Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(3): 2283-2286
Received: 17-03-2019
Accepted: 19-04-2019

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Study on physical characterization of coco peat with different proportions of organic amendments for soilless cultivation

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Abstract
Investigation on "study on physical characterization of coco peat with different organic amendments for soilless cultivation*"* was carried out at Botanical garden, Department of Floriculture and Landscaping, Tamil Nadu Agricultural University, Coimbatore. Data on selected physical properties such as bulk density, particle density, porosity, water holding capacity, moisture content and evaporation rate of six different media comprising of (w/w) coco peat alone (T_1), Coco peat + Vermi compost (5:1) (T_2), Coco peat + Bio compost (5:1) (T_3), Coco peat + Press mud (5:1) (T_4), Coco peat + Vermi compost + Bio compost (5:1:1) (T_5), Coco peat + Vermi compost + Press mud (5:1:1) (T_6) were determined and their suitability as growing media was tested. The results showed that the maximum bulk density (0.14 g/cc) and particle density (0.32 g/cc) was found in Coco peat + Vermi compost + Bio compost (5:1:1) (T_5) and minimum bulk density (0.09 g/cc) and particle density (0.23 g/cc) was found in coco peat alone (T_1). The maximum porosity (61.57 %), water holding capacity (66.37 %) and moisture content (37.74 %) was observed in coco peat alone (T_1) and minimum porosity (54.90 %), water holding capacity (57.35%) and moisture content (32.80%) was observed in Coco peat + Vermi compost + Bio compost (5:1:1) (T_5). The data on evaporation rate of different media showed that the maximum water loss (95.78 %) was observed in coco peat alone (T_1) at the end of fifth day and minimum water loss (75.21 %) was registered in Coco peat + Vermi compost + Press mud (5:1:1) (T_6). Hence the findings proved the efficiency of different media for soilless cultivation to support plants in turn of its physical characteristics.

Keywords: Soilless cultivation, physical characterization, coco peat

Introduction
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 cultivation system utilizing all the resources efficiently for maximizing yield of crops and the most intense form of agricultural enterprises for commercial production of greenhouse plants (Dorais *et al.*, 2001 and Grillas *et al.*, 2001) [3, 6]. A by-product of processing coconut husks is known as coir dust, coco peat, coir pith or simply coir. Coir is a versatile natural fibre extracted from meso carp tissue, or husk of the coconut. The husk contains 20 % to 30 % fibre of varying length and holds 8-9 times its weight in water. It can be reused for up to 4 years (Preethi *et al.*, 2018) [10]. A growing medium, such as peat, that naturally possesses a similar pH range, will provide a relatively optimal availability of nutrients with minimal intervention from the manufacturer. In contrast, composted materials, may contain high levels of soluble salts which are complicated and expensive to remedy (Rainbow and Wilson, 1998) [11].
Vermi compost is the end product of the breakdown of organic matter by the earthworm. It is an odourless, clean, organic material containing adequate quantities of N, P, K and several micronutrients essential for plant growth (Preethi *et al.*, 2018) [10].
Organic waste, such as press mud or filter cake, is generated as a by-product of sugarcane industries and characterized as a soft, spongy, amorphous, and dark brown to brownish material (Ghulam *et al.* 2012) [4]. It is generated during the purification of sugar by carbonation or sulphitation process. Both the processes separated clear juice on top and mud at the bottom. It is rich in essential plant nutrients which can be an alternate source of inorganic fertilizer. In general, when 100 tonnes of sugarcane is crushed, about 3 tonnes of press mud are produced as a by-product (Gupta *et al.* 2011) [5]. The raw spent wash generated after fermentation and distillation process is acidic in nature, having dark brown color with unpleasant odour, high COD and BOD (1,00,000 and 45,000mg l^{-1}). Treated spent wash, press mud, and other agro-based industrial bio-resources can be bio-composted into nutrient rich organic products, which can serve as a good nutrient amendment for soilless cultivation (Kulkarni *et al.*, 1987) [7].

Hence, the present study is done with the objective of assessment of physical characteristics of coco peat in different proportions and combinations such as vermi compost, press mud and bio compost suitable for soilless production system.

Materials and methods

The study on physical characterization of coco peat with different organic amendments for soilless cultivation was carried out at Department of Floriculture and Landscaping, Tamil Nadu Agricultural University, Coimbatore.

Composting

The mixtures of coco peat and organic wastes were composted in piles (1.5m high, 3m width and 80m long). The piles were turned periodically to maintain adequate O_2 levels. The piles were turned weekly during the maturation phase in order to improve the O_2 level inside the pile. Pile moisture was controlled by adding enough water to keep the moisture content not less than 50 per cent. Samples were taken at the end of the composting process to determine the chemical and physical properties. Each sample was made by mixing five sub samples taken from five points in the pile. Samples were placed in polyethylene bags and subjected to the laboratory analysis.

Table 1: Physical properties of growing media

Media components	Bulk Density (g/cc)	Particle Density (g/cc)	Porosity (%)	Moisture Content (%)	Water holding Capacity (%)
Coco peat	0.09	0.23	60.91	37.36	65.49
Vermi compost	0.52	1.05	50.78	34.05	44.53
Press mud	0.70	1.37	48.77	31.06	39.01
Bio compost	0.75	1.42	46.79	30.38	31.29

Data on physical properties such as bulk density, particle density, porosity, water holding capacity, moisture content and evaporation rate of six different media comprising of (w/w) coco peat alone (T_1), Coco peat + Vermi compost (5:1) (T_2), Coco peat + Bio compost (5:1) (T_3), Coco peat + Press mud (5:1) (T_4), Coco peat + Vermi compost + Bio compost (5:1:1) (T_5), Coco peat + Vermi compost + Press mud (5:1:1) (T_6) were determined and their suitability as growing media was tested.

Bulk Density (BD)

The bulk density was determined using measuring cylinder. An empty 250 ml measuring cylinder was filled with oven dried sample and then the sample weight was taken. The bulk density was calculated using the following formula.

Bulk Density (g/cc) = (weight of the sample)/(volume of the sample)

Particle Density (PD)

The particle density was determined using measuring cylinder. The measuring cylinder was weighed initially and filled with oven dried sample up to a known volume and again the weight was taken. Then the sample was slowly saturated using distilled water along the inner walls of the measuring cylinder till its saturation point. The increase in volume was noted. Hence the particle density was calculated using the following formula.

Particle Density (g/cc) = Weight of the sample / (V_1 – Pore space volume)

V_1- Volume of soil taken,

V_2 - Volume of water added,

V_3 -Volume of soil + water at the end of the experiment

(V_1+V_2) – V_3 ml = pore space volume

Porosity (%)

Porosity is the percent volume of a substrate or component that is comprised of pores or holes. This is the volume fraction which provides the water and aeration in a substrate. The total porosity and the percent solids = 100 per cent. The porosity was determined using the following formula as suggested by Murumkar *et al.* (2013) [8].

$$\text{Porosity (\%)} = [1 - \frac{BD}{PD}] \times 100$$

Water holding capacity (%)

The water holding capacity was determined using Kneer-Rackzowski box method as suggested by Viji *et al.* (2012) [14].

Moisture content (%)

The moisture content was determined by drying a known weight of the soil sample in an electric oven at 105 ^{0}C for about 15 minutes. The moisture bottle and the stopper is removed and placed in a desiccator. Then its weight was recorded. The moisture bottle was filled to about 2/3 of its capacity with soil and the stopper was placed over it. The weight of the moisture bottle with soil was recorded and it was placed in the oven at 105^{0}C for 24hours. Then it was cooled in the dessicator and weighed. The process was repeated till the constant weight of the oven dry soil is obtained. The moisture content was calculated by the loss (Viji *et al.*, 2012) [14].

Evaporation rate (%)

The oven dry weight of all the media was taken. Then the media were fully saturated with water and weighed again and then left under observation for five days. The loss in weight calculated up to fifth day and expressed in percentage (%).

Statistical Analysis

The experiment was conducted in Completely Randomised Design (CRD). The data obtained were compared according to the method described by.

Results and Discussion

The results of the bulk density, particle density and porosity of different Medias are presented in Table.1. The maximum bulk density (0.14g/cc) and particle density (0.32g/cc) was recorded in Coco peat + Vermi compost + Bio compost (5:1:1) (T_5) combination while the minimum bulk density (0.09g/cc) and particle density (0.23g/cc) was recorded in coco peat alone (T_1). The maximum porosity (61.57%), water holding capacity (66.37%) and moisture content (37.74%) was registered in coco peat alone (T_1) while the minimum porosity (54.90%), water holding capacity (57.35%) and moisture content (32.80%) was registered in Coco peat + Vermi compost + Bio compost (5:1:1) (T_5).

Table 2: Bulk density, particle density and porosity of different soilless media

Treatments	Bulk Density (g/cc)	Particle Density (g/cc)	Porosity (%)
T_1	0.09	0.23	61.57
T_2	0.10	0.25	58.78
T_3	0.12	0.29	55.43
T_4	0.11	0.28	56.98
T_5	0.14	0.32	54.90
T_6	0.13	0.31	56.37
Mean	0.11	0.28	57.34
S. Ed	0.01	0.01	2.70
C.D (p=0.05)	0.02	0.03	5.40

The water holding capacity and moisture content of different media are presented in Table.2. The maximum water holding capacity (66.37%) and moisture content (37.74%) was recorded in coco peat alone (T_1) while minimum water holding capacity (58.71%) and moisture content (33.33%) was recorded in Coco peat + Vermi compost + Bio compost (5:1:1) (T_5). Nagaraj *et al.* (2018) [9] reported that water holding capacity was more in rice husk generally more water and less aeration considering the potential shortage of poor oxygen required for aerobic composting and also there is a problem of fungus. Hence, high water holding capacity can be brought down to optimum level by organic amendments.

Table 3: Water holding capacity and moisture content of different soilless media

Treatments	Moisture Content (%)	Water Holding Capacity (%)
T_1	37.74	66.37
T_2	35.87	63.25
T_3	33.87	59.69
T_4	34.59	60.80
T_5	32.80	57.35
T_6	33.33	58.71
Mean	34.70	61.03
S. Ed	1.63	2.86
C.D (p=0.05)	3.26	5.73

Table 4: Evaporation rate of different soilless media

Treatments	Evaporation rate (%)				
	1st day	2nd day	3rd day	4th day	5th day
T_1	11.73	27.98	44.87	67.94	95.78
T_2	8.45	24.13	40.78	60.34	85.27
T_3	10.63	26.89	43.67	65.45	93.43
T_4	9.57	25.67	42.87	62.56	89.79
T_5	7.34	22.49	38.56	56.21	80.36
T_6	5.45	19.45	35.56	52.23	75.21
Mean	8.86	24.43	41.05	60.79	86.64
S. Ed	0.42	1.16	1.95	2.88	4.10
C.D (p=0.05)	0.85	2.32	3.90	5.76	8.21

From the Table 3. It was observed that the maximum water loss (95.78%) was registered in coco peat alone (T_1) at the end of fifth day and minimum loss (75.21%) was registered in Coco peat + Vermi compost + Press mud (5:1:1) (T_6). The graphical representation of water loss (%) of different media were shown in (Fig.1.).

This was in accordance with the report by water loss by evaporation was higher in the CP mix and lower in the VC 2:1 by the 14th day of observation. All other treatments had the same rate of evaporation, which was between those for the CP mix and the VC 2:1 mixture. Vermi compost is hydrophilic and provides good structural properties when added to other substrates (Arancon *et al.,* 2004; Vijaya *et al.,* 2008) [2, 13].These properties reduced water loss by evaporation, and medium with the highest vermi compost content had the lowest evaporation rate compared to the other treatments (Abbey *et al*., 2012) [1].

Conclusion

In the present study, all the media shown more or less good physical characteristics required for plant growth. Hence, organic amendments were found to provide good structural support to the soilless coco peat media.

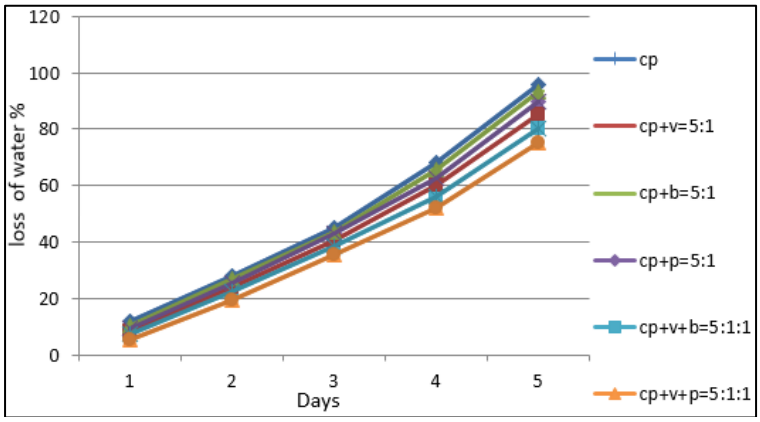

Fig 1: Water loss (%) of different soilless media

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