



Different Growth Media Effect the Germination and Growth of Tomato Seedlings

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Abstract: Effect of peat, compost (vegetable waste) and traditional practicing media (soil, sand and farmyard manure) alone and in combinations, was examined on the quality of tomato seedlings (*Lycopersicon esculentum* L.) at Directorate of Vegetable, DHRD, NARC, Islamabad, during 2013-14. Germination and several seedling quality variables, like, days to emergence, shoot length, height, vigor index, dry matter accumulation and benefit cost ratio, were monitored. Maximum germination percentage (95), seedlings shoot length (26.67 cm), seedling height (35 cm), seedling vigor index (3325) and minimum days to emergence (15.33) were observed in T₀ (peat, compost and traditional practicing media in 1:1:1 ratio). Maximum dry matter accumulation (34.80%) was recorded in T₁ (peat). Maximum benefit cost ratio (2.70) is calculated for T₀; traditional practicing media (soil, sand and farmyard manure in 1:1:1 ratio). Optimum growth of tomato seedlings was observed when peat, compost and traditional practicing media were used in equal proportions.

Key words: Tomato, seedlings, peat, peat substitutes (compost and traditional media)

INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) from family solanaceae is popular cultivated vegetable in the world and is famous for its nutritive and medicinal value (Opena and Kyomo, 1990). It is 2nd most consumed after potato, ranks 1st among the processing crops and undeniably most popular garden crop (Kalia and Palanisamy, 2014). Among vegetables, tomato is the 2nd major vegetable, produced in Pakistan. It is grown on 173.36 in Kharif and 455.94 square kilometer in Rabi season with average yield of 145.872 thousand tons in Kharif and 453.72 thousand tons in Rabi season in Pakistan (GOP., 2014). It is a cheap source of vitamins (A, C, E), calcium, niacin and minerals (Olaniyi *et al.*, 2010). Tomatoes grow best at temperatures 20-27°C.

Healthy seedlings production is prerequisite for raising vigorous and profitable crops. Seedlings are grown in different growth media, which plays a vital role in efficient production of horticultural seedlings in nurseries (Sterrett, 2001). Soilless substrates have been used for the production of horticultural crops in containers, including organic materials, such as, peat moss. Peat is collected from bogs, marshes, and wetlands, which are often fragile ecosystems of great ecological and archaeological value (Bustamante *et al.*, 2008). Peat moss, due to its appropriate physical properties, such as, low bulk density and high total porosity and its high nutrient exchange capacity constitute one of the main substrate components

for seedling production in containers (Abad *et al.*, 2001; Maher *et al.*, 2008). Use of peat for growing seedlings is however expensive.

Many authors have indicated the feasibility of vegetable waste composts, solid urban wastes and the residues of the wine industry as seedbed substrates for the production of horticultural seedlings in nurseries (Castillo *et al.*, 2004; Garcia-Gomez *et al.*, 2002; Herrera *et al.*, 2008; Kostov *et al.*, 1996; Perez-Murcia *et al.*, 2006). Use of vegetable composts also results in their safe disposal and hence there is no environmental risk as well. It is estimated that about 40% of vegetables in the country are wasted due to poor handling during the harvesting and lack of storage facilities. Vegetable waste left behind during harvest, lying unused and unwanted in farm fields and processing plant, can be used to grow horticultural seedlings in order to achieve good crops. Use of mixtures of compost with peat can diminish the possible poor properties of single materials, such as, high salinity, heterogeneity, or high content of pollutants (Raviv *et al.*, 1986). Therefore, the proportion of compost in the growing media is essential to decrease potential hazards, especially salinity (Bustamante *et al.*, 2008). Keeping in view, the importance of peat and vegetable waste compost for the production of seedling this research work focused at production of quality seedling with desired morphological and physiological features that guarantee crop success after transplanting using economical growth media was the main objective of the study.

MATERIALS AND METHODS

The experiment was carried out at the experimental field of Directorate of Vegetable, DHRD, NARC, Islamabad, during 2013-14. The experimental site is located at 73.08° (longitude), 33.42° (latitude) and 683 msl (elevation) on the global scale. The experiment was conducted under plastic tunnel. Seedlings of tomato (var. Riogrande) were raised in multiport trays. Peat and peat substitutes (compost and traditional practicing media) alone or in combinations were tested for economical and successful growth of tomato seedlings. Plants were periodically and equally irrigated, but no additional nutrient elements were supplied all nursery time. The experimental treatments were arranged in a completely randomized design (CRD), i.e., T₀: Traditional practicing media (soil, sand and farmyard manure in 1:1:1 ratio), T₁: Peat, T₂: Compost, T₃: Peat and compost (1:1), T₄: Peat and compost (1:1/2), T₅: Peat and compost (1/2:1), T₆: Peat and traditional practicing media (1:1), T₇: Peat and traditional practicing media (1:1/2), T₈: Peat and traditional practicing media (1/2:1), T₉: Peat, compost and traditional practicing media (1:1:1). Each treatment was replicated thrice. Germination percentage, days to emergence, seedling shoot length (cm), seedling height (cm), seedling vigor index, dry matter accumulation (mg/05 seedling) and benefit cost ratio were recorded. Seedling vigor index is calculated by multiplying germination (%) and seedling length. The seedling showing the higher seedling vigor index is considered to be more vigorous (Abdul-Baki and Anderson, 1973). Data were subjected to analysis of variance (ANOVA) to compare the effects of media. The differences between the means were compared, using the least significant difference test (LSD, $p < 0.05$), (Steel *et al.*, 1997). All statistical tests were conducted using the Statistix 8.1 software package. Germination percentage, seedling vigor index and dry accumulation percentage was calculated, using the following formulae:

$$\text{Germination (\%)} = \frac{\text{Seeds germinated}}{\text{Total No. of seeds}} \times 100 \quad (1)$$

$$\text{Seedling vigor index} = \text{Germination (\%)} \times (\text{Shoot length} + \text{Root length}) \quad (2)$$

$$\text{Dry matters accumulation (\%)} = \frac{\text{Dry weight}}{\text{Fresh weight}} \times 100 \quad (3)$$

BCR was calculated by the following formula (Asaduzzaman *et al.*, 2011).

$$\text{BCR} = \frac{\sum_{i=1}^t \frac{B_i}{(1+r)^i}}{\sum_{i=0}^t \frac{C_i}{(1+r)^i}}$$

Where:

B : Benefits of the project

C : Cost of the project

t : Time measured in years

r : Discount rate

Organic matter content (%) was estimated by Loss-On-Ignition method (Atkinson *et al.*, 1958), while modified Walkley-Black procedure (Nelson and Sommers, 1982) was adopted for the determination of organic carbon. Total nitrogen and phosphorus contents (%) were determined by the method described by Cleaver (1966). Potassium (%) was determined by Kjeldahl and Flannery (1975). Zinc, Fe, Cu and Mn (mg kg⁻¹) were determined by dry ash method (Issac and Johnson, 1975). Ash content was determined by AOAC (1994). The nutrient composition of different ratio of media is given in Table 1.

RESULTS AND DISCUSSION

Results related to germination percentage, days to emergence, seedling height (cm), seedling vigor index,

Table 1: Nutrient composition of different ratios of media

Treatment	Ash content (%)	Organic matter (%)	Organic carbon (%)	Total N (%)	Total P (%)	K (%)	Zn (mg kg ⁻¹)	Fe (mg kg ⁻¹)	Cu (mg kg ⁻¹)	Mn (mg kg ⁻¹)
T ₀	0.18	99.82	57.90	0.76	1.46	0.09	70.8	3.4	39.2	76.8
T ₁	1.33	98.67	57.23	0.54	2.41	0.14	159.0	4.2	43.2	311.6
T ₂	1.33	98.87	57.34	0.47	2.37	0.15	118.6	3.6	34.8	237.6
T ₃	0.86	99.14	57.50	0.44	2.17	0.15	110.0	1.6	36.0	217.8
T ₄	1.08	98.92	57.37	0.54	1.58	0.09	92.4	3.6	31.8	241.2
T ₅	1.21	98.79	57.30	0.36	1.52	0.09	83.8	1.8	27.6	189.6
T ₆	1.45	98.55	57.16	0.19	1.46	0.09	72.2	0.6	30.2	136.4
T ₇	1.49	98.51	57.14	0.25	1.68	0.09	81.4	3.6	34.8	169.0
T ₈	1.30	98.70	57.25	0.41	1.42	0.09	112.4	4.0	29.8	208.6
T ₉	1.70	98.30	57.01	0.22	1.76	0.09	68.6	8.0	26.8	210.0

Table 2: Comparison of peat and peat substitutes for tomato seedling production

Treatment	Germination (%)	Days to emergence	Seedling shoot length (cm)	Seedling height (cm)	Seedling vigor index	Dry matter accumulation (%)	Cost benefit
T ₀	84.10 ⁱ	23.67 ^a	12.67 ^g	19.00 ^g	1598.0 ⁱ	33.20 ^a	2.70
T ₁	85.27 ^h	22.33 ^b	15.00 ^e	23.00 ^f	1961.5 ^h	34.80 ^a	0.18
T ₂	87.07 ^g	22.00 ^{bc}	16.67 ^e	24.67 ^e	2147.6 ^g	28.97 ^{bc}	2.62
T ₃	89.10 ^f	21.00 ^{cd}	18.33 ^d	26.33 ^d	2346.3 ^f	35.20 ^a	-0.15
T ₄	91.10 ^e	20.33 ^{de}	20.00 ^c	28.00 ^c	2550.9 ^e	26.33 ^{cd}	0.21
T ₅	91.90 ^d	19.33 ^{ef}	21.00 ^c	29.33 ^c	2695.7 ^d	28.17 ^{bcd}	0.54
T ₆	92.90 ^c	18.33 ^f	21.00 ^c	31.67 ^b	2941.8 ^c	29.17 ^{bc}	-0.17
T ₇	87.07 ^g	16.67 ^g	21.00 ^c	33.67 ^a	3138.8 ^b	22.93 ^e	-0.18
T ₈	94.23 ^b	16.00 ^{gh}	26.33 ^a	34.00 ^a	3204.0 ^{ab}	26.00 ^d	0.11
T ₉	95.000 ^a	15.333 ^h	26.667 ^a	35.000 ^a	3325.0 ^a	30.100 ^b	1.58
LSD	0.42	1.24	1.31	1.59	142.91	2.88	

dry matter accumulation percentage and cost benefit ratio are summarized in Table 1. The highest germination percentage (95), seedlings shoot length (26.67 cm), seedling height (35 cm), seedling vigor index (3325) and minimum days to emergence (15.33) were observed, whereas peat, compost and traditional media were used in equivalent ratio (1:1:1). Increase in the above-mentioned parameters might be due to higher phosphorous content, due to equivalent ratio of peat, compost and traditional practicing media. Phosphorous is involved in the formation of energy rich compounds, which in return derive various bio-chemical reactions within the plant include adenosine triphosphate and adenosin diphosphate (Memon, 1996). Balanced proportion of Zn, Cu, Fe and Mn may also have promoted the growth of the seedlings. Our results were in line with various scientists, such as, Riaz *et al.* (2008), advocated use of different growing media for zinnia and suggested physical and chemical properties of media, like, structure, texture, pH, as well as, nitrogen, phosphorus and potassium, as a dominant factor for the growth and development of plant. Furthermore, Ahmad *et al.* (2012) suggested that incorporation of rice hulls and press mud in traditional substrates improved the growth and quality indices and increased flower yield of *Rosa hybrid* L. cvs. 'Kardinal', 'Anjlique' and 'Gold Medal'.

Maximum dry matter accumulation (34.80%) was recorded in T₁ (peat). The data regarding Benefit Cost Ratio (BCR) of seedling produced in different planting medias explicated in Table 2, which elaborates that maximum profit (2.70) can be earned, using T₀: traditional practicing media (soil, sand and farmyard manure in 1:1:1 ratio). The world is shifting from peat moss to other planting media, such as compost, etc., because peat moss is a scarce and expensive growth media, in order to reduce cost and environmental concerns substitutes (compost, vermi-compost, sand, farmyard manure and poultry manure, etc.) of peat became the best choice either alone or in combination with each other (Abad *et al.*, 2001). The results of our findings are in line with aforesaid

statement. Previous studies showed that the organic media had greater P and K levels than the commercial media (Amassa and Manenoi, 2008). Our results show greater growth of tomato seedlings with the use nutrient rich composted media, which were also observed by other researchers, such as, with the use of composted rice straw, poultry manure and banana waste mixed with peat moss, show better growth of tomato seedlings (Nadia *et al.*, 2007). Herrera *et al.* (2008) found that tomato sown on 65% white peat (WP) mixed with 30% municipal solid waste compost (MSWC) had better quality seedlings than those grown with standard peat mixtures, old peat mixtures and with WP+MSWC mixtures that had a high proportion of MSWC. In this study, we found that a lack of available essential nutrients in the growth media resulted in reduced-seedling growth. Our results were similar to the Mg and K deficiency symptoms observed on Khayaivorensis seedlings which resulted in poor growth and lesser nutrient tissue levels (Jeyanny *et al.*, 2009).

The most suitable treatment for vegetative variables of seedlings is T₉ (peat, compost and traditional practicing media in 1:1:1 ratio), whereas the most economical treatment for seedling production is T₀: Traditional practicing media (soil, sand and farmyard manure in 1:1:1 ratio).

CONCLUSION

This study shows that the most suitable treatment for vegetative variables of seedlings is T₉ (peat, compost and traditional practicing media in 1:1:1 ratio) whereas the most economical treatment for seedling production is T₀: Traditional practicing media (soil, sand and farmyard manure in 1:1:1 ratio).

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