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Research Article

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Effect of Different Growth Media on Emergency and Growth Performance of Tomato (*Lycopersicon esculentum* L.) Seedlings at Samara University

Melese Endeshaw Kefale*, Zenebe Abebu, Yibeltal Ayana, Adamtew Alemnew and Seid Eshetu

Department of Horticulture, College of Dryland Agriculture, Samara University, Ethiopia

***Corresponding Author**
Melese Endeshaw Kefale, Department of Horticulture, College of Dryland Agriculture, Samara University, Ethiopia.

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Abstract

Tomato (Lycopersicon esculentum L.) is a popular warm-season vegetable crop that is cultivated in the world, including Ethiopia, and is famous for its nutritional and medicinal value. This study evaluated the effect of media mixtures on the emergence and growth performance of tomato seedlings under a shade house at Samara University in the year, 2019. Eleven locally available growth media with different ratios were used. A completely randomized block design with three repetitions was used. Tomato seeds were sown with three seeds per pot to evaluate seedling emergence. Thereafter, the following growth and development parameters were measured: leaf number, plant height, root length, and 50% emergence. Data were subjected to analysis of variance (ANOVA). Results showed that significant differences ($p>0.05$) in seedling emergence among the eleven-growing media for the entire study period. From this study, Sand (6 days) recorded the fastest emergence. Peat moss and Sand soil also gave significantly ($p>0.05$) larger leaf numbers than others; Peat moss also has potential treatment in terms of plant height. Similarly, treatment with peat moss was a potential treatment in terms of root length. Therefore, soil media Peat moss and Sand containing a mixture of a 3:1 ratio was recommended for developing tomato seedlings, as their combination improved both emergence and subsequent growth compared to the soil media used alone.

Keywords: Farm Yard Manure, Peat Moss, Sand, Topsoil

1. Introduction

Tomato (Lycopersicon esculentum L.) is one of the most popular and widely grown commercial vegetable crops in the world [1]. Tomato fruits are consumed fresh or processed and are a source of minerals and vitamins [2,3]. Seedling production is an important step in the horticultural production system because it influences the final crop yield. Growing media is a major factor that influences seed germination, seedling emergence, seedling growth, and quality of seedlings in a nursery [4]. Healthy seedlings production is pre-request for raising vigorous and profitable crop seedlings that are grown in different growth media, which play a vital role in the efficient production of horticultural seedlings in nurseries [5]. A good growing medium should be composed of mixtures that are tender enough for seeds to easily germinate, retain moisture, drain excessive water, and provide sufficient plant nutrients for seedling growth and development [6]. Growth media should have the basic properties such as proper drainage, water holding capacity, good cation exchange capacity, and lack of weed seeds, pests, diseases, and other harmful materials [7]. They should preferably have organic sources that are more easily returned to nature and be relatively inexpensive or available to reduce production costs [8].

Use of a mixture of manure with peat moss can diminish the possible poor properties of single materials, such as high salinity, heterogeneity, or high contents of pollutants [9]. Therefore, the proportion of compost in the growing media is essential to decrease potential hazards, especially salinity [10]. Preparing transplants is one of the most important steps in the various stages of production of tomato, which is effective in terms of time and quality, and will play a decisive role. The quality of the growing media used in

containerized seedling production is largely influenced by physical, chemical, and biological properties, the growing environment, and plant management [11,12]. Good growing media should be composed of mixtures that are tender enough for seeds to easily germinate, retains moisture, drains excessive water and provide sufficient plant nutrients for seedling growth and development, but there is scantly information to fill large gap between the works done and the demand of the producer; Some media are of natural origin while others are produced artificially in factories [6,13]. So, this study aimed to evaluate the effect of locally available media mixtures: sand, peat moss, farm yard manure, top soil alone, and their combination on tomato seedling quality with desired morphological and physiological features that guarantee tomato seedling success for transplanting.

2. Materials and Methods

2.1. Description of the Study Area

This study was conducted under a shade house with potting growing media at Samara University, College of Dryland Agriculture, on a demonstration site in 2019. The average mean maximum and minimum temperatures are 38.500c and 23.800c respectively. Average rainfall is 53.3mm annually [14].

2.2. Experimental Design and Treatment

The experiment was laid out in a Completely Randomized Block Design (RCBD) consisting of eleven treatments with three replications. This design was aimed at removing variability in experimental media and reducing experimental error between treatments. The treatments used for these experiments depended on the media alone and in combination (mixture). The total pots that were required for those experiment were 33 pots. The area of each pot was ½ (2(3.14) r^2) =113.03 cm^2 (radius of pot was 6cm). Total gross work area was Length*Width (L*W), i.e. [11(16cm) +10(40cm)] x [3(16cm) +2(60cm)] = 96768cm^2. Volume of the pot; V = 1/2(3.14(r^2) h m^3) =1/2(3215.36cm^3) =1607.68. The spacing of the seedlings in each pot was 5cm apart. Spacing within intra pots should be 40cm apart, and also the spacing between blocks should be 60cm to allow free access/movement.

Treatment	Treatment Combination	Ratio
T1	Farmyard manure (FYM)	**Alone**
T2	peat moss mixed with sand (S+P)	**3:1**
T3	Peat moss mixed with topsoil (P+T)	**1:3**
T4	Top Soil (T)-Control	**Alone**
T5	Peat moss (P)	**Alone**
T6	Sand only (S)	**Alone**
T7	Farm yard manure +Sand+Peat moss +Top soil	**1:1:1:2**
T8	Sand mixed with farm yard manure (S+FYM)	**1:3**
T9	Farm yard manure mixed with top soil (FYM+T)	**1:3**
T10	Top soil with sand (T+S)	**3:1**
T11	Farm yard manure mixed with Peat moss (FYM+P)	**1:3**

Table 1: The Mixture of Media Used

2.3. Experimental Material

The experimental materials that were used during the experiment were tomato seeds (Melkasalsa) variety. That Melkasalsa variety had been selected based on its wider cultivation in this region by farmers due to it is lowland adapted variety. It is warm season crop, and the optimum temperature for growth is about 21 ^{0}C -24 ^{0}C and for germination 26^{0}c -30^{0}c. It is a determinant variety with pear-shaped fruit, and its maturity date is 100-110 days. This variety gives a yield of 45000kg/ha and is used for processing as well as fresh form. The seeds of these Melkasalsa varieties were obtained from the Germplasm collections maintained at Melkasa Agricultural Research Center [15].

2.4. Experimental Procedure

An experiment was laid out after the media was mixed and filled in pot with 75%, within the diameter of the cylindrical pot of 12cm and height of 16cm. The treatments of each experimental unit were determined by mixing the ratio of different growing media. The pots were washed with clean water; each pot was filled with different media alone and in combination. After the media mixture was prepared, two days later, three tomato seeds of the Melkasalsa varieties were sown in each pot by the equilateral triangular planting method, and a total of 99 seedlings were obtained. Watering was given to each pot once a day until the seedlings emerge true leaves, subsequently two-day interval. Generally, we had tagged randomly one seedling from each treatment, and a total of 33 seedlings were tagged, so that we had taken our sampling from those tagged seedlings and measured growth parameters of the seedlings.

2.5. Data Collection

- **50% Seedling emergence** was determined cumulatively by taking the day of 50% emergence date. The data was taken by counting the days starting from sowing until emergence, and we had taken the average of day with the sampled plant at the end of the experiment.

- **Leaf number** was measured cumulatively by counting the true leaves after three weeks starting from the sown date, from the sampled plant of each replication at the end of the experiment.
- **Plant height (cm)** was measured quantitatively using a 30 cm ruler from the base to the tip of the leaf. At the tip, fully expanded leaves were randomly sampled from each replication at the end of the experiment.
- **Root length (cm)** was measured quantitatively by uprooting the plant, and we used a ruler from the base to the underground root. The expanded root was randomly sampled from each replication at the end of the experiment.

2.6. Data Analysis

All data was conducted to analysis of variance (ANOVA) for all measured parameters when the treatments showed the means were compared by using the LSD test at 5% of probability level using the Microsoft software SAS version 9.0.

3. Result and Discussion

3.1. Effect of Different Growth Media on 50% Seedling Emergence of Tomato

The result obtained from the analysis of variance (ANOVA) shows that the 50% seedling emergence of each treatment was statistically significantly different at 5% probability level. The treatment of topsoil with peat moss had the highest mean value, and the lowest mean value was recorded from treatment sand (Table 2). But the highest 50% seedling emergence (at 6 days of sowing date) was obtained from the seed sown with sand treatment, which was statistically significant compared to other treatments, and it emerged early. While the lowest 50% seedling emergence (at 8days of sowing date) was obtained from seed sown with T+P, it emerged the latest. The tomato seed sowned with sand increased the 50% seedling emergence by 82% than the seed sowned with T+P media. The reason why sand emerged faster than others was that it had high macro and micro pore space, which support for transportation of water and oxygen in the soil, and it was easy to permeate for upward penetration of the soil. Although our result showed that sand was good media, Vaugh *et al*. (2011) reported that sand was poor in nutrients, and especially fine sand must never be used as an addition to potting substrates, since it clogs up pores. Several production medias one shoot growth and leaf cell expansion were observed previously in tomato plant growth in sand culture were not have good growth performance [16,17].

Treatment	50%emergence
FYM (T1)	6.67^{abc}
P+S (T2)	6.67^{abc}
T+P (T3)	7.33^{a}
T (T4)	7.0^{ab}
P (T5)	6.67^{abc}
S (T6)	6.0^{c}
P+S+FYM+T(T7)	7.0^{ab}
S+FYM (T8)	6.67^{abc}
T+FYM (T9)	6.67^{abc}
T+S (T10)	6.67^{abc}
P+FYM (T11)	6.33^{bc}
%CV	7.67
LSD	0.87

Table 2: Mean Comparisons on 50% Seedling Emergence of Tomato.

Means within the same column followed by different letters are significantly different at 5% probability level.

3.2. Effect of Different Growth Media on Leaf Number of Tomato

The result obtained from the analysis of variance (ANOVA) shows that the number of leaves of each treatment was statistically significantly different at 5% probability level. Treatment P+S had the highest mean and mean value (5.67). While the treatment S+FYM, T+FYM, S, and FYM+P (3.67) were recorded as the lowest mean value and were not statistically different from each other (Table 3). Therefore, the highest leaf number was obtained from the treatment P+S (at 21days of sowing date). This means that the tomato seed sowned with the P+S treatment counted more leaves than others treatment. While the treatments S+FYM, T+FYM, S, and FYM+P (3.67) recorded the lowest leaf numbers. The tomato seeds sown with P+S increase the leaf numberby64.73% than the seed sown with S+FYM, T+FYM, S, and FYM+P media. This happened due to S+P, and FYM contains more nutrient that enough for plant growth requirements and has enough pore space since sand was mixed with peat and good aeration of the root. These results were supported by the findings of Clinton *et al*. (2010), who counted the maximum number of leaves in the leaf compost mixture. The possible reason was the nutritional contribution of the treatment

that produced the maximum number of leaves [18].

Treatments	Leaf Number's means
FYM (T1)	5.33[a]
P+S (T2)	5.67[a]
T+P (T3)	5.0[ab]
T (T4)	4.33[ab]
P (T5)	4.33[ab]
S (T6)	3.67[b]
P+S+FYM+T(T7)	4.33[ab]
S+FYM (T8)	3.67[b]
T+FYM (T9)	3.67[b]
T+S (T10)	4.67[ab]
P+FYM (T11)	3.67[b]
%CV	20.394
LSD	1.53

Table 3: Mean Comparisons on Leaf Numbers of Tomato

Means within the same column followed by different letters are significantly different at 5% probability level.

3.3. Effect of Different Growth Media on Plant Height of Tomato

The result obtained from the analysis of variance (ANOVA) shows that the plant height of each treatment was statistically significantly different at 5% probability level. Treatment FYM and P and S+P had the highest mean value, and they are not significantly different. While the treatments T+FYM, S+ FYM, and P+FYM were recorded as having the lowest mean value and were not statistically different from each other (Table 4). Therefore, the highest plant height was obtained from tomato seed planted in media P, FYM, and P+S (at 21days of sowing date). Conversely, the media T+FYM, S+FYM, and P+FYM recorded the lowest plant height. The tomato seed sowned with FYM and P increase the plant height by 61.2% than the seed sowned with S+FYM, T+FYM, S, and FYM+P medias followed by P+S 64.73%. This happened due to the media P, FYM, and S+P were anchors or supports the plant and serve as a reservoir for nutrients and water, allowing oxygen diffusion to the roots and gaseous exchange between the roots and the atmosphere outside the root substrate they provide large plant height. Mixed growth media is a good growth media with acceptable pH, our findings were also in agreement with who reported that application of FYM,P and P+S had the best effects on growth of annual flowers petunia (*Petunia hybrida* L.) and marigold (*Tageteserecta* L.) and they increased plant height, flower diameter and number of flowers [19,20].

Treatments	Plant height's means
FYM (T1)	6.0[a]
P+S (T2)	5.67[a]
T+P (T3)	5.33[ab]
T (T4)	4.33[ab]
P (T5)	6.0[a]
S (T6)	4.33[ab]
P+S+FYM+T(T7)	5.0[ab]
S+FYM (T8)	3.67[b]
T+FYM (T9)	3.67[b]
T+S (T10)	4.67[ab]
P+FYM (T11)	3.67[b]
%CV	21.954
LSD	1.78

Table 4: Mean Comparisons of Plant Height of Tomato

Means within the same column followed by different letters are significantly different at 5% probability level.

3.4. Effect of Different Growth Media on Root Length

The result obtained from the analysis of variance (ANOVA) shows that the plant height of each treatment was statistically significantly different at 1% probability level. Treatment Peat moss alone had the highest mean value, followed by P+S. Whereas treatment FYM+S was recorded as the lowest mean value (Table5). Therefore, the highest root length was obtained from the tomato seed planted in the media treatment of peat moss. while the lowest root length was recorded with FYM+S. The tomato seed sowned with Peat moss increase the root length by37.5% than the seeds sown with S+FYM media. The reason why peat moss had high root length was that peat had high plant residues and more nutritious, loose organic media. Roots may fail to penetrate smaller pores than their diameter because compaction both increases soil strength and decreases the number of macro pores the rate of root elongation and therefore root length is reduced significant reduction in seedling growth [20].

Treatments	Root length's means
FYM (T1)	4.67^{c}
P+S (T2)	7.0^{b}
T+P (T3)	4.0^{dce}
T (T4)	3.33^{fe}
P (T5)	8.0^{a}
S (T6)	3.67^{dfe}
P+S+FYM+T(T7)	3.67^{dfe}
S+FYM (T8)	$3.o^{f}$
T+FYM (T9)	3.33^{fe}
T+S (T10)	4.33^{dc}
P+FYM (T11)	3.67^{dfe}
%CV	10.85
LSD	0.82

Table 5: Mean Comparisons on Root Length

Means within the same column followed by different letter are highly significantly different at 1% probability level.

4. Conclusion

A good growing medium should be composed of mixtures that are tender enough for seeds to easily germinate/ emergence, retain moisture, drains excessive water, and provide sufficient plant nutrients for seedling emergence and growth performance. Healthy seedlings production is pre-request for developing vigorous and profitable crop seedlings that are grown in different growth media, which play a vital role in efficient production of horticultural seedlings. This study shows that the most suitable treatment for tomato seedlings emergence was recorded in sand treatment due to the sand having enough pore space (macro and micro) for good drainage and aeration, as well as being easy for upward penetration of plumule. Growing media had a significant effect on seedling emergence; hence, growers should select growing media that can sustain the growth and development of the seedlings. Whereas the most treatment which provide large leaf number was recorded with P+S and FYM as well as they were best media for provide large plant height and the treatment P was the best media for root length followed by P+S Although, the data is obtained from pot experiment, only one season and with particular Melkasalsa tomato variety, we recommend for the grower as the media peat moss with sand was good with proportion 3:1 ratio for developing tomatoes seedling as their combination improved both emergence and subsequently growth performance of tomato seedlings.

The challenge of growers was the selection of good growing media; therefore, we recommend that farmers select locally available growing media to assure healthy seedlings, because healthy seedlings were the prerequisite of good production. From this study, further conduct with soil media containing a mixture of a proportion (1:1:2) of FYM, S, and P is recommended for raising tomato seedlings, as their combination improves both emergence and subsequent growth compared to soil media used alone. For the future, we also recommend that growers should do further study on different seasons by combining farm yard manure, sand, and peat moss in 1:1:2 ratios to provide good seedling emergence and growth performance of tomato. Moreover, it will be further studied for the worth of repeating the experiment under field conditions, across different seasons and locations, including various varieties and soil types, to draw sound recommendations.

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