality parameters of tomato fruit increased significantly with the integrated use of compost and inorganic fertilizers (Khan et al., 2017). The transplant quality of tomato plants depends on climate, growing media, nutrition and other factors (Jankauskieno, 2013). Bangladesh is one of the most populated countries in the world and the population growth is extremely high. Pot culture and rooftop farming can provide to growing food demand of increasing population. Fresh and safe food can be ensured through roof gardening. Tomatoes are heavy feeders and need to be fertilized potting soil. It requires large amounts of water to grow well. The soil for growing tomatoes in containers should be nutrient rich and moisture retentive but well-draining system. Pot capacity and growing medium could have specific and selective effects on the growth (Olosunde et al., 2017). The effects of growing media and potting size on seedling growth and development parameters of plant are well documented (Segaw et al., 2016).

Containers are one of the necessary tools for growing plants on rooftops and in home premises. The size of pots with suitable potting media is an important factor for the successful cultivation of a crop, while considering planting area, nutrient and water availability of the pot substrate. The quality of the potting medium is recognized as being one of the foundations of successfully growing pot plants (Bunt, 1988). The potting substrate is a plant's first food and its primary support for growing seedlings, storing and supplying nutrients, water, and air to the root system (Mulugeta, 2014). The growing medium and the container size are possibly the most determinant factors in the quality of growing seedlings (Das, 1992). Thus, the current research was carried out in order to evaluate the impact of pot substrate and volume, considering pot size on yield, TSS%, Vitamin C and pH value of cherry tomato.

Materials and Methods

A pot experiment was conducted at the Agricultural Field Research Center of Bangladesh Open University, Gazipur, Bangladesh during the winter season of 2021. The aim was to evaluate the effects of pot substrate or mixture and pot size on yield and qualities of cherry tomato. The experimental area was characterized by relatively scanty rainfall, low humidity, and low temperature, short day and long clear sunshine from October to March. Monthly average temperatures gradually decreased from October to December and then became stable up to February. Minimum monthly rainfall and maximum sunshine hours with sunny days were observed from December to February. Monthly average relative humidity gradually decreased from October to March.

Cherry tomato was cultivated in 4 different size pots by using 4 types of potting media. The plastic pots had different capacities (2L, 6L, 10L and 14L). Each pot was filled with air-dried soil without fertilizer and organic fertilizers, namely, cow-dung (1:1), poultry litter (1:1) and vermicompost (1:1) as per treatments. The experimental 16 pots were laid out in a randomized complete block design (RCBD) with 4 replications in the field. The small cultivated land of experimental site was ploughed by spade to prepare pot soil. Soil was mixed with dry cow dung (50%+50%), poultry litter (50%+50%), vermicompost (50%+50%) respectively to prepare 3 types pot mixture and one control (without fertilizer) as per treatments. Prepared pot mixtures were placed in 64 pots. In this experiment, cherry tomato cv. BARI Tomato-11 (*Jhumka*) was used as a test crop. Seeds were collected from Horticulture Research center of Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh. Seeds were sown on October 30, 2021, in a seedbed. Healthy and uniform sized 30 day-old seedlings were taken separately from the seedbed and were transplanted on November 30 in the experimental pots maintaining spacing of 60 cm and 50 cm between the pot rows. The treatments were applied per pots. In each pot, one plant was grown. The tomato seedlings were irrigated uniformly with one-day interval to ensure good stand establishment. Stalking is done by bamboo stick ring to overcome plants fall down on ground due to weak stem. Stacking facilitated the management operations such as irrigation; inter tillage, pest control and harvesting. Plant height and yield data were measured at the Agricultural Laboratory of Bangladesh Open University. Plants of each pot was selected for data collection of plant height, fruits per plant and fruit weight per plant. Fruit yield was recorded on a single plant basis. The plant height was measured from the soil level to the tip of the shoot and expressed in cm. Fruit yield per plant was expressed in grams

(g) and total yield per hectare was recorded in tons ($t.ha^{-1}$). Harvested, ripened fruit samples (200g) of each treatment were sent for quality tests to the Post Harvest Technology Division Laboratory of Bangladesh Agricultural Research Institute, Gazipur. All biochemical parameters associated with this study (TSS%, pH, Vitamin C) were analyzed following a standard procedure. Data were collected on plant height (cm), number of fruits per plant, fruit weight per plant (g), individual fruit weight (g), yield ($t.ha^{-1}$), TSS (%), vitamin C (mg 100 g^{-1}) and pH. Fruit yield was recorded in $t.ha^{-1}$. Data on plant height, number of fruits per plant, weight of fruits per plant, yield ($t.ha^{-1}$), TSS, vitamin C, pH were analyzed by using MSTAT-C software to find out the analysis of variance. Comparison of mean values were carried out by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results

Effects of pot substrate

The pot mixture, irrespective of pot size, had significant effects on plant height (cm), fruit count per plant, fruit yield per plant (g), individual fruit weight (g), fruit yield per hectare ($t.ha^{-1}$), TSS and pH value, but not on vitamin C content (Table 1). A significant superiority was noted for the S_2 treatment over the rest of the treatments, i.e. S_1, S_3, and S_4. This clearly indicated that different manures, along with soil, in similar combinations (1:1) had different qualitative and quantitative effects on cherry tomato under pot cultivation. The results showed significant differences among plant height of cherry tomato due to pot media or mixture treatments, irrespective of pot size. The plant height increased slowly up to 30 days after transplantation (DAT), increased rapidly up to 75 DAT and then remained almost constant. All treatment groups followed almost similar trends in response to the pot mixtures. The plant height differed (67.43 to 90.85 cm) at harvesting stage (90 DAT) under different pot mixture treatments. The tallest plants (90.85 cm) were found in the S_4 treatment where vermicompost was used with soil (1:1) in a pot, whereas the shortest plant (67.43 cm) was observed in the S_1 treatment (soil without fertilizer). The number of fruits per plant was significantly influenced by the type of pot mixture. The highest number of fruits per plant (90.25) was recorded from a cherry tomato plant grown under S_2 treatment where cow dung was used in a pot with soil (1:1). The lowest number of fruits per plant (47.18) was observed under the control treatment (S_1) where soil was used without fertilizers. Average individual fruit weight under different treatments varied due to the culture media. Maximum individual fruit weight (4.04g) was found in S4 treatment where vermicompost was used with soil (1:1) in a pot and the lowest individual fruit weight was observed in the control treatment. The highest fruit yield per plant (371.50g) and per hectare (14.86t) was recorded in the S_2 treatment where cow dung was used in the soil (1:1). The lowest yield per plant (132.50g) and per hectare (5.31t) were recorded in the control treatment (S_1). Adding organic fertilizers in pot soil significantly affected the TSS% and pH but not vitamin C content of ripened fruits. Among the treatments, maximum TSS% (8.58) was found in plants of the vermicompost pots, whereas the minimum value (6.52) was recorded in the control. Vitamin C content did not differ significantly due to pot mixture, and the highest value of vitamin C content (24.66mg100g^{-1}) was recorded in the treatment of poultry litter. The minimum amount of vitamin C content (23.49 mg100g^{-1}) was recorded in the control pot. The pH value of fruit juice slightly varied due to the pot media. Higher pH values of ripened fruits were observed under different organic fertilizer treatments in the control treatment. Maximum ripened fruit juice pH value (4.34) was recorded in the S_4 treatment where poultry litter was used with soil in pots, whereas the lowest pH value (4.16) was recorded in the control treatment pot where plants were grown without fertilizers.

Effect of pot size

The pot size, irrespective of pot mixture, had significant influences on plant height (cm), fruit count per plant, fruit yield per plant (g), individual fruit weight (g), fruit yield per hectare ($t.ha^{-1}$) but not on TSS, vitamin C content and pH value of cherry tomato (Table 2). This result indicated that different pot sizes had no significant qualitative effect on cherry tomato under pot cultivation. The highest plant height (101.05 cm) was found in the P_4 treatment where pot size was 14L. The lowest plant height (66.00 cm) was observed in P_1 (2L). The number of fruits per plant was significantly influenced by different pot sizes. The highest number of fruits per plant (87.25) was recorded in cherry tomato plants grown in large pots (14 L). The lowest number of fruits per plant (55.00) was observed in small-sized pot (P_1). Average individual fruit weight under different treatments varied due to pot size. Maximum individual fruit weight (4.27g) was found in the P_4 treatment (14L) and the lowest individual fruit weight (3.13g) was observed in the P_1 treatment (2L).

Table 1. Effect of pot substrate on yield and quality of cherry tomato

Pot substrate	Plant height (cm)	Fruit per plant	Yield per plant (g)	Individual fruit wt. (g)	Yield (t.ha^{-1})	TSS (%)	Vitamin C (mg 100 g^{-1})	pH
S_1	67.43d	47.18d	132.50d	2.72d	5.31d	6.52d	23.49	4.16cd
S_2	83.76bc	90.25a	371.50a	4.01ab	14.86a	7.40 c	24.58	4.17bc
S_3	86.41b	69.81c	281.18c	3.95a-c	11.24c	7.89b	24.66	4.25ab
S_4	90.85a	77.00b	321.68b	4.04a	12.86b	8.58a	24.63	4.34

* in a column with similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% level of probability. [S_1-Pot substrate (sole soil), S_2-Pot substrate (Soil: Cow dung 1:1), S_3-Pot mixture (soil: poultry litter 1:1), S_4-Pot substrate (soil: vermicompost 1:1)].

Table 2. Effect of pot size on the yield and quality of cherry tomato

Pot size	Plant height (cm)	Fruit plant^{-1}	Yield plant^{-1}(g)	Individual fruit wt. (g)	Yield (tha^{-1})	TSS (%)	Vitamin C (mg 100 g^{-1})	pH
P_1	66.00d	55.00d	177.56d	3.13d	7.10d	7.60	24.26	4.21
P_2	74.36c	64.00c	224.31c	3.42c	8.97c	7.59	24.31	4.22
P_3	87.05b	78.00b	316.87b	3.90b	12.68b	7.60	24.38	4.23
P_4	101.05a	87.25a	388.12a	4.27a	15.52a	7.60	24.40	4.24

* in a column with similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% level of probability. S_1-Pot size (2L), S_2-Pot size (6L), S_3-Pot size (10L), S_4-Pot size (14L).

The highest fruit yield per plant (388.12g) and per hectare (15.52t) were recorded in the P_4 treatment (14L). The lowest yield per plant (177.56g) and per hectare (7.10t) were recorded in small-sized pots (2L). The pot sizes did not significantly affect the TSS%, vitamin C and pH of ripened fruits, irrespective of pot mixture.

Interaction effect of pot mixture and pot size

The interaction effect of pot mixture and pot size showed significant effects on plant height (cm), fruit count per plant, individual fruit weight (g), fruit yield per plant (g), fruit yield per hectare (t.ha-1) and TSS (%), but not on vitamin C content and pH of cherry tomato (Table 3). The tallest plant (112.57 cm) was obtained in the S_4P_4 treatment where 14L pots were fertilized by vermicompost with soil (1:1). The shortest plant (54.72 cm) was recorded in the S_1P_1 treatment when 2L pot was filled only with soil (control).

The tallest plants were found in bigger pots when vermicompost was applied to cherry tomato plants. This might be due to the supply of more N and other nutrients to the plants. The highest number of fruits per plant (108.75) was found in the S_2P_4 treatment where cow dung was used with soil (1:1) in 14L pots. Whereas the lowest number of fruits (36.25) was found in S_1P_1 treatment, the highest fruit yield per plant (504.25g) was recorded in the S_2P_4 treatment where cow dung was used with soil (1:1) in 14L pots. The best performance of cherry tomato in terms of yield (20.17 t ha^{-1}) was observed in the same treatment. The lowest yield per plant (94.75g) was observed in the S_1P_1 treatment where small pots (2L) were filled with soil only. Interaction of pot mixture and pot size showed significant effects on the TSS% but not on vitamin C content and pH value of ripened fruits. The highest TSS% (8.60) was recorded in the S_4P_4 treatment where vermicompost was used with soil (1:1) in 14L pots.

Table 3. Interaction effect of pot mixture and pot size on the yield and quality of cherry tomato

Pot substrate X Size	Plant height (cm)	Fruit plant^{-1}	Yield plant^{-1}(g)	Individual fruit wt. (g)	Yield (tha^{-1})	TSS (%)	Vitamin C (mg 100 g^{-1})	pH
S_1 P_1	54.72p	36.25p	94.75p	2.45n	3.79o	6.51m	24.54	4.16
S_1 P_2	62.25m-o	44.75o	118.00no	2.58n	4.72n	6.55m	24.61	4.17
S_1 P_3	70.55j-l	51.25l-n	139.00n	2.70n	5.61m	6.52m	24.67	4.16
S_1 P_4	82.20g	56.50j-l	178.lm	3.15j-m	7.13 l	6.50m	24.70	4.18
S_2 P_1	67.55k-n	67.25hi	219.2ij	3.26j-l	8.77ij	7.41e-j	24.48	4.16
S_2 P_2	75.45g-j	82.50de	297.00g	3.60g-i	11.88g	7.38e-l	24.52	4.18
S_2 P_3	90.20d-f	102.50b	465.50bc	4.54a-c	18.62bc	7.39e-k	24.66	4.15
S_2 P_4	101.87bc	108.75a	504.25a	4.64ab	20.17a	7.42e-i	24.68	4.16
S_3 P_1	69.07j-m	54.75 k-m	189.00kl	3.46g-j	7.56k	7.89a-g	24.59	4.24
S_3 P_2	78.02g-i	59.50jk	223.25i	3.75g	8.93i	7.86a-h	24.62	4.23
S_3 P_3	91.00de	77.50e-g	319.25f	4.12ef	12.77f	7.91a-e	24.71	4.25
S_3 P_4	107.57ab	87.50d	393.25d	4.48b-d	15.73d	7.90a-f	24.72	4.27
S_4 P_1	72.65i-k	61.75ij	207.25i-k	3.36i-k	8.29ij	8.58a-c	23.46	4.31
S_4 P_2	81.72gh	69.25 h	259.00h	3.74gh	10.36h	8.57a-d	23.49	4.32
S_4 P_3	96.47cd	80.75ef	343.75e	4.25c-e	13.75e	8.59ab	23.50	4.37
S_4 P_4	112.57a	96.25c	476.75b	4.82a	19.06b	8.60a	23.52	4.36

* in a column with similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 5% level of probability. S_1-Pot substrate (sole soil), S_2-Pot substrate (Soil: Cow dung 1:1), S_3-Pot mixture (soil: poultry litter 1:1), S_4-Pot substrate (soil: vermicompost 1:1); S_1-Pot size (2L), S_2-Pot size (6L), S_3-Pot size (10L), S_4-Pot size (14L).

Discussion

The pot mixture, irrespective of pot size, had significant effects on plant height, fruit count per plant, individual fruit weight, fruit yield, TSS% and pH value of cherry tomato. This finding was similar to those previously reported by Olosunde et al. (2017). They reported that the growing media could have a marked effect on the growth of potted plants. Vitamin C content did not differ significantly due to pot mixture in the said study. These results were in agreement with those of Olle et al. (2012). They stated that the growing medium had no distinct effect on the content of sugars and ascorbic acid of tomato. The pot size, irrespective of pot mixture, had significant effects on plant height, fruit count per plant, individual fruit weight, and fruit yield of cherry tomato. The highest fruit yield was recorded in the P4 treatment (14L) and the lowest yield was recorded in small pots (2L). Pot size did not significantly affect the TSS%, vitamin C and pH of ripened fruits. Small containers are synonymous with a small quantity of substrate that reduce the availability of nutrients and water for the plant. Poorter et al. (2012) reported that pots generally impede root growth. The interaction effect of pot mixture and pot size showed significant influences on the plant height, fruits number per plant, individual fruit weight, fruit yield and TSS (%) but not on vitamin C content and pH of cherry tomato. The tallest plants were found in bigger pot when vermicompost was applied to cherry tomato plants, which might be due to the supply of more N and other nutrients to the plants. These results are similar to Kalbani et al. (2016). The highest fruit yield per plant was recorded in the S_2P_4 treatment where cow dung was used with soil (1:1) in 14L pots.

The best performance of cherry tomato in terms of yield was observed in the same treatment, due to higher availability and absorption of nitrogen, phosphorous, potassium with other macro and micro nutrients by plants from the cow dung mixture with soil (1:1) which filled in larger pots, and was responsible for vigorous growth, more flowering and fruiting per plant. The lowest yield per plant was observed in the S_1P_1 treatment where small pots (2L) were filled with soil only. Without fertilizer treatments, the lowest yield of tomato was obtained which might be due to a shortage of nutrients throughout the growing period.

Blanchard and Runkle (2008) reported a significant response of plants to container opacity and growing media components. Rajya et al. (2015) reported that an increase in quality parameters under organic farming might be due to increased availability of nutrients, whereas a minimum might be due to a lack of availability of sufficient nutrients. The nutrient composition of tomato fruit is affected by the levels of manure application either organic or inorganic manure. Organic manure increases some of the nutrients component better than the inorganic fertilizers as reported by Abolusoro et al. (2017). Cabrera (2003) stated that the most important physical properties of the growing media used in horticultural crops for stability are good aeration, drainage and optimum water retention capacity. On the other hand, Sahin et al. (2004) reported that the optimal conditions required for good plant growth are 20% air content and 20-30 % available water. Cow dung with soil mixture as a pot substrate can produce higher yield, probably owing to an increase in nutrient availability, water holding capacity and better soil aeration. The pot of a plant should be big enough to hold the plant, and should be large enough to contain the soil necessary to deliver nutrients and water for plant growth.

Conclusion

The pot growing media and its volume in a pot play vital roles in the growth and development of a plant by providing nutrients and anchoring the plant. The project focused on the cherry tomato yield and quality performance under different available pot sizes and pot medium that were available for households in Bangladesh. The highest total number of fruits and fruit yield per plant were obtained from the plants raised in pots by using cow dung with soil (1:1) irrespective of pot size. Cow dung was a superior growing media for cherry tomato plant than other tested media. Because cow dung ensures more supply of nutrients and water in pot soil. Organic fertilizers in pot soil significantly affected the TSS% and pH but not vitamin C content of ripened fruits. Pot size affected the total fruit yield per plant significantly and the best results were obtained from plants raised in comparatively bigger pots (14L). Generally, bigger pots enhanced the performance of the plants as compared to smaller ones. Pot size did not significantly affect the TSS%, vitamin C and pH of ripened fruits. Interaction of pot mixture and pot size had significant effects on fruit yield. The highest total number of fruits and fruits yield per plant were obtained in plants raised in 14L pots by using cow dung with soil (1:1), because they contained more water and nutrients for plant growth. The highest TSS% was recorded in 14L pots where vermicompost was used with soil (1:1). From the present study, it was concluded that larger pots with organic substrate (cow dung: soil=1:1) ensure the requirements of proper nutrients and water availability with proper pH for cherry tomato plants. Thus, cow dung and soil mixture, as a pot substrate, with medium large sized pots (14L), can ensure a better yield and quality of cherry tomato for pot culture in home gardening.

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Conflict of interest

The author declares that he has no conflict of interest.

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