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Study on Particle Size Distribution in Different Coir Fiber Pith Media and Their Effect on Growth and Development of Bell Pepper

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ABSTRACT

Particle size distribution is an important factor determining performance of coir fiber pith media. Two experiments were carried out at Madampalla coir processing mill, Jiffy products S.L (Pvt.) Ltd. and Wayamba University of Sri Lanka Makandura. First experiment studied the effect of coir fiber extraction method on the particle size distribution in coir fiber pith media. Dry milling method and four retting periods of wet milling methods were studied as five treatments of the experiment. Results revealed that there is a significant difference among dry milling method and wet milling coir dust extraction methods for particle size distribution. Dry milling extracted method showed the highest particle size percentage for highest particle size range and lowest percentage for lowest particle size range compared to the wet milling methods. However, increase of retting period had resulted in increase of small particle size percentage.

The second experiment was to investigate effect of different coir dust media on the performance of bell pepper. Variety "Orabelle" was grown with five treatments. The grow bags produced using coir dust with three month, two weeks, three weeks and four week retting perieds were considered as T1, T2, T3 and T4 respectively. T5 was normal potting media used by farmers was T5. The experiment was arranged in a CRD with five replicates. Experiment proved that retting period had an effect on plant growth. Three week retted coir dust media showed the highest plant performances. Hence, it is superior than other retting periods to produce grow bags.

KEYWORDS: *Bell Pepper, Coir Dust, Extraction Techniques, Grow Bags.*

INTRODUCTION

Coir fiber production industry produces large quantities of coir dust and few other waste materials. By weight, coir fiber account for about one- third of the coconut pulp. The other two-third, coir pith (also known as coir dust), has generally been considered as useless waste material. Therefore, Millions of tons sit in huge piles in India and Sri Lanka, during the last half of the 1980s (Anon, 2010b).

Coir waste has some agricultural value. It is a useful soil mulch and absorbs as much as eight times of water (Nargarajan et al., 1987). The particular structure of coconut fiber and their physical and chemical properties make them suitable for container plant growth media purpose (Batra, 1985). Therefore, physical properties of coir dust are very important to consider because it gives excellent properties for plant propagation as media and it gives many unique characteristics including the ability to be compressed in packaging with keeping the original structure of the material for a useful extent. Physical properties of coir dust involve particle size distribution, expansion power, volume weight, moisture content, fiber content, testability, capillarity air filled porosity, physical stability and sand content. Chemical properties involve electrical conductivity and pH value (Ariyawansa, 2006).

However, chemical, physical and biological properties of coir dust are varied from source to source (Evans 1996). It is due to difference in the raw coconut fruit, fruit age, method of coir extraction, retting period and age of the coir dust heap. The retting period of the coir dust is the main factor that can be altered the physical, chemical and biological characters of the material.

Different coir dust products are used as soil less medium for agricultural and horticultural purpose. Jiffy Grow bag is the one of growing media that made of 100 % coco substrate. The Grow bag is used in a broad range of crops. The product is delivered as a dry plate enclosed in plastic foil with a black inside and a white outside layer.

It is made out of compressed coir dust and it expands when water is applied. Fast rooting, trouble free irrigation, better drainage properties better air porosity, fast and healthy growth biodegradable and renewable source are some expected advantage in grow bags (Anon, 2010a).

Many of green house farmers in Sri Lanka use coir dust and sand mixture as growing media. It may be a one reason for low yield of green house crops (bell pepper, tomato),

compared to other countries. Bell pepper yield in Sri Lanka is about 1-4 kg/m^2 (Weerakkody, 2003).

Therefore, the objective of this study was to evaluate effect of coir fiber extraction methods on particle size distribution in coir fiber pith media and performance of bell pepper plant on extracted coir dust media and potting media used by farmers under rain shelter.

MATERIALS AND METHODS

Experimental Site

The study was carried out at the Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila and Madampalla coir dust processing mill (NWP) in low country intermediate zone from March to July 2010, to study the effect of coir dust extraction method on quality of Jiffy grow bags as medium for bell pepper plant cultivation. Brown coconut husks were kept in the retting pit and on the ground to produce coir dust according to experiment.

The decorticator machine was used to extract coir dust from above husks and extracted material were collected, sieved and put in to soaking tank separately. Then, Calcium Nitrate was added to reduce chloride ion content and the tank was filled with water and kept for 20 minutes to allow chemical reaction. The treated materials were soaked twice in water for 15 minutes to reduce EC (salinity) and to remove excess Calcium nitrate. The washed materials were sun dried to reduce moisture content up to the standards of Jiffy products S.L (pvt.) Ltd. and were sieved to remove remaining fiber. The received coir dust was used to conduct two experiments

Experiment-1

Study on The Particle Size Distribution in Coir Pith

T1- Normal coir dust (Produced by using coconut husks with three months of retting period in the pith)-control

T2- Coir dust with two weeks retting period of the husks.

T3- Coir dust with three week retting period of the husks.

T4- Coir dust with four week retting period of the husks

T5- Coir dust without retting of husks

Crop establishment and management:

Bell pepper seedlings of variety "Orabelle" were raised in Jiffy 7C pellets according to the recommendations of the Jiffy products S.L (Pvt.) Ltd. Four different grow bag types were made by using coir dust produced with four different retting periods and normal potting media used by farmers were used to establish the bell pepper plants. According to that T1, T2, T3 and T4 treatments of the experiment that were similar to experiment-1 and T5 was normal potting media used by farmers. The total area of experimental plots was 20 m^2 and the experiment was laid out in a Completely Randomized Design with five replicates.

Healthy vigorous 33 days old seedlings were transplanted to grow bags. Each plot was consisted eight plants and planting space was 25 cm×35 cm and Fertilizer application was done according to recommendation.

Table 1. Fertilizer application

Vegetative period weeks after planting	Albert fertilizer per plant per day (g)
2-3 (WAP)	0.2
4-5 (WAP)	0.4
Flowering stage	0.6
Development of fruit	0.8
Ripening stage of fruits	0.6

WAP- Week after planting
Source- 1 CIC, Colombo
2 Unipower Colombo
3Senaviratna A.P. (2000)

The crop was irrigated in two days intervals and Admire was applied to control vectors of leaf curl complex.

Data Recording

Following parameters were recorded during the experiment:

Plant height (cm)
Plant girth (mm)
Leaf area (cm^2)
Shoot dry weight (g)
Root dry weight (g)
Days to first flowering

Shoot and Root dry weights were obtained after placing plant part in an oven at $80C^0$ for 48 hours.

Statistical Analysis

The parametric data of above were subjected to General Linear Model and analyzed using Minitab package.

RESULTS AND DISCUSSION

Table 2. Particle size distribution of coir pith media

Treatment	pH	EC (Micro simons)	Particle size distribution range				
			>1.5mm	1.5-1 mm	1-0.5 mm	0.5-0.2 mm	<0.2 mm
T1	5.59	30	6.27%	18.78%	27%	30.73%	17.73%
T2	5.29	10	13.19%	12.75%	38.81%	28.74%	6.4%
T3	5.34	310	9.07%	10.92%	32.32%	36.49%	11.15%
T4	5.41	18	12.27%	14.39%	37.97%	27%	8.37%
T5	6.37	32	48.63%	21.59%	23.88%	5.7%	0.1%

Particle Size Distribution in Coir Pith Media

According to the results, T5 showed the highest particle size percentage (48.63 %) for higher than 1.5 mm range (Table 1) and T1 showed the lowest particle size percentage (6.27 %) for the same range. Between 1.5-1 mm range, T5 showed the highest particle size percentage (21.59 %) and T3 showed the lowest particle size percentage (10.92 %).

Between 1-0.5 mm range, T2 showed highest particle size percentage (38.81%) and T5 showed lowest particle size percentage (23.88 %). Between 0.5-0.2 mm range, T3 showed the highest particle size percentage (36.49 %) and T5 showed the lowest particle size percentage (5.7 %). The highest particle the size percentage (17.73 %) was recorded in T1 and the lowest particle size percentage (0.10%) was recorded in T5 for less than 0.2mm range. The dry milling method showed lowest small particle size percentage compared to wet milling methods. The small particle size percentage had increased with retting period. Decomposition of bonding tissues between fibers and biochemical changes occurred during retting period may result in the breaking of smaller particles.

Effect of Particle Size Distribution on Growth and Development of Bell Pepper

Plant Height

Significant differences were observed among the treatments for plant height and it ranged from 24.425 cm to 21.35 cm (Table 3). The T3 showed the highest plant height (24.425 cm) while the T5 showed the lowest plant height (21.35 cm). T3 and T4 were significantly different from the control (T1) and there was no significant difference between T2, T5 and control. According to the results retting period has affected for plant height. Plants cultivated in T3 and T2 showed highest plant height (24.425 cm and 22.725 cm)

Plant Girth

Treatments were significantly different for stem girth and it ranged from 7.0385 mm to 5.665 mm (Table 3). The T3 showed the highest stem girth (7.0385 mm) while T4 showed the lowest stem girth (5.665 mm). T3, T4 and T5 were significantly different from control (T1) and there was no significant difference between T2 and control.

Table 3. Effect of media on plant girth and plant height

Treatment	Mean value	
	Plant height (cm)	Plant girth (mm)
T1-control	21.950a	6.2755a
T2	22.725a	6.1320a
T3	24.425b	7.0385b
T4	20.625c	5.6650c
T5	21.350ac	5.8465c

Means in a column followed by the same letters are not significantly different at p<0.05 level

Dry Weight of Root System

There were significant differences among treatments for root dry weight and it ranged from 0.927 g to 0.579 g (Table 4). The T3 showed the highest root dry weight (0.927 g) while T4 showed the lowest root dry weight (0.579 g). Significant difference recorded between T3, T4, T5 and the control (T1), while there was no significant difference between T2 and control.

Shoot Dry Weight

Shoot dry weights were significantly different among treatments and it ranged from 3.9767 g to 1.448 g (Table 4). The highest shoot dry weight was recorded in T3 (3.9769 g) and lowest was recorded in T4 (1.448 g). T3 and T4 were significantly different from the control (T1) and there was no significant difference between T2, T5 and control.

Table 4. Effect of media on shoot dry weight and root dry weight

Treatment	Mean value	
	Shoot dry Weight (g)	Root dry Weight (g)
T1	2.4050a	0.789a
T2	2.4140a	0.762a
T3	3.9769b	0.927b
T4	1.4480c	0.579c
T5	1.7710ac	0.602c

Mean in a column followed by the same letters are not significantly different at p<0.05 level

Leaf Area

There were significant differences among treatments for leaf area and it ranged from 475.8 cm^2 to 217.20 cm^2 (Table 5). The highest leaf

area was recorded in T3 (475.8 cm2) and lowest was recorded in T4 (217.20 cm^2). A significant difference was observed in T3, T4 and T5 from control (T1) and there was no significant difference between T2 and control.

Days to Fist Flowering

There was no significant differences among treatments for first flowering and it ranged from 54 days to 57 days. The lowest days were recorded in the T3 (54 days) and highest days were recorded in T1 (57 days). T2 and T3 were significantly different from control (T1) and there was no significant difference between T4, T5 and control (T1).

Table 5. Effect of media on leaf area and days to first flowering

Treatment	Mean value	
	Leaf area (cm^2)	Days to first flowering
T1	289.6a	57a
T2	307.8a	55b
T3	475.8b	54c
T4	217.2c	56a
T5	225.1c	56a

Mean in a column followed by the same letters are not significantly different at P<0.05 level

Results of the study on the effect of particle size distribution on growth and development of Bell pepper revealed that the significantly highest plant height, girth, dry weight of roots, shoot dry weight and leaf area were developed by plants in T3. Ball pepper plant in the same media reached the flowering stage earlier than the plants in other media. This may be attributed to the characteristics related with the particle size distribution in T3. The highest percentage of particle size in T3 was within the range of 0.5-0.2mm. Particle size of a coir fiber pith media can directly affect to the other characters, porosity, aeration, water holding capacity, expansion power, moisture content etc. Those characters are directly influencing the growth and development of crop plant by having effects on water and nutrient supply and absorption.

CONCLUSIONS

The result revealed that the duration of the retting period of coconut husks in the retting pit have a significant effect on the particle size distribution in the coir fiber pith media. Dry milling coir dust extraction method had recorded highest large particle size percentage and lowest small particle size percentage compared to wet milling extraction methods. The small particle size percentage had increased with the increase of retting period when compare the four different wet milling coir dust extraction methods. Therefore, increasing of retting period can affect the particle size of coir dust.

Further, according to the results and observations of the second experiment, it is clear that different coir dust media with different particle sizes had showed significant effect on plant height, root dry weight, shoot dry weight, stem girth and leaf area. Three week retted coir dust showed the better plant growth performances. Therefore, grow bags produced by the coir dust from three week retting period is superior to cultivate bell pepper plant than other grow bag types and farmer used potting media tested in the experiment.

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