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Growth Response of Tomato to Plant Growing Structures and Media Grown in the Rooftop Garden Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: to evaluate the growth response of tomato to plant growing structures and media grown in the rooftop garden conditions.
Study Design: The factorial experiment was laid out in a Completely Randomized Design (CRD)
Place and Duration of Study: This experiment was carried out at the rooftop garden of the Department of Agricultural Botany, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, Bangladesh from October 2017 to March 2018.
Methodology: The experiment had two factors, factor A- two plant growing structures, *viz*., S_1= Plastic pot, S_2= Earthen pot and factor B- six different plant growing medium *viz*. M_0=Soil 100% (w/w) + inorganic fertilizer (IF)/(control), M_1=Soil 80% (w/w) + 20% cow dung (w/w) + IF, M_2=Soil 70% (w/w) + 30% cow dung (w/w) + IF, M_3=Soil 90% (w/w) + 10% vermicompost (w/w) + IF, M_4=Soil 80% (w/w) + 20% vermicompost (w/w) + IF, M_5=Soil 80% (w/w) + 10% cow dung (w/w) + 10% vermicompost (w/w) + IF.

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Results: Considering plant growing structures, the plastic pot (S_1) gave the highest plant height, number of leaves per plant, branches per plant. The soil 80% (w/w) + 10% cow dung (w/w) + 10% vermicompost (w/w) + IF marked as (M_5) had the highest plant height, number of leaves per plant, branches per plant. The highest morphological data were obtained from the treatment combination of S_1M_5 (plastic pot along with the soil 80% (w/w) + 10% cow dung (w/w) + 10% vermicompost (w/w) + IF)).

Conclusion: On the basis of the findings in this study, it can be concluded that, plastic pot along with soil 80% (w/w) + 10% cow dung (w/w) + 10% vermicompost (w/w) + IF be able to increase the growth of BARI tomato14 for *rabi* season in the rooftop garden under the climatic conditions of SAU(Sher-e-Bangla Agricultural University).

Keywords: Plant height; SPAD value; Branch.

1. INTRODUCTION

The global population expansion increases the resource consumption, ultimately threatens the ecosystem, changes the environment and strains the humanity's ability to feed itself. It is well known that the following reasons have been contributing to change environment *viz*: over population, rising temperature, excess carbon-di-oxide (CO_2), methane (CH_4), nitrous oxide (N_2O) emission etc. In the urban area, the atmospheric temperature is high which creates urban heat island (UHI) compared to the suburban and rural areas. As a part of urban vegetation, rooftop garden systems improve air quality and decrease the UHI, extend roof life, reduce energy use, increase property value, pleasing work environment, increased biodiversity and source of crop production, etc. [1]. Rooftop garden regulates the temperature on the roof as well as the room below the roof garden [2]. The augmentation of urban vegetation is an outstanding mitigation strategy to keep the sound environment in the city. The concrete structure including building roofs occupies almost 60% area of the total area along with decreased vegetation which increases urban temperature and create UHI in the Dhaka city [3]. Although rooftop gardening is an old practice in Bangladesh but recently it is gaining popularity in urban area, especially Dhaka city. There are numerous fruits, vegetables such as brinjal, chili, capsicum and tomato are easy to grow in the rooftop garden. Tomato (*Solanum lycopersicum*) is one of the most important popular vegetable crop under Solanaceae family which grown throughout the world including, Bangladesh. In terms of human health, tomato is a major component in the daily diet and constitutes of important sources including antioxidants- like lycopene which has anti-carcinogenic effect. It also contains vitamins A, B and C and minerals especially potassium (K^+), iron (Fe^{++}), calcium (Ca^{2+}) etc. In addition**,** total arable land of our country is decreasing at alarming rate due to over population, road construction, urbanization and changes of environment. Thus,it has nice scope to grow crops in the roof garden to minimize the total demand of agricultural crops especially in urban locations as a component of urban agriculture. As a high value crops tomato possible to cultivate in the rooftop garden as a part of climate smart agriculture in Bangladesh. It has been reported that urban agriculture provides one fifth of the total demand of the world food. Rooftop gardening as a part of urban agriculture influences ecology, health, and poverty in a city. The rooftop garden contributes to ensure local food security and safety and improve nutrition, community relations, education and research and urban agriculture. It is well known to us that rooftop gardening has been practicing long before but the technologies related to tomato cultivation are not sufficient due to lack of researchers interest. The knowledge and skill about plant growing structures, fertilization, irrigation, mulching, pest management, shoot and root pruning are essential to ensure long term success of the rooftop garden. In the rooftop garden, plant growing structures such as earthen and plastic pot, wooden and concrete bed, half drums and their sizes are major concern to grow different crops including, pepper, tomato, chili etc. [4]. Morphological, physiological and yield responses of tomato, cauliflower and cabbage were uneven to container sizes [5, 6]. In addition, recently our laboratory found that the water requirement also unequal to both *Rabi* and *kharif* season in different types of pots. However, to my knowledge limited study have been conducted on the selection of plant growing structures including earthen and plastic pot for growing tomato as *kharif* season crops in the rooftop garden in the Dhaka city. Likewise, plant growing media is also a major concern for sustainable rooftop gardening. Plant growing media including soil organic matter such as decomposed cowdung, vermicompost, cocopit and inorganic fertilizer play a direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization, improving the physical and physiological properties of soils. Plant growing media including soil organic matter such as decomposed cowdung, vermicompost, cocopit and inorganic fertilizers play a direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization, improving the physical and physiological properties of soils [7]. Organic manures such as cow dung, poultry manure and vermicompost improves the soil structure, aeration, slow release nutrient which support root development leading to higher growth and yield of tomato plants. Considering the significance of plant growing structures and media, the investigation aimed to evaluate the growth response of tomato to plant growing structures and media grown in the rooftop garden conditions.

2. MATERIALS AND METHODS

2.1 Location of the Experiment Field

This experiment was carried out at the rooftop garden of the Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh from October 2017 to March 2018 to evaluate morpho-physiology and yield of tomato is influenced by different kinds of plant growing structures and plant growing media during *rabi* season in the rooftop garden.

2.2 Climate of the Experimental Area

The area is characterized by hot and humid climate. The average rainfall of the locality of the experimental area is 209.06 mm, the minimum and maximum temperature is 11.10 °C and 34.80 ºC respectively. The average relative humidity was 75.8 % during October 2017 to March 2018.

2.3 Soil Type

The soil for experiment was collected from an area that belongs to Modhupur Tract under AEZ (Agro Ecological Zone) No. 28 [8]. The soil characteristics of experiment pH: 6.0, Organic matter: 1.21 %, Total nitrogen 0.061 %, Potassium: 0.19 meq/100 g, Phosphorus: 1.31 ppm, Sulphur: 42.13 ppm, Zinc: 0.95.

2.4 Plant Materials Used

In this research work, the seed of one tomato variety was used as planting materials. The tomato varieties used in the experiments were BARI Tomato 14. This variety is semi-indeterminate type. BARI Tomato-14 was collected from the Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI) at Joydebpur, Gazipur.

2.5 Raising of Seedlings

In raising of seedlings, a common procedure was followed in the seedbed. Seeds were sown in the seedbed on 1st November 2017. Tomato seedlings were raised in seedbed of 2 m x 1m size. A distance of 50 cm was maintained between the beds. The soil was well prepared and converted into loose friable and dried mass by spading. All weeds and stubbles were removed. Four gram of seeds was sown on each seedbed. 50gm Furadan (carbofuran) was applied around each seedbed as precautionary measure against fungus, ants, worm and other harmful insects. The emergence of the seedlings took place with 6 to 8 days after sowing. Diathane M-45 was sprayed in the seedbeds @ 2 g/l, to protect the seedlings from damping off and other diseases. Weeding, Mulching and Irrigation were done as and when required.

2.6 Treatments and Layout of the Experiment

The experiment consisted of two factors; (A) Different types of plant growing structures and (B) Different plant growing medium. The levels of the two factors were as follows:

2.6.1 Factor (A) Different types of plant growing structures

i. S_1= Plastic pot
ii. S_2= Earthen pot

2.6.2 Factor (B) Different plant growing medium

I. M_0=Soil 100% (w/w)+ Inorganic Fertilizers (IF)/ (control),
II. M_1=Soil 80% (w/w)+ 20% cowdung (w/w) and Inorganic Fertilizers (IF),

III. M_2=Soil 70% (w/w)+ 30% cowdung (w/w) and Inorganic Fertilizers (IF),
IV. M_3=Soil 90% (w/w)+ 10% vermicompost (w/w) and Inorganic Fertilizers (IF),
V. M_4=Soil 80% (w/w) + 20% vermicompost (w/w)and Inorganic Fertilizers (IF),
VI. M_5=Soil 80% (w/w) + 10% cowdung (w/w) + 10% vermicompost(w/w) and required calculative amount of Inorganic Fertilizers (IF).

2.6.3 Design and layout of the experiment

The factorial experiment was laid out in a Complete Randomized Design (CRD) with four replications. The 48 plants were planted in the earthen pot and Plastic pot. The earthen and plastic pot size were 40 cm in diameter and 30 cm in height with the depth of 25 cm.

2.6.4 Pot preparation

Earthen pots, plastic pot were filled 10 days before transplanting. Soils were made completely stubbles and weed free.

2.6.5 Manure and fertilizer application

Urea, TSP and MP were applied as a source of N, P_2O_5 and K_2O. Throughly, in addition required amount of Zn, B, Mg were also applied in the pot. Total amount of TSP and half of MOP were applied. Urea and MOP were applied in splits. At the time of final preparation the entire amounts of TSP and MOP were applied and Urea was applied in three equal installments. During bed preparation well-rotten cow dung was also applied.

2.6.6 Uprooting and transplanting of seedlings

Seedlings of 30 days old were uprooted separately from the seedbed and were transplanted in the pots in the afternoon of 4th December 2017 maintaining one seedling in each pot. Before uprooting the seedlings, seedbed was watered to minimize damage to roots. After transplanting, seedlings were watered and also shading was provided for three days to protect the seedlings from the hot sun. Shading was kept after till the establishment of seedlings.

2.6.7 Data collection

Ten plants were selected randomly from pot for data collection in such a way that the border effect could be avoided for the highest precision. Data on the following parameters were recorded from the sample plants during the course of experiment.

2.6.8 Plant height (cm)

Plant height at 40 and 60 days after transplanting (DAT) was taken from sample plants from the ground level to the tip of the plant and mean value was calculated in centimeter (cm).

2.6.9 Number of leaves and primary branches per plant

Number of leaves and primary branches per plant was counted at 40 and 60 days after transplanting (DAT).

2.6.10 SPAD values of leaf

SPAD values of leaf were measured by SPAD meter.

2.7 Statistical Analysis

The recorded data on various parameters were statistically analyzed by using MSTAT statistical package programmed. The mean for all the treatments was calculated and analysis of variance for all the characters was performed by F-test. Difference between treatment means were determined by Duncan`s new Multiple Range Test (DMRT) according to Gomez and Gomez, [9].

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

Plant height is one of the important parameter, which is positively correlated with the yield of tomato. Plant height was recorded at 40 and 60 days after transplanting (DAT) which showed significant differences to different plant growing structures. At 40 DAT, plant growing structure plastic pot (S_1) had the highest plant height (68.34cm). The lowest plant height (54.67cm) was obtained from the plant growing structure earthen pot (S_2) (Table 1). The plant growing structure of plastic pot (S_1) had the highest plant height (87.93 cm) at 60 DAT. The lowest plant height (77.08 cm) was obtained from the earthen pot (S_2).An increase in the container size results in plants of higher size and yield also plants grown in big pots system has the highest values regarding plant height [5,4]. Although these results indicate that both type and size of container is the most important factor for the development of sustainable roof garden. As plant growing structures, plant growing media i.e. different composition of inorganic and organic materials also showed significant difference on plant height at both 40 and 60 date after transplanting (DAT) of tomato (Table 2). At 40 DAT, the composition of Soil and organic matter (soil 80% (w/w) + 10% cowdung (w/w) + 10% vermicompost (w/w) M_5 produced the tallest plant (72.38cm) while the shortest plant (48.33 cm) was produced by control M_0 condition. The composition of Soil 80% (w/w) + 10% cowdung (w/w) + 10% vermicompost (w/w) M_5 produced the tallest plant (88.96 cm) at 60 DAT and the shortest plant (77.29 cm) was obtained from control condition. Application of cowdung + biofertilzierrecords higher plant height, number of leaves, leaf area and leaf area index [10]. Although these results are also consistence with the previous findings. Altogether this experimental results suggest that the height of the tomato plant increase with the addition of organic matter either sole or together use of cowdung or vermicompost. The effect of plant growing structures and different plant growing media showed a significant variation in plant height at both 40 and 60 DAT (Table 3). At 40 DAT, the tallest plant height (77.42cm,) was found in S_1M_5 plastic pot treatment combination with Soil 80% (w/w) + 10% cowdung (w/w) + 10% vermicompost (w/w) and the smallest plant height (42.33cm) was found in S_2M_0 earthen pot with control treatment combination. The tallest plant height (91.33) was obtained from in S_1M_5 at 60 DAT. The smallest plant height (72.00 cm) was found in S_2M_0. These results suggest that plastic pot along with together use of cowdung and vermicompost gave the heighest plant height compared to earthen pot along with together or sole application of cowdung and vermicompost. The presence of organic matter like vermicompost or cowdung in growing media might has improved the soil physico-chemical properties to ensure efficient water and nutrient uptake and utilization resulting in better growth of tomato plants [7].

3.2 Number of Leaves per Plant

The effect of different plant growing structures was influenced on number of leaves per plant at 40 and 60 DAT (Table 1). At 40 DAT, the plant growing structures, plastic pot had the highest number of leaves per plant (12.59) and the lowest number of branches per plant (10.22) was obtained from the earthen pot (S_2). The plastic pot S_1 had the highest number of leaves per plant (28.23) at 60 DAT and the lowest number of leaves per plant (21.28) was obtained from S_2, earthen pot. These results showed that plastic pot has given highest number of leaves per plant whereas from earthen pot show the lower number of leaves per plant. As plant growing structures, plant growing media i.e. different composition of inorganic and organic materials also showed significant difference on leaves per plant at both 40 and 60 date after transplanting (DAT) of tomato (Table 2). At 40 DAT, the maximum number of leaves per plant (14.71) was produced byM_5treatment. The control condition M_0 produced the minimum number of leaves per plant (8.50).The maximum number of leaves per plant (29.13) was observed in M_5 condition at 60 DAT. The control condition M_0 produced the minimum number of leaves per plant (19.63). These results also consistent with the plant height of tomato (Table 2). Therefore, now it indicates that higher composition of organic substance creates a favorable environment by supplying required amount of nutrients along with increasing water holding capacity increase the number of leaves of tomato plants. The interaction between different plant growing structures and different plant growing medium was found significant on the number of leaves per plant at 40 and 60 DAT (Table 3). At 40 DAT, the maximum number of leaves per plant (14.67) was found in S_1M_5 treatment combination, which was statistically similar withS_1M_4 and S_1M_5 treatment combination. Whereas the lowest number of leaves per plant (7.42) was found in S_2M_0 treatment combination. The maximum number of leaves per plant (32.42) was observed in S_1M_5treatment combination at 60 DAT. The lowest number of leaves per plant (15.83) was found in S_2M_0treatment combination. These findings also similar with my previous data of plant height of tomato (Table 3).These results suggest that plastic pot along with together use of cowdung and vermicompost gave the highest leaves per plant compared to earthen pot along with together or sole application of cowdung and vermicompost which could be due to improvement in properties of growing medial due to addition of vermicompost and/or cowdung for potted plants as discussed by Spehia *et al.* [11] for tomato plants grown in growing bags under protected condition.

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Table 1. Effect of plant growing structures on the plant height and Leaf Number of tomato

Plant growing structures (S)	Plant height (cm)				Leaf number			
	40 DAT		60 DAT		40 DAT		60 DAT	
S_1	68.34	a	87.93	a	12.59	a	28.23	a
S_2	54.67	b	77.08	b	10.22	b	21.28	b
$LSD_{(0.05)}$	3.10		1.04		0.87		1.07	
Level of sig.	*		*		*		*	
CV (%)	5.5		6.41		8.25		7.3	

S_1= Plastic pot, S_2= Earthen pot

Table 2. Effect of different plant growing medium on the plant height, Leaf Number of tomato

Plant growing media (M)	Plant height (cm)				Leaf number			
	40 DAT		60 DAT		40 DAT		60 DAT	
M_0	48.33	d	77.29	e	8.50	d	19.63	e
M_1	59.67	c	79.45	d	9.76	cd	22.45	d
M_2	61.86	bc	81.80	c	10.86	bc	24.25	cd
M_3	63.07	bc	83.10	bc	11.93	b	25.94	bc
M_4	63.72	b	84.45	b	12.67	b	27.16	ab
M_5	72.38	a	88.96	a	14.71	a	29.13	a
$LSD_{(0.05)}$	3.33		1.92		1.12		2.58	
Level of sig.	*		*		*		*	
CV (%)	5.5		6.41		8.25		7.3	

M_0=Soil 100% (w/w)+ Inorganic Fertilizers (IF)/ (control), M_1=Soil 80% (w/w) + 20% cowdung (w/w) and Inorganic Fertilizers (IF), M_2=Soil 70% (w/w) + 30% cowdung(w/w) and Inorganic Fertilizers (IF), M_3=Soil 90% (w/w) + 10% vermicompost (w/w) and Inorganic Fertilizers (IF), M_4=Soil 80%(w/w) + 20% vermicompost (w/w) and Inorganic Fertilizers (IF), M_5=Soil 80% (w/w) + 10% cowdung (w/w) + 10% vermicompost (w/w)and Inorganic Fertilizers (IF).

Table 3. Interaction of different plant growing medium and plant growing structures on plant height and Leaf number of tomato

Interaction		Plant height (cm)				Leaf number			
(S× M)		40 DAT		60 DAT		40 DAT		60 DAT	
S_1	M_0	54.33	e	82.58	e	9.58	de	23.42	ef
	M_1	68.33	bc	85.56	d	11.11	cd	26.67	c
	M_2	69.22	bc	88.5	bc	12.22	bc	27	c
	M_3	70.89	b	89.44	ab	13.78	ab	29.55	bc
	M_4	69.85	bc	90.19	ab	14.18	a	30.33	ab
	M_5	77.42	a	91.33	a	14.67	a	32.42	a
S_2	M_0	42.33	g	72	i	7.42	f	15.83	h
	M_1	51	d	73.33	hi	8.42	ef	18.22	g
	M_2	54.5	e	75.1	gh	9.5	de	21.5	f
	M_3	55.25	de	76.75	fg	10.08	de	22.33	ef
	M_4	57.58	f	78.7	f	11.15	cd	23.98	de
	M_5	67.33	cd	86.58	cd	14.75	a	25.83	cd
$LSD_{(0.05)}$		2.72		2.07		1.74		2.17	
Level of sig.		*		*		*		*	
CV (%)		5.5		6.41		8.25		7.3	

In column, means containing same letter indicate significantly similar under DMRT at 5% level of significance. Values are the means of three replications

S_1= Plastic pot, S_2= Earthen pot

M_0 = Soil 100% (w/w) + Inorganic Fertilizers (IF)/ (control), M_1 = Soil 80% (w/w) + 20% cowdung (w/w) and Inorganic Fertilizers (IF), M_2 = Soil 70% (w/w) + 30% cowdung (w/w) and Inorganic Fertilizers (IF), M_3 = Soil 90% (w/w) + 10% vermicompost (w/w) and Inorganic Fertilizers (IF), M_4 = Soil 80%(w/w) + 20% vermicompost (w/w) and Inorganic Fertilizers (IF), M_5 = Soil 80% (w/w) + 10% cowdung (w/w) + 10% vermicompost (w/w) and Inorganic Fertilizers (IF).

3.3 Number of Branches per Plant

It is established that proper vegetative growth is an important factor for increasing the fruit yields of different crops including tomato. The formation of branches of a plant is the character of vegetative growth. In this study I counted number of branches of tomato with reference to different plant growing structures. The data of number of branches per plant showed significant differences at 40 days after transplanting (DAT) and 60 days after transplanting. (Table 4). Number of branch per plant was influenced by plant growing structures. The plant growing structures of plastic pot had the highest number of branch per plant (10.69) and the lowest number of branch per plant (9.88) was obtained from earthen pot. The different plant growing medium showed significant variation in the length of branch (Table. 5). The maximum number of branch (11.08) was produced by M_5 treatment. The control (M_0) produced the minimum number of branch (9.36). The combined effect of plant growing structures and different plant growing medium was found significant on the number of branch per plant. The maximum number of branch per plant (11.33) was found in S_1M_5 treatment, whereas the lowest length of branch (8.83) was found in S_2M_0 treatment (Table 6). The more branching due to combination of vermicompost and cowdung in growing media has improved nutrient uptake and utilization throughout the growing phase to ensure better vegetative growth and photosynthetic activities for higher yield and fruit quality [12].

3.4 SPAD Value of Leaf

SPAD Value of leaf was influenced by plant growing structures. However, the S_1 treatment had the highest SPAD Value of leaf (43.94) and the lowest SPAD Value of leaf (42.72) was obtained from the S_2 treatment (Table 4).The different plant growing medium was significant influenced on the SPAD Value of leaf (Table 5).

Table 4. Effect of plant growing structures on SPAD value and number of primary branches of tomato

Plant growing structures (S)	Numbers of different parts/plant at 60 DAT			
	Primary branches		SPAD value	
S_1	10.69	a	43.94	a
S_2	9.88	b	42.72	b
$LSD_{(0.05)}$	0.26		1.25	
Level of sig.	*		*	
CV (%)	6.4		5.68	

S_1= Plastic pot, S_2= Earthen pot

Table 5. Effect of plant growing media on SPAD value and number of primary branches of tomato

Plant growing media (M)	Numbers of different parts/plant at 60 DAT			
	Primary branches		SPAD value	
M_0	9.36	b	39.07	c
M_1	10.11	ab	39.96	c
M_2	10.09	ab	43.38	b
M_3	10.45	ab	45.08	ab
M_4	10.63	ab	45.74	ab
M_5	11.08	a	46.75	a
$LSD_{(0.05)}$	1.119		4.89	
Level of sig.	*		*	
CV (%)	6.4		5.71	

M_0 = Soil 100% (w/w) + Inorganic Fertilizers (IF)/ (control), M_1 = Soil 80% (w/w) + 20% cowdung (w/w) and Inorganic Fertilizers (IF), M_2 = Soil 70% (w/w) + 30% cowdung (w/w) and Inorganic Fertilizers (IF), M_3 = Soil 90% (w/w) + 10% vermicompost (w/w) and Inorganic Fertilizers (IF), M_4 = Soil 80%(w/w) + 20% vermicompost (w/w) and Inorganic Fertilizers (IF), M_5 = Soil 80% (w/w) + 10% cowdung (w/w) + 10% vermicompost (w/w) and Inorganic Fertilizers (IF).

Table 6. Interaction of different plant growing medium and plant growing structures on SPAD value, number of primary branches, flower clusters, total flowers of tomato

Interaction (S× M)		Numbers of different parts/plant at 60 DAT			
		Primary branches		SPAD value	
S_1	**M_0**	9.89	b-e	39.53	d
	M_1	10.55	a-d	39.72	d
	M_2	10.62	a-d	45.35	b
	M_3	10.8	a-c	45.5	b
	M_4	10.95	ab	46.26	ab
	M_5	11.33	a	47.25	a
S_2	**M_0**	8.83	e	38.6	d
	M_1	9.67	c-e	40.2	cd
	M_2	9.55	de	41.4	c
	M_3	10.1	b-d	44.65	b
	M_4	10.3	a-d	45.22	b
	M_5	10.82	a-c	46.25	ab
$LSD_{(0.05)}$		1.04		4.891	
Level of sig.		*		*	
CV (%)		**6.4**		571	

In column, means containing same letter indicate significantly similar under DMRT at 5% level of significance. Values are the means of three replications

S_1= Plastic pot, S_2= Earthen pot; M_0 = Soil 100% (w/w) + Inorganic Fertilizers (IF)/ (control), M_1 = Soil 80% (w/w) + 20% cowdung (w/w) and Inorganic Fertilizers (IF), M_2 = Soil 70% (w/w) + 30% cowdung (w/w) and Inorganic Fertilizers (IF), M_3 = Soil 90% (w/w) + 10% vermicompost (w/w) and Inorganic Fertilizers (IF), M_4 = Soil 80%(w/w) + 20% vermicompost (w/w) and Inorganic Fertilizers (IF), M_5 = Soil 80% (w/w) + 10% cowdung (w/w) + 10% vermicompost (w/w) and Inorganic Fertilizers (IF).

The maximum SPAD Value of leaf (46.75) was produced by hormones M_5 treatment, which was statistically similar with M_3 and M_4. The treatment M_0 produced the minimum SPAD Value of leaf (39.07). The interaction between different plant growing structures and plant growing medium significant effect on the SPAD Value of leaf (Table 6). The maximum SPAD Value of leaf (47.25) was found in S_1M_5 treatment. The lowest SPAD Value of leaf (38.60) was found in S_2M_0 treatment.

4. CONCLUSION AND RECOMMENDATIONS

Based on the findings of this study, it can be concluded that, morphophysiological parameters positively correlated with plant growing structures and plant growing medium. However, BARI Tomato-14 planted with plastic pot and soil 80% (w/w) + 10% cowdung (w/w) + 10% vermicompost (w/w) would be beneficial for the farmers. Considering the situation of the present experiment, further studies in the following areas may be suggested: 1. Repeated trial is needed in the rooftop garden for analogy the accuracy of the experiment. 2. It needs to conduct related experiment with other summer varieties. 3. Scope to conduct similar experiment for Rabi season in the rooftop. Scope to conduct advance experiments how, plant growing structures and plant growing medium physiologically increase yield of tomato. According to Kumar, [13].

• Most of the urban pedestrians are aware and well conscious about Roof Top Gardening, at least they have heard about it once but the fear of extra load to be thrived due to the soil and the hefty containers remain a major problem. However, If the design of the building and roof are modified in such a way that it can hold and thrive certain load of vegetations, growing media and containers, these problems can be solved. Use of light rooting media other than soil like coco peat, clay balls, can also be practised. Durable grow bags can be used instead of heavy clay pots. • Ceiling dampness/Roof dampness is also a great fear and a threat to the householders. Placing the containers, drums, pots above brick or any firm substance can help to avoid this problem.

- Although being a Metropolitan City, the extension of the education of rooftop farming and the proper way to carry it out still remain in the dark corners. The government sectors should make people aware of the probable good impact of training and seminars about rooftop gardening in growers/residents through training.

- Choice of crops is also another important point to consider. Instead of harvesting in bulk and once, multiple picking can be of great advantage. For this advantage, the crop which can grow moderately for a longer period with multiple picking can be selected. On an important note, they can be of great advantage for evergreen freshness and ambience in the roof if done so.
- The problem of the scorching sun is prevalent on the roof which reduces the moisture level in the growing substrate and leads to volatilization of nutrients. For avoiding this problem, continuous moisture should be maintained by installing a drip irrigation system.
- Hailstones and strong wind prevalence in monsoon are the problems of concern in Pokhara. For avoiding all these we can use roof boundary wall, hail nets to avoid hail problem and good staking must be maintained to make plants more stable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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