Original Research Article

Analysis of Physio-Chemical Properties and Plant Growth Characteristics using Different Growing Media

Abstract

Soilless culture is a technique of crop production using no soil. The main reason towards need for soil to soilless culture for horticultural crops is the problem related to proliferation of soil borne pathogen in the soil cultivation. Research studies have reported that commercial production of greenhouse vegetables with soilless media adopted to reduce economic losses caused by soil-borne pathogens. In this context, the present study was initiated to identify suitable substrate mixes for soilless culture. The experiment was laid out in a randomized block design. There were fifteen different media levels including control, with three replications. Crop Tomato TNAU hybrid CO3 were assessed for the mean performance in respect of growth characters viz., shoot length, root length, germination percent and vigour index. The treatment Vermicompost: Coirpith (3:1) was found to have the highest value for growth characters for the crop. In the point of physical and chemical properties, all combination media almost showed optimal range for crop growth. Further a cost analysis was made to find the suitable media based on cost aspects comparing reduction in vigour index and cost of media with that of best media. Treatment T_7 (Vermicompost: coir pith (2:1)) and T_6 (Vermicompost: Coir pith (1:3) were found to be the best media considering above factors.

Keywords: Physio-Chemical properties, plant growth characteristics, soilless growing media, cost analysis

Introduction

Soil-based agriculture is facing some major challenges with the advent of civilization all over the world, such as decrease in per capita land availability, non-availability of work force, incidence of pests and diseases, etc. Apart from this, due to rapid urbanization and industrialization as well as threats from climate change and its related adverse effects, the land cultivation is going to face further challenging threats. Under such circumstances, in the near future it becomes intricate to feed entire population using the production from soil field system. Naturally, soilless culture is gaining its relevance in the present scenario, to cope-up with these challenges. Soilless culture is the modern cultivation system of plants that use either inert organic or inorganic substrate through nutrient solution nourishment. Possibly it is the most intensive culture system utilizing all the resources efficiently for maximizing yield

of crops and the most intense form of agricultural enterprises for commercial production of vegetables. Several studies suggested soilless culture is an alternative to traditional field production for high-value vegetable crops. Therefore, quality of horticultural crops grown through soilless culture improves significantly compared to conventional soil culture. This artificial growing system provides plants with mechanical support, water and mineral nutrient for higher growth and development. Soilless growing media are easier to handle and it may provide better growing environment (in terms of one or more aspects of plant growth) compared to soil culture. Organic substrates includes sawdust, coco peat, vermicompost, peat moss, woodchips, fleece, marc, bark, etc. whereas, inorganic substrate of natural origin are perlite, vermiculite, zeolite, gravel, rock wool, sand, glass wool, pumice, sepiolite, expanded clay, volcanic tuff and synthetically produced substrates are hydrogel, foam mates (polyurethane), oasis (plastic foam), etc. Various raw materials have been used to produce growing media for vegetable production throughout the world. In this context, the present study was initiated to identify suitable substrate mixes for soilless culture with the following objectives,

1. Physio-chemical properties of different growing media
2. To conduct germination studies to find the best media
3. To assess the economical viability of growing media

Methodology

The field experiment was conducted in the farm Imayam Institute of Agriculture and Technology, Thuraiyur. The experimental site lies geographically in between 11° 8’ 29” N latitude and 78° 35’ 40” E longitude and at an altitude of 151 m above mean sea level. The experiment was designed under Randomized block design as 15 treatments with three replications as mentioned in Table (1). The loamy soil available was used as control. Physico chemical prosperities of media characteristics like bulk density, particle density, porosity, pH and EC were analyzed by standard procedure. The climatic parameters temperature and relative humidity are monitored throughout the crop growth period.

Table.1. Media and their combinations for different treatments

Treatment	Growing media(v/v)
T_1	Coir pith
T_2	Sawdust
T_3	Vermicompost
T_4	Vermicompost : Coir pith (1:1)
T_5	Vermicompost : Coir pith (1:2)
T_6	Vermicompost : Coir pith (1:3)
T_7	Vermicompost : Coir pith (2:1)
T_8	Vermicompost : Coir pith (3:1)
T_9	Vermicompost : Sawdust (1:1)
T_{10}	Vermicompost : Sawdust (1:2)

$\mathbf{T_{11}}$	Vermicompost: Sawdust(1:3)
$\mathbf{T_{12}}$	Vermicompost : Sawdust (2:1)
$\mathbf{T_{13}}$	Vermicompost : Sawdust (3:1)
$\mathbf{T_{14}}$	Vermicompost : Coir pith: Sawdust (1:1:1)
$\mathbf{T_{15}}$	Control (Clay loam)

Hybrid variety of Tomato crop (CO3) were chosen for the study and their physiological parameters and growth characteristics were determined as follows.

Root length

Root length was measured from the collar region to the tip of the primary root and the average expressed in centimeters.

Shoot length

The length from the collar region to the tip of the shoot was measured as shoot length and the average was expressed in centimeters.

Germination percentage (GP)

The germination percentage was calculated based on formula

$$GP = \frac{No.of\ sprouted\ seed}{No.of\ total\ seeds} x\ 100 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Vigour index (VI)

$$VI = GP\ x\ (Root\ length, cm\ +\ Shoot\ length, cm) \dots\dots\dots\dots\dots (2)$$

Statistical analysis

Statistical analysis (AGRES) was carried out to study the effects of alternate growing systems in plant growth parameters. Least significant differences test (LSD) was used to compare the significant differences among mean of the treatments at 0.05 level of probability.

Cost analysis

Cost analysis was made to find the suitable media based on cost aspects comparing reduction in vigour index and cost of media with that of best media.

Results and Discussion

The study was thus aimed to identify a suitable growing media for plant growth. The main aim of this work is to investigate the physical and chemical properties of growing medium. Therefore an attempt has been made in present study to find out suitable growing media for plants.

Selection of suitable growing media based on physio-chemical properties, temperature relative humidity, shoot length, root length, germination percent, and vigour index

bulk density and particle density

Bulk density of medium is one of the indices for the evaluation of physical conditions of the growing media. Optimum bulk density for better plant growth ranges between 0.25 to

0.58 g cm^{-3} and it is high as 1.3 g cm^{-3} (Conover, 1967). In this study the combination of Vermicompost : Coir pith (T_8 - 3:1) was observed with bulk density of 0.55 g cm^{-3} was in the recommended range. The highest value of bulk density was observed for loamy soil (1.3 g cm^{-3}) and lowest bulk density was noticed in coir pith (0.28 g cm^{-3}) as individual media but in combination, T_9 - Vermicompost : Sawdust (1:1) recorded the lowest value (0.35 g cm^{-3}).

Porosity characteristics

The porosity characteristics of a media are measured in terms of Total Porosity (TP), Air Filled Porosity (AFP) and Water Holding Capacity (WHC). The highest porosity (88%) was obtained for coir pith followed by Vermicompost: Coir pith (3:1) (78%). Loamy soil had low porosity 40 percent. But all combination media almost showed optimal total porosity (65 – 80 %), air filled porosity (20 - 30%) and water holding capacity (45- 55%). These results are in conformity with the results reported by (Di Lorenzo *et al.*, 2013). (Raviv and Lieth 2008) reported that most media and mixes have an air filled porosity of (10-30 %). The results obtained in this experiment are similar and all media combinations employed as treatments have shown ideal porosity characteristics.

pH variation during crop growth period

The values were all in slightly acidic or neutral range**.** Except for control none of the media showed pH in the alkaline ranges. The highest pH was observed in treatments, T_3- Vermicompost (7.32) and in control (7.57) but in the case of media combination highest pH was observed in T_{13} - Vermicompost: Sawdust (3:1) (7.05), the lowest value of pH was observed in the case of media T_1 - coir pith (6.1). pH is an important factor in the availability and the uptake of nutrients and satisfactory pH of the medium ranged between 5.5 and 6.5 as reported by (Waters *et al.*, 1970).

Variation of media EC value during crop growth period

The EC value of the different media varied between 0.13 to 0.45 dS m^{-1} during the growing period. The maximum EC value of 0.45 dS m^{-1} was recorded for T_3 (Vermicompost) and the lowest value for T_2- Sawdust (0.13 dS m^{-1}). According to the results of the study, there was no salinity problem in the substrates (Bunt 1988). Substrate should have low salinity because roots develop directly in them. The EC values were below the established limit (0.5 dS m^{-1}) for an ideal substrate (Abad *et al.,* 2001). The low pH and EC values might have been ideal for crop growth whereas the high values recorded for these parameters might have led to reduced plant growth as already reported by (Francesco *et al.*, 2005).

Variation of temperature and relative humidity during the growth period

The maximum minimum temperature and relative humidity 38.5°C, 26.0°C and 79 %, 26 % respectively was recorded during the crop growing period (9/03/19 to 8/04/19). For most of the days, the temperature exceeded 35°C during the recorded time. The average 24 hr

temperature is believed to be responsible for the growth rate of the crop the higher the average air temperature, the faster the growth. Higher humidity was observed during morning hours and gradually decreased in the afternoon because of increase in temperature. Growth is positively correlated to relative humidity and normal plant growth occurs at relative humidity of 25 - 80 percent. The humidity values except for morning hours were less in this experiment as the temperature was high especially towards the later part of growing season.

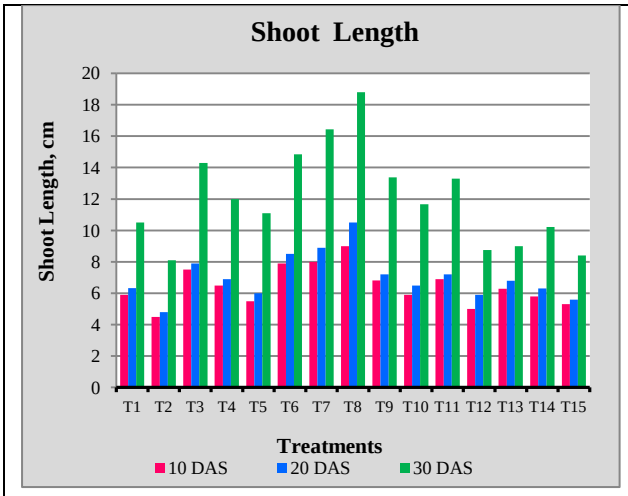

Fig. 1 Effect of different growing media on shoot length (cm)

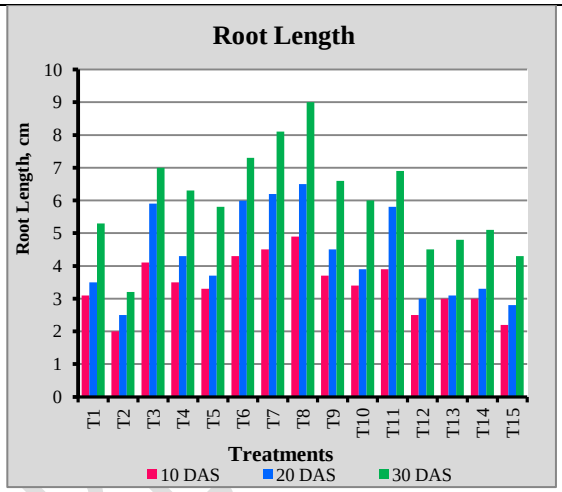

Fig. 2 Effect of different growing media on Root length (cm)

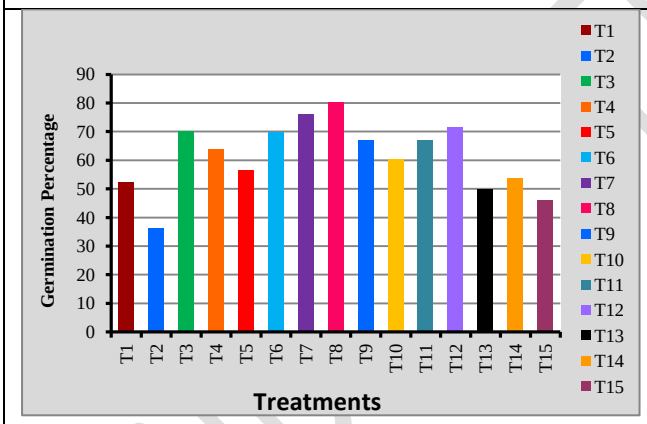

Fig. 3 Effect of different growing media on germination percentage

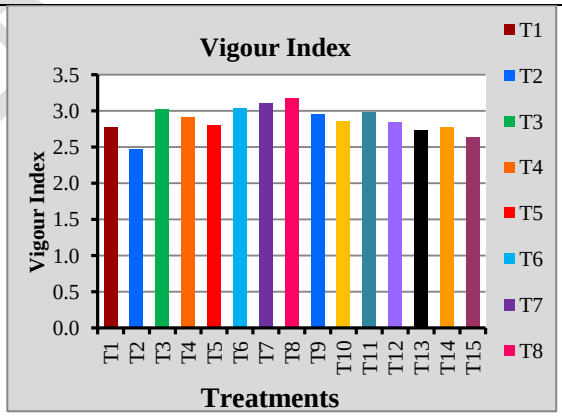

Fig.4 Effect of different growing media on vigour index

Plate 1 Better treatment

Plate 2 Poor treatment

Effect of different growing media on plant growth parameters

Significant differences were observed in the mean shoot length, root length, germination percentage and vigour index between treatments. Treatment T_8 (Vermicompost: Coir pith- 3:1) and treatment T_2 (Sawdust) recorded the highest and lowest root length, shoot length, germination percentage and vigour index as 18 cm, 9.0cm, 80.11%, 3.18 and 8.1cm, 3.2cm, 36.13%, 2.47 respectively, 30 days after sowing. The variations are graphically illustrated in Fig (1 to 4).

The significant increase in plant growth in treatment T_8 (Vermicompost: Coirpith - 3:1) may be because of the good physical properties of vermicompost and due to high organic matter, macro and micronutrient content present in it. The better and poor treatments were shown in plate 1 and 2. Similar results were obtained by (Umamaheswari, 2005) who reported that the vermicompost is the granular aggregate, the stability of which is due to the mucopolysaccharides of microbes and earthworms and it is rich in plant nutrient.

Cost analysis of growing media

The plant growth was high in treatments in which coirpith as combination media, because coipith had good physical properties such as high water holding capacity, good aeration and excellent thermal properties and it enhanced root and shoot development throughout crop period. The treatment T_2 (Sawdust) and treatments in combination with sawdust showed poor performance compared to other media. Based on all treatments conducted T_8 displayed more positive influence on plant growth but was costly based on economic aspects. As compared to T_8, treatments T_7 (Vermicompost: Coir pith (2:1)) and T_6 (Vermicompost: Coir pith (1:3)) shows the lowest reduction in vigour index and highest reduction in cost (2.3 %), (4.3 %) and (8.5%), (45.3%) respectively. Based on the above analysis regarding performance of different media in, T_6 (Vermicompost: Coir pith (1:3)) and T_7 (Vermicompost: Coir pith (2:1)) may be suggested as suitable and economically viable media.

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