Influence of Rose Oil Processing Waste Compost Media on Tomato Seedling Quality

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Abstract
The seedling growing media play an important role in the production of high quality and healthy seedlings. Seedlings are grown in different growth media. The most commonly used medium in seedling growing is peat. Depletion of peat resources and high peat cost increase interest to cheap and local materials that easily supplied. Therefore, studies on the use of composts prepared from different wastes in seedling cultivation are being carried out. This study was carried out to determine usability of compost prepared from rose oil processing wastes in tomato (*Solanum lycopersicum* cv. Şencan 9) seedling cultivation and the most suitable seedling growing medium. With this aim, peat (control) and 6 growing media prepared from the mixtures of the rose oil processing waste compost (RC) with vermicompost (V), soil (S) and peat (P) at the different ratios (100%P, 50%RC+50%P, 25%RC+75%P, 50%RC+25%P+25%V, 50%RC+25%5P+25%S, 50%RC+25%S+25%V and 25%RC+50%P+25%S) were compared. Significant differences were found among the growing media. The highest stomatal conductance (410.94 mmol m^{-2} s^{-1}), root dry weight (0.31 g), leaf dry weight (0.58 g) and total seedling dry weight (1.17 g) were obtained from 25%RC+75%P medium. The highest seedling length (13.27 cm) and leaf area (15.42 cm^2) were determined in 50%RC+25%S+25%P medium. The highest stem dry weight (0.3 g) was obtained from 50%RC+50%P, while the highest chlorophyll content (20.16 CCI) was determined in 100%P medium. It was determined that the mixture of 25%RC+75%P had a significant effect on seedling quality.

Keywords: Compost, rose oil processing waste, seedling, tomato, vermicompost

1. Introduction

Tomato is one of the most commonly cultivated vegetables in the world. Turkey is the fourth country in tomato production after China, USA and India in the world (Duman and Düzyaman 2017). Tomato has the highest production among all the vegetables with approximately 12.6 million tons in Turkey (TUIK 2018) and its fruits are commonly consumed as fresh vegetable or in the form of tomato paste, canned, dried, and frozen.

In parallel with the increasing vegetable cultivation, seedling production also increased rapidly. In

Turkey, 140 vegetable nursery companies produced 14 different species of vegetable seedlings. With 991.3 million seedlings production tomato is the first rank among the vegetables produced by seedling (Yanmaz et al., 2015).

Growing media used in seedling production play a vital role in efficient production. Unsuitable growing media cause decrease of number of seedlings, increase of amount of seed used, time, and labor. For this reason, growing media must be cheap, easily available and provide required environment for seedling growth. In this regard, it is necessary to identify the ideal mixture or the optimum mixture which provide suitable environment to each species (Uzun et al., 2000).

Some organic media are used extensively in greenhouse vegetable production by agricultural companies either alone or as a mixture with inorganic media. In the Mediterranean region where intensive greenhouse production is carried out, the ready-made seedling production is carried out in mixtures consisting of 100% peat, peat-perlite or mostly peat-perlite-vermiculite (Varış et al., 2004; Çinkılıç 2008). For many reasons such as reduction of perlite and peat reserves and resources due to high consumption in the world as well as in Turkey, demands alternate ways of raising seedlings by using different growing media (Tüzel and Gül 2008). It is reported that the use of different plant wastes as seedling growing media may be a good alternative, but it would be more appropriate to evaluate these wastes by composting. Use of composts for the production of horticultural seedlings in nurseries has been investigated (Kostov et al., 1996; Castillo et al., 2004; Perez-Murcia et al., 2006; Bustamante et al., 2008; Herrera et al., 2008; Atif et al., 2016; Öztekin et al., 2017). However, Raviv et al. (1986) reported that use of mixtures of compost with peat can decrease the possible poor properties of single material, such as high salinity, high content of pollutants and/or heterogeneity.

The waste materials left after rose oil extraction may be an alternative for commercial seedling growing media (Herrera et al., 2008; Öztekin et al., 2017). In Isparta, the city where rose production is the highest in our country, about 26500 tons of pulp formed in 1.5 month during rose processing season (Tosun et al., 2008). Results of chemical analysis of rose oil processing waste composts showed that it is rich in nitrogen and mineral matter (Tosun et al., 2008; Öztekin et al., 2017). Studies have shown that rose oil processing waste compost can be used as seedling growing media (Tosun 2003; Onursal 2006; Öztekin et al., 2017). However, there is a need to develop these growing media in order to increase seedling growth and quality.

The aim of this study was to disclose the effects of 6 growing media prepared from the mixtures of the rose oil processing waste compost (RC) with vermicompost (V), peat (P) and soil (S) on tomato seedlings growth and quality and to compare with peat medium.

2. Material and Method

Experimental setup

The research was carried out in greenhouse belonging to the Ondokuz Mayis University, Faculty of Agriculture, Department of Horticulture, during March-June, 2018. Seeds of tomato (*Solanum lycopersicum* L.) cultivar Şencan 9 were used. Rose oil processing waste compost was obtained from the mixture of rose oil processing wastes, separated dairy manure, poultry manure, and wheat straws. All input materials were received from agricultural farms with organic production certificates. The mixture used for the composting experiment was 20% of rose oil processing wastes with 61.83% of separated dairy manure, 8.17% of poultry manure and 10% of straw based on dry weight with initial C/N ratio of 28.56. The mixture was composted with aerated static pile composting methods. Composting (active and maturation phase) lasted for 105 days for both methods periods.

Peat (control) and 6 growing media prepared from the different ratio mixtures of the rose oil processing waste compost (RC) with vermicompost (V), soil (S) and peat (P) were tested for successful growth of tomato seedlings. Growing media tested in this study and abbreviations are given in Table 1.

At start of the experiment pH and EC of growing media were measured by keeping 1:10 substrate / water mixture ratio after shaking the solution for an hour (Table 2). The seeds of Şencan 9 cultivar with 3 replicates were sown on 15.03.2018 in viols with an eye volume of 128 cm^3 (5 cm x 6.5 cm) after filling with growing media. The viols were placed under controlled temperature in greenhouse.

Plants were periodically and equally irrigated during the growing period. No additional nutrient elements were supplied at all nursery time.

Table 1. Growing media tested in this study

Abbreviations	Growing media
100P	100% Peat (P)
50RC+50P	50% Rose oil processing waste compost (RC) + 50% Peat (P)
25RC+75P	25% Rose oil processing waste compost (RC) + 75% Peat (P)
50RC+25P+25V	50% Rose oil processing waste compost (RC) + 25% Peat (P) + 25% Vermicompost (V)
25RC+50P+25S	25% Rose oil processing waste compost (RC) + 50% Peat (P) + 25% Soil (S)
50RC+25P+25S	50% Rose oil processing waste compost (RC) + 25% Peat (P) + 25% Soil (S)
50RC+25S+25V	50% Rose oil processing waste compost (RC) + 25% Soil (S) + 25% Vermicompost (V)

Measurements of variables

In order to determine the seedling quality, seedling length (cm) was measured with ruler and seedling diameter (mm) was measured with digital Vernier caliper. Leaf chlorophyll content was measured by using chlorophyll meter (CCM-200, Opti-Sciences, Hudson, USA) and presented in the form of chlorophyll content index (CCI) unit. Leaf stomatal conductance was measured with a porometer (SC-1, Decogon Devices, USA) as mmol m^{-2} s^{-1}. Leaf chlorophyll content and stomatal conductance measurements were made on all seedling leaves.

Seedlings were uprooted at four-leaf stage, after that roots were washed and separated into root, leaf and stem. Separated parts of seedlings were dried at 80 °C until constant weight, then their dry weights were measured with digital electric balance. Tomato leaves (terminal, right and left leaflets) length and width were measured according to Beyhan et al. (2008), to determine leaf area (cm^2).

Statistical analysis

The study was conducted in completely randomized design (CRD) with 3 repetition and 10 seedlings in each repetition. Results of the study were assessed through SPSS 17.0 software. Data were subjected to analysis of variance (ANOVA) to compare the effects of media. Means were compared using Duncan's multiple range tests at $p<0.05$.

3. Results and Discussions

Results related to pH and EC of growing media are summarized in Table 3. The highest EC 1.63 dS m^{-1} was observed in 50RC+25P+25V growing media. The EC of the growing media increased with the addition of RC and vermicompost in the medium. The pH value of peat was 6.57, after mixing with RC growing media raised pH values between 7.81 and 8.37.

Table 2. EC and pH values of growing media prepared from the different ratio mixtures of the rose oil processing waste compost (RC) with vermicompost (V), soil (S) and peat (P)

Growing media	pH	EC (dS m^{-1})
100P	6.57	0.69
50RC+50P	8.37	0.89
25RC+75P	7.81	0.64
50RC+25P+25V	8.12	1.63
25RC+50P+25S	7.86	0.75
50RC+25P+25S	8.08	0.58
50RC+25S+25V	8.11	1.08

In the study, it was observed that different growing media had significant ($p<0.05$) effects on all parameters examined except seedling diameter (Table 3 and 4).

The highest leaf area 15.42 cm^2 was obtained from 50RC+25P+25S medium. The lowest leaf area (8.98 cm^2) was obtained from 100P growing media (Table 3). In previous research, the highest leaf area was obtained in cucumber when combination of farm yard manure with soil (2:1) mixture was used as growing media (Kandemir et al., 2013). In the present study it was observed that RC having high organic

content increased leaf area. Leaf area and the number are important parameters of seedlings. Leaves are the organs that play an important role in photosynthesis. Hence, photosynthesis is linked with the yield of tomato (Taiz and Zeiger 2008). A study was under taken to evaluate the response of plants to different organic fertilizers, there were very important relationships between leaf count, leaf chlorophyll content, photosynthesis rate and yield were found (Özer 2012).

Table 3. Effects of growing media prepared from the different ratio mixtures of the rose oil processing waste compost (RC) with vermicompost (V), soil (S) and peat (P) on seedling diameter and height, leaf area, leaf chlorophyll content and stomatal conductivity

Growing media	Seedling diameter (mm)	Seedling height (cm)	Leaf area (cm^2)	Leaf chlorophyll content (CCI)	SC ($mmol\ m^{-2}s^{-1}$)
100P	2.94±0.02	10.96±0.09 bc	8.98±0.12 b	20.16±1.12 a	317.56±7.03 ab
50RC+50P	3.22±0.02	10.74±0.08 c	10.63±0.14 ab	15.40±1.15 bc	307.78±7.62 ab
25RC+75P	3.27±0.02	11.44±0.11 bc	11.86±0.12 ab	18.02±1.02 ab	410.94±8.04 a
50RC+25P+25V	3.90±0.02	12.18±0.12 ab	13.81±0.13 ab	16.29±0.93 b	179.33±5.71 b
25RC+50P+25S	2.96±0. 01	12.19±0.14 ab	12.85±0.21 ab	17.06±1.44 b	281.28±7.21 ab
50RC+25P+25S	3.62±0.02	13.27±0.13 a	15.42±0.29 a	14.97±0.99 bc	309.44±8.09 ab
50RC+25S+25V	3.40±0.02	11.49±0.10 bc	11.22±0.20 ab	12.71±1.75 c	288.44±6.14 ab

Means with different letters in the same column were significantly different ($p<0.05$), SC; Stomatal conductivity

In our study, significant effects of growth media on leaf chlorophyll content and stomatal conductance were determined. The highest leaf chlorophyll content was obtained from medium with 100P with 20.16 CCI. This value was followed by the 25RC+75P growing media with 18.02 CCI value. The lowest value (12.71 CCI) were obtained from 50RC+25S+25V. Leaf chlorophyll contents increased in the environment where the ratio of the soil increased. However, chlorophyll content in RC was reduced when used in combination with vermicompost (Table 3). This is thought to be due to the high salt content of the media (Table 2). Bustamante et al. (2008) reported that the proportion of compost in the growing media is essential to reduce potential hazards such as salinity.

There are important relationships between leaf chlorophyll content and stomatal conductance (Özer 2012). In our study similar relationships was found. The highest stomatal conductance (410.94 mmol m^{-2} s^{-1}) was detected in 25RC+75P seedlings growing media where leaf chlorophyll contents were high (Table 3).

Stomatal conductivity is a sign of gas exchange that occurs in the leaves. The opening and closing of the stomata have a positive effect on photosynthesis. This result increased in yield (Herrera 2008).

Leaf chlorophyll content has been reported to be strongly related to stomatal conductance and yield (Özer 2012). For this reason, chlorophyll contents and stromal conductivity affect seedling quality, seedling adaptation, growth rate, yield and quality parameters.

Root, shoot and leaf dry weight were significantly affected by the growing media. In this study, the highest root (0.31 g), leaf (0.58 g) and total seedling dry weight (1.17 g) were obtained from 25RC+75P. 50RC+50P gave the highest shoot dry weight (0.30 g) among the tested growing media, followed by 0.28 g of 25RC+75P medium. Öztekin et al. (2017) reported that root and shoot dry matter were significantly affected by the compost types, rates and their interaction. 50RC+25S+25V and 50RC+25P+25V media prepared with vermicompost gave the lowest total seedling dry weight (Table 4). EC values of those media were higher than other tested growing media (Table 2). Growing media comprises with vermicompost given the low quality seedlings might be due to high EC. Seedlings stage is considered sensitive to salt stress, so during seedling stage ratio of vermicompost should be keep low.

It is well known that there is a significant relationship between stomatal conductance and photosynthesis rate (Özer 2012). Increasing stomatal conductance and photosynthesis lead to high dry matter accumulation (Uzun 2000) Similarly, in this study, 25RC+75P growing media seems to have profound impact on stomatal conductance which resulted in the highest value of total seedling dry weight (Table 3 and 4).

Table 4. Effects of growing media prepared from the different ratio mixtures of the rose oil processing waste compost (RC) with vermicompost (V), soil (S) and peat (P) on root, shoot, leaf and total seedling dry weight

Growing media	Dry weight (g)			
	Root	Shoot	Leaf	Total
100P	0.24±0.001 b	0.18±0.001 bc	0.41±0.001 ab	0.83±0.001 b
50RC+50P	0.27 ±0.001 ab	0.30±0.001 a	0.50±0.001 ab	1.06±0.001 ab
25RC+75P	0.31±0.001 a	0.28±0.001 ab	0.58±0.001 a	1.17±0.001 a
50RC+25P+25V	0.16±0.001 c	0.19±0.001 bc	0.51±0.001 ab	0.86±0.001 b
25RC+50P+25S	0.19±0.001 bc	0.23±0.001 bc	0.46±0.001 ab	0.88±0.001 ab
50RC+25P+25S	0.21±0.001 bc	0.16±0.001 c	0.52±0.001 ab	0.88±0.001 ab
50RC+25S+25V	0.18±0.001 bc	0.21±0.001 bc	0.38±0.001 b	0.77±0.001 b

Means with different letters in the same column were significantly different ($p<0.05$)

4. Conclusion

In present study, 50RC+50P and 25RC+75P were determined as the most suitable growing media for seedlings growth. Among the growing media, seedling quality was found to be better than peat medium. Peat is expensive and scarce, therefore, other growing media such as compost for seedling production are being investigation instead of peat in world. Compost made with rose oil processing waste material rich in nutrients and involve in quality seedlings production. The rose oil processing waste compost can be used economically and environmentally friendly to benefit agriculture.

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