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Evaluation of Physical Characteristics and Matric Potential of Soil Less Media

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ABSTRACT

An effort was made to study the physical characteristics of soil less media. Different proportions of soil less media mixture were chosen for the study. The physical properties of soil less media and its effect on germination percentage of tomato were determined. The matric potential for different media mixtures also found out. Bulk density and Aeration Porosity were found maximum in the mixture of 1:1:1 (Coir pith : Vermicompost : Sand) because the proportion of sand was more in this mixture. Water holding capacity was found maximum in the mixture 3:2:1 (C:V:S). As the tension increased the moisture content decreased in soil less media over the period of time. This study gave the comparative analysis for choosing suitable soil less media for healthy crop growth.

Keywords : Germination percentage, Matric potential, Physical property, Soil less media.

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INTRODUCTION

Cultivation of crops in soil less culture is being practiced mainly in urban area as open land area availability is less. Even shortage of labors, less fertile soil and irrigation water availability are also few reasons to adopt soil less culture. Soil less media is free from pest and disease problem. The water holding capacity and nutrient absorption capacity is more in soil less culture. Nutrient content of soil less mixture can be adjusted according to the type of crop. The properties of soil less culture depends upon the material mixture and its proportion. Hence detailed study was carried out to find out physical properties of soil less media and its effect on germination percentage of tomato.

The soil less media mixture either organic or inorganic should have good water holding capacity and stability to hold roots to ensure proper proportion of air and water (Bilderback *et al.* 2005, Nair *et al.* 2011). The composed material was always used as a growing medium as it provided nutrients for better crop growth (Schroeder and Sell 2009). The physical and chemical characteristics and nutrient status of the soil less media determined the yield and quality of the vegetables that were grown (Grunert *et al.* 2008). Soil less growing media provided a favorable environment for the plant growth (Mastouri *et al.* 2005). Rippy *et al.* (2004) found that soil less media pH affected the micro nutrient availability and there by plant growth and yield. Cultivation in soil less

media reduced soil borne disease; salinization caused excess application of fertilizers and the labor requirement for crop management (Lorenzo *et al.* 2013).

Murumkar *et al.* (2012) conducted study with eight different soil less media like coir pith, perlite, vermiculite, peat as separate treatments and each media mixed with 50% vermicompost as other four treatments and found the growth characters of Beet root crop. Raviv and Lieth (2008) reported that high bulk density of soil less media was obtained when mixed with sand, soil and clay. Quintero *et al.* (2009) studied media mixture of rice husk (35%) : Coconut fiber (65%) and rice husk (65%) : Coconut fiber (35%) and analyzed particle size distribution, solid and bulk density, total porosity, air and water distribution for each media mixture in rose crop. The bulk density was found high in rice husks (0.26 g/cm^3) and low in coconut fiber (0.13 g/cm^3). Nagavallemma *et al.* (2004) reported that macropore space was increased in soil less media with the addition of vermicompost which resulted in improving aeration in soil less media.Water absorption capacity of the media was increased with the addition of burnt rice hull and perlite into coco peat. Air-Filled Porosity was higher when 30% burnt rice hull was mixed with coco peat.

Lorenzo *et al.* (2013) reported that water and air ratio decided the balance in macro and micro pores and stated that the materials with high porosity ensured sufficient aeration to the roots. Nair *et al.* (2011) tested different soil less media mixtures and reported that air and water holding capacity should maximum to achieve proper plant growth. Abd El-Hady *et al.* (2006)obtained result that increasing perlite in soil less media mixture improved total pore space, free air space and available water to the plant growth. Paramanandham *et al.* (2013) stated that the graded coir pith pH was moderately acidic during first wash and it attained alkaline after final wash in the sequence washing. Maboko *et al.* (2009) reported that plants grown in soil less media showed fast growth with high yield compared to normal cultivation in soil. Krishnamurthy *et al*. (2009) reported that tomato seedlings growth rate was faster in coir media than in peat media. Soil less media should contain proper water retention capacity and enough aeration capacity in order to enrich plant growth. Hence the physical properties of different soil less media were determined in this study during 2016 at Agricultural Engineering College and Research Institute, TNAU, Kumulur, Trichy.

MATERIALS AND METHODS

Coir pith, Vermicompost and Sand (C:V:S) were mixed with different proportions for determining physical properties of soil less media. The ratio of different compositions were 1:1:1, 2:1:1, 3:1:1, 1:2:1, 2:2:1, 3:2:1, 1:3:1, 2:3:1 and 3:3:1 C:V:S respectively. There were nine treatments in the study.

Bulk density of soil less media

The different soil less media mixtures were analyzed to determine physical characteristics like bulk density and particle density by the following formula.

$$\text{Bulk density (g/cc)} = \frac{\text{Dry mass of soil less media soild}}{\text{Total volume of soil less media}}$$

Porosity of soil less media

The total porosity (TP), aeration porosity/air filled porosity (AFP) and water holding capacity (WHC) of the different soil less media were measured. Small container with a drainage hole at the bottom was taken. It was plugged to seal drainage holeand filled with water. The volume of water in the container was recorded as “container volume”.

The water drained from the container was collected in a small container and the liquid volume was measured with a graduated cylinder. The empty dry container was filled with dry growing media. The medium was slowly saturated with water until the surface glistens. The total volume of water added was recorded as “total pore volume”. The container was placed over the drainage collector and the seal over the drain holes in the container was removed. All the free water was allowed to drain out of the container. The amount of this drainage water was measured and recorded as “aeration pore volume”. The total porosity, aeration porosity (air filled porosity) and water holding capacity were computed by :

$$\text{Total porosity} = \frac{\text{Total Pore Voliume (\%)}}{\text{Container Volume}} \times 100$$

$$\text{Aeration porosity (\%)} = \frac{\text{Aeration Pore Volume (\%)}}{\text{Container Volume}} \times 100$$

Water holding capasity = Total Porosity Aeration—Porosity
(Source : Adapted from Gessert 1976, Whitcomb 1988).

Matric potential of the medium

A tensiometer is an equipment used to measure moisture tension or matric potential. It consists of a long tube fixed with a porous ceramic tip at one end and a pressure gauge on the other end. The long tube was filled with water and inserted in the soil less media mixture pot. Three pots with 6 liters capacity was taken and filled with different media mixtures. The mixtures were saturated completely. In each pot tensiometer was inserted at the depth of 15 cm. The gauge pressure was monitored daily and the corresponding moisture content of the media at 15 cm depth was measured by gravimetric method (Source: Heiner Lieth and Lorence Oki 2008).

RESULTS AND DISCUSSION

Bulk density

Bulk density was found maximum in T^1 (Corpith: Vermicompost: Sand 1:1:1) treatment (0.82 g/cc) followed by T^4 (Corpith: Vermicompost: Sand 1:2:1) treatment (0.78 g/cc). This may be due to the presence of high proportion of sand in T^1 treatment. Bulk density of different soil less media mixture was calculated and it is given in Fig.1. Similar study was conducted by Murumkar *et al.* (2013) and stated that the bulk density of soil less media was found as 0.608 g/cc, particle density was found as 0.517 g/cc and porosity was 78.79%.

Porosity characteristics of the substrate media

The treatment 6 (Coir pith : Vermicompost: Sand 3:2:1) was having high water holding capacity. This was because of presence of more volume of coir pith which increases the water retention capacity of the media. Whereas treatment 1 (Coir pith : Vermicompost : Sand - 1:1:1) was having comparatively more volume of sand among all media relatively and had less water holding capacity. The same trend was noticed in case of total porosity.

The aeration porosity was less in treatment 6 (Coir pith: Vermicompost: Sand 3:2:1) than the porosity in treatment 1 (Coir pith : Vermicompost : Sand1:1:1). This was due to the presence of maximum amount of coir pith which absorbed more water and

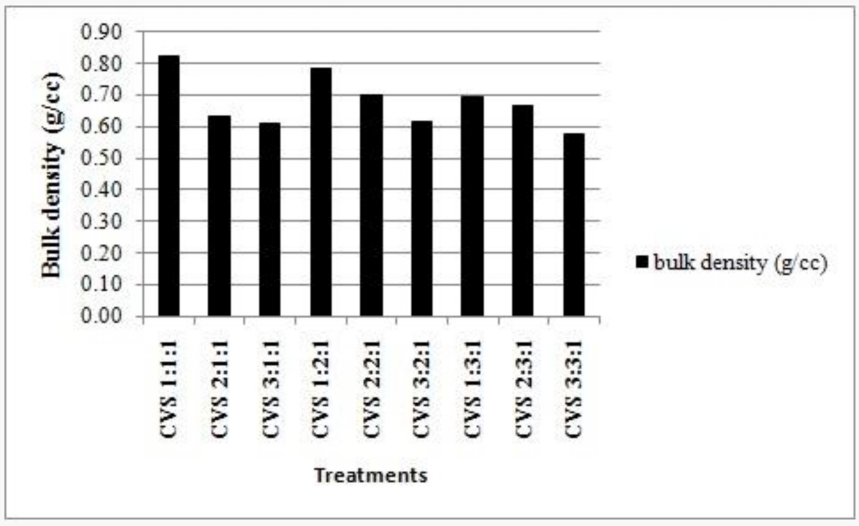

Fig. 1. Bulk density of different soil less media.

Table 1. Physical characteristics of soil less media. C:V:S – Coir pith : Vermi compost : Sand.

	Compositions	Water holding capacity (%)	Total porosity (%)	Aeration porosity (%)
T_1	C:V:S 1:1:1	62.60	67.00	4.40
T_2	C:V:S 2:1:1	72.00	75.80	3.80
T_3	C:V:S 3:1:1	76.00	80.00	4.00
T_4	C:V:S 1:2:1	76.80	80.80	4.00
T_5	C:V:S 2:2:1	76.40	79.20	2.80
T_6	C:V:S 3:2:1	81.20	84.20	3.00
T_7	C:V:S 1:3:1	74.00	77.60	3.60
T_8	C:V:S 2:3:1	72.00	76.00	4.00
T_9	C:V:S 3:3:1	72.00	75.60	3.60

increased its volume there by hindered the air pore-space. Porosity of different soil less media mixture was calculated and it is given in Table 1. Similar study was conducted by Awang *et al.* (2009) and found that the difference between air filled porosity ranges from 1.1 % to 7% after 2 h and 5 h of soaking of soil less media.

Matric potential of the soil less media

The matric potential was observed for three media viz., 1:1:1 (C:V:S), 2:1:1 (C:V:S) and 3:1:1 (C:V:S). From the experiment, it showed that tensiometer reading gradually decreased as days goes on. Three proportions were taken and each proportion showed different results at different pressure. This gave the moisture condition of the medium at different tension (kPa). Sarkar *et al.* (2008) reported that tensiometers are useful to impose water stress on crops grown on soil less media for getting quality produce.

T_1 (Coir pith: Vermicompost: Sand) (1:1:1)

In this proportion, coir pith, compost and sand was taken equal quantity and saturated. It was found that there was decrease in moisture content with increase in pressure. Initially it was found sudden decreasing trend in moisture content and then decreased gradually. It was due to less water holding capacity as it contains equal volume of sand content.

T_2 (Coir pith : Vermicompost : Sand) (2:1:1)

In this proportion, coir pith, compost and sand were taken as 2:1:1 proportion. Comparing above mixture, in this proportion the moisture content was less decreasing when there was increase in pressure. Since the coir pith quantity was more in this proportion, the water was not evaporated suddenly instead the coir pith holds some amount of water. Due to the presence of more quantity of coir pith, the decrease in moisture content was slow comparing above proportion.

T_3 (Coir pith : Vermicompost : Sand) (3:1:1)

In this proportion, the quantity of coir pith was three times more than other proportions. So the coir pith could hold water more than other proportion which made the water to sustain inside the coir pith. Comparing above two mixtures, in this proportion the moisture content was found less as the pressure increased. Moisture content was found decreased as pressure gradually increased. The moisture holding was maximum compared to other two mixtures. Among all the media taken, media 1:1:1 (C:V:S) showed the very advantageous properties which highly favors the proper and healthy growth of nursery. The moisture characteristics curve of soil less media mixtures is given in Fig. 2.

Germination percentage of seeds

Tomato seeds were sown in all the nine treatments to test the germination percentage. Small containers were filled with media and saturated initially. The excess water was removed by the punctures created at the bottom of the container. For each treatment soil less mixture was filled in 20 containers. For nine treatments, totally 180 containers were filled with soil less media and kept inside shade nethouse. After 15 days of dippling of seeds, germination percentage for

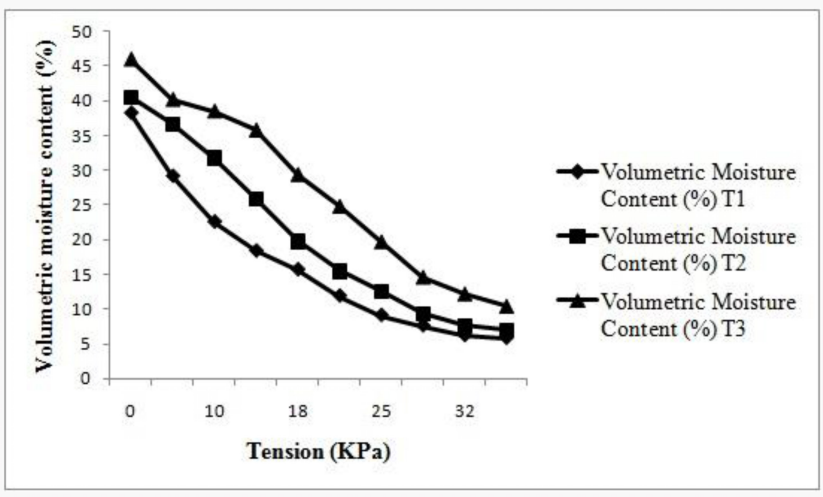

Fig. 2. Moisture characteristics curve of soil less media mixtures.

tomato seeds in different soil less media placed inside shade net house was calculated using the following formula.

$$\text{Germination \%} = \frac{\text{Number of seedlings germinated}}{\text{Number of seeds dippted in container}}$$

The germination percentage was found maximum in treatment 1 that is C:V:S 1:1:1 and treatment 9 C:V: S 3:3:1 (Fig. 3).

CONCLUSION

A study was conducted to determine the physical properties of soil less media. Bulk density and Aeration Porosity were found maximum in the mixture of 1:1:1 (C:V:S) because the proportion of sand was more in this mixture. Water holding capacity was found maximum in the mixture 3:2:1 (C:V:S). As the tension increased the moisture content decreased in soil less media over the period of time. The matric

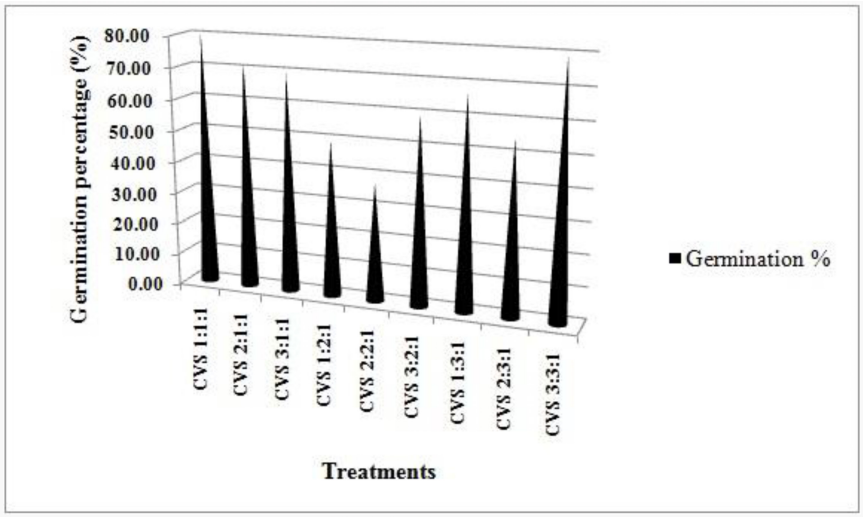

Fig. 3. Germination percentage of seeds in different soil less media.

potential was observed for three media viz., 1:1:1 (C:V:S), 2:1:1 (C:V:S) and 3:1:1 (C:V:S). Among all the media taken, media 1:1:1 (C:V:S) showed the very advantageous properties which highly favors the proper and healthy growth of nursery.

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