Effect of Coir Fiber Pith and Its Extraction Method on Quality of Jiffy 7-C Pellets as a Medium for Vegetative Plant Propagation

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ABSTRACT

Coir dust, also known, as coco peat is a by-product of coconut industry and used as a substitute for peat like growing media in horticulture. There are different kinds of coir dust sources available but all of them do not have similar properties mainly due to the methods used in the extraction process of coir fiber such as Wet milling and Dry milling. Wet milling involves retting process while retting does not take place in dry milling. Jiffy 7-C Pellets made out of coir pith from green husks, old husks and retted husks were used as treatments and pellets from current production were used as the control of the experiment. Cane cuttings of *Polyscias filicifolius* and top cuttings of *Dracaena godseffiana* were used as planting materials. Expanded height (mm) of the pellets, root dry weight (g), shoot dry weight (g), shoot length (mm) and survival percentage of the plants were recorded. Retted dust based pellets and old dust based pellets indicated less reduction in expandable height with time. Though variation in growth performances of plants were observed among treatments, the retted coir dust exhibited a better growth performance for both plants, especially during the last two weeks of the experiment.

KEYWORDS: Jiffy 7-C Pellets, Expandable Height, Coir Dust, Retting, Wet Milling, Dry Milling.

INTRODUCTION

Coir dust is a spongy, peat like residue obtained after processing of coconut husks (Mesocarps) for coir fiber. It is also known as coco peat, and consists of short fibers (<2cm) around 2-13% of the total and cork like particles ranging in size from granules to fine dust (Creswell, 1992).There are different kinds of coir dust sources available for horticultural amendments, but all sources of coir dust do not have similar properties (Santha and Santha, 1999). It mainly depends on the methods used for the extraction of coir fiber in coir fiber industry.

Broadly, there are two types of coir extraction methods. They are Wet milling and Dry milling. In wet milling, starting material is matured/brown husk and it involves in a retting process. Retting is the separation of the fiber bundles by effecting a partial digestion of the cementing tissue components usually through the action of microorganisms (Banson and Velasco, 1982). Then, the retted husks are beaten in a Defibering machine and Ceylon drum, or with wooden mallets as in the traditional case. The types of fiber extracted through this process are bristle and mattress fiber. In dry milling, starting material is green husk and retting process is not involved. Decorticator machine is used for fiber extraction and only one type of fiber can be obtained. This is much similar to mattress fiber in appearance.

In the process of extraction of Coir fiber from husk, generally about 1/3rd of it is obtained as fiber and 2/3rd obtained as Coir pith. Coir pith with a range of interesting properties finds various applications. Coir pith has a high lignin (31 %) and cellulose (27 %) content and carbon-nitrogen ratio of 104:1(Shekar, 1999). Water holding capacity of coir pith varies 5 to 6 times of its weight. At present the demand for coir dust is rising. Now it is considered as a multipurpose soil conditioner and growing medium used along with organic supplements in crop fields in horticulture. It is also used as a rooting and growing medium for most of the horticultural plants (Sudhira and Jacob, 2000).

Due to range of interesting properties of coir dust as plant propagation medium, there are many coir dust based products available in the market. They are available in various forms and shapes as compressed products. Jiffy 7-C pellet is a compressed product of coir pith, which is the new product range of the jiffy company as alternate to the peat like growing media. It is round in shape and enclosed in a minimal netting film of non-woven material, serving as an envelope for the substrate. The net is made to allow optimal root development of the plant by allowing roots to penetrate and expand freely, while at the same time providing adequate strength for the root ball during handling, shipment and transplantation. When the product is dipped in water, it gets expanded nearly seven times more than original size.

The expanded pellet is used for propagation of plants from seeds, cuttings, or tissue culture. The substrate used in jiffy7-C is produced from carefully selected raw materials and the principle constituent of the substrate mix is coir pith from selected sources, undergoing chemical and structural optimization with addition of tailor made fertilizer mixture (Anon, 2005a).

When producing jiffy pellets the most important parameter is the expansion power and it determines the expansion ability of the pellet. Expansion power depends on the various sizes of coir pith particles in the sample, also known as particle size distribution. Mostly particle size distribution depends on the type of coconut husk and methods used to extract coir pith from the husk.

Quality parameters associated with Jiffy7-C raw materials such as pH, EC (Electron Conductivity), particle size distribution, volume weight and expansion power are subjected to change with the method of coir pith extraction and the type of the husk.

The main problems associated with the current production are high level of EC, Chloride ions of the raw materials and reduction of expandable height of the pellets with time.

Different coir pith materials show different expansion behaviors and different growth performance when used them as media for vegetative plant propagation. However, there is no sufficient research work carried out to study the effect of coir fiber pith and its extraction method on quality (especially on expandable ability) of Jiffy 7-C pellets and on plant growth performance when it is used as a media for vegetative plant propagation. The objective of this experiment is, therefore, to identify the best coir pith material having both optimum expandable height and plant growth in order to minimize the quality problems associated with current pellet production.

MATERIALS AND METHODS

An experiment was conducted at the Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (Low country intermediate zone) from February 2005 to July 2005, to study the effect of coir pith/coir dust extraction method on quality of Jiffy7-C pellets as a medium for vegetative plant propagation. Three different types of coconut husks were used to produce coir pith for this experiment. They were Green husks/Fresh husks, Brown husks/Matured husks and Retted husks.

The decorticator machine was used to extract coir pith from above husks and extracted materials were collected, sieved and put in to a 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 then soaked twice in water to reduce EC (salinity) and to remove excess Calcium nitrate. The washed materials were sun dried to reduce moisture content up to Jiffy standards and were sieved to reduce to a fine dust. Finally, the dried materials were used to produce three different types of pellets according to the Jiffy production technology.

Following treatments were used in the experiment

T1-: Coir pith from Green husks/Fresh husks
T2-: Coir pith from Brown husks/old husks (1 to 2 months old)
T3-: Coir pith from Retted husks (after 1 to 2 weeks of retting)
T4-: Pellets from current production (Control)

Properties of the treatments used in the experiment are given in the table 1.

Experiment 1: Variation in expansion of Jiffy 7-C pellets with time

The pellets (30mm in diameter) from 4 treatments were dipped in pure water until they reached full expansion and the height (mm) of the pellets was measured. Ten pellets from each treatment were dipped and average height (mm) was recorded. The expansion rate was measured at 1 month after production of pellets and continued up to 22 weeks at two-week intervals.

Experiment 2: Study on growth performance of Polyscias filicifolius and Dracaena godseffiana grown on Jiffy 7-C pellets

A Propagator was prepared on a 3m x 1m sand bed in a plant house with 65% shade level, using 300 gauge transparent polythene. Healthy *Polyscias filicifolius* cane cuttings (15cm in height) and *Dracaena godseffiana* top cuttings (25cm in height) were planted in water soaked Jiffy pellets (30mm diameter) containing four different coir pith materials as described before (one cutting per pellet), and were placed in plastic trays. The plastic trays were kept in the propagator and sealed.

The experiment was arranged in completely randomized design (CRD) with 3 replications and 4 treatments. Each treatment had 25 cuttings which replicated thrice and kept up to 14 weeks inside the propagator. Two weeks after planting root dry weight (g), shoot dry weight (g), shoot length (mm), and survival percentage were recorded. All the cultural practices were carried out according to the recommendations of Sunflower Lanka (Pvt)) Ltd. The data were analyzed using SAS statistical software (SAS, 1999).

RESULTS

1. Variation in expansion with time

During the first 12 weeks after production of pellets, no significant differences were observed among treatments for height (Table 2). After 14 weeks, treatments began to show differences and treatment 3 recorded the highest value (39mm) which was significantly different from T1, T2 and T4. Treatment 4(Control) recorded the lowest value and was significantly different from T3. After 16 weeks, the treatment 3 also recorded the highest value (39mm) and was significantly different from T1 and T4. The lowest value (29mm) was also recorded by the treatment 4 and it was significantly different from T1, T2 and T3.

Table 1.The properties of the treatments used in the experiment.

Treatment	pH	EC (Micro Simons /cm)	Chloride ion content (ppm)	Moisture content (%)	Expansion power (g)	Particle size distribution (%)			
						> 1.5mm	1.5-1mm	1-0.5mm	<0.5mm
T1	6.03	1028	30-60	16.79	830	45.6	22.8	30.2	1.4
T2	6.05	1156	30-60	12.84	821	58.2	15.9	24.2	1.7
T3	5.9	900	30-60	13.08	1105	44.3	23.4	30.8	1.5
T4	5.8	1188	30-60	14.59	1188	46.5	26.5	25.5	1.5

The pellets of treatment 3, after keeping for 18 and 20 weeks recorded the highest value (38mm) and were significantly different from T1, T2 and T4. Treatment 4 recorded the lowest values (29mm and 26mm) and was significantly different from T1, T2 and T3. During the week 22, the treatment 3 recorded the highest value (37mm) and was significantly different from T1, and T4. Treatment 4 recorded the lowest value (26mm) and was significantly different from T1, T2 and T3.

Table 2. Expanded height of Jiffy 7C pellets recorded at different time periods after production

Treat-ment	Expanded Height(mm)									
	W4	W6	W8	W10	W12	W14	W16	W18	W20	W22
T1	44^{a}	41^{a}	38^{a}	38^{a}	37^{a}	37^{b}	35^{b}	35^{b}	35^{b}	31^{b}
T2	44^{a}	39^{a}	38^{a}	38^{a}	37^{a}	37^{b}	36^{ab}	35^{b}	35^{b}	35^{a}
T3	45^{a}	41^{a}	40^{a}	40^{a}	39^{a}	39^{a}	39^{a}	38^{a}	38^{a}	37^{a}
T4	44^{a}	39^{a}	38^{a}	38^{a}	37^{a}	35^{b}	29^{c}	29^{c}	26^{c}	26^{c}
LSD	1.7	3.4	3.5	2.7	2.3	3.6	3.1	1.9	1.7	2.8
CV	2.5	4.9	5.9	4.5	3.9	6.3	5.9	3.7	3.3	5.7

Treatment means in a column having common letters are not significantly different at least significant difference test (LSD) 5%, W=Weeks after production

According to the above results, it was evident that during the first 22 weeks the treatment 3 showed a better keeping time than other treatments as its reduction rate was minimal when compared to T1, T2 and T4. The treatment 4 (Control) showed a drastic reduction rate 12th week after the production. There were no significant reductions recorded up to first 12 weeks after production.

2. ***Study on growth performance of Polyscias filicifolius and Dracaena godseffiana grown in Jiffy pellets***

2a. *Polyscias filicifolius*

i. Root dry weight

After two weeks of planting significant differences were observed among treatments for root dry weight (Table 3).Treatment 4 (control) exhibited the highest root dry weight (0.0086g) which was significantly different from T1 and T2. Treatment 3 gave the second highest value (0.0077g) and was significantly different from T1 and T2. During week 4 T1 exhibited the highest value (0.0104g) and was significantly different from T2, which recorded the lowest value (0.0061g).

After week 6 and 8, treatment 1 recorded the highest values (0.0126g and 0.0182g, respectively.) and was significantly different from T2, T3 and T4 while the lowest values (0.007g and 0.0083g) were observed in treatment 2 and was significantly different from T1, T3 and T4. After 10 weeks, treatment 3 recorded the highest root dry weight (0.0258g) and was significantly different from T1, T2 and T4 while the lowest (0.0138g) was recorded in T2 which was significantly different from T1 and T3. These results clearly indicate that treatment 3 has enhanced root growth significantly in *Polyscias filicifolius* during the initial 10-week period over the other treatments.

Table 3. Root dry weight of *Polyscias filicifolius* recorded at 2, 4, 6, 8 and 10 weeks after planting

Treatment	Root dry weight(g)				
	W2	W4	W6	W8	W10
T1	0.0049^{b}	0.0104^{a}	0.0126^{a}	0.0182^{a}	0.0229^{b}
T2	0.0020^{c}	0.0061^{b}	0.0070^{c}	0.0083^{c}	0.0138^{c}
T3	0.0077^{a}	0.0098^{a}	0.0106^{b}	0.0158^{b}	0.0258^{a}
T4	0.0086^{a}	0.0090^{a}	0.0101^{b}	0.0118^{b}	0.0161^{c}
LSD	0.0011	0.002	0.0009	0.0011	0.0026
CV	10.1025	11.871	4.854	4.2014	6.9312

Treatment means in a column having common letters are not significantly different at least Significant difference test (LSD) 5%, W=Weeks after planting

ii. Shoot dry weight

After two weeks of planting significant differences were observed among treatments for shoot dry weight (Table4). Treatment 3 recorded the highest value (0.0384g) followed by T4 and T2 and no significant differences were observed. Treatment 1 recorded the lowest value (0.0155g) and was significantly different from T2, T3 and T4. After 4th week, treatment 4(Control) exhibited the highest value (0.1559g) and was significantly different from T1, T2 and T3. Treatment 3 recorded the lowest value (0.0739g) and was significantly different from T1, T2 and T4. No significant differences were observed between T1 and T2, which recorded the second and third highest shoot dry weights, respectively. During week 6, the highest value (0.1947g) was achieved by T1 and was significantly different from T2 and T3. Treatment 4 recorded the second highest value followed by T2 and T3 and no differences were observed. Treatment 3 recorded the lowest value (0.1255g) and was significantly different from T1.

After 8 weeks, treatment 2 recorded the highest shoot, dry weight (0.2646g) followed by T2, T3 and was significantly different from T4, which recorded the lowest value (0.1924g). However, at the 10th week no differences were observed among treatments for shoot dry weight. T1 recorded the highest value (0.3967g) followed by T4, T3 and T2.

Table 4. Shoot Dry Weight of *Polyscias filicifolius* recorded at 2, 4, 6, 8 and 10, weeks after planting

Treatment	Shoot dry weight(g)				
	W2	W4	W6	W8	W10
T1	0.0155^{b}	0.1249^{b}	0.1947^{a}	0.2484^{a}	0.3967^{a}
T2	0.0337^{a}	0.1157^{b}	0.1474^{b}	0.2646^{a}	0.3426^{a}
T3	0.0384^{a}	0.0739^{c}	0.1255^{b}	0.2220^{ab}	0.3466^{a}
T4	0.0370^{a}	0.1559^{a}	0.1574^{ab}	0.1924^{b}	0.3595^{a}
LSD	0. 0086	0.0093	0.0447	0.043	0.0605
CV	14.716	4.1988	15.209	9.8537	8.895

Treatment means in a column having common letters are not significantly different at least Significant difference test (LSD) 5%, W=Weeks after planting

iii. Shoot length

After Two weeks of planting significant differences were observed between treatment 4 (Control) and other treatments for shoot length (Table 5).Treatment 4 recorded the highest shoot length

(44.33mm) followed by T1, T2 and T3. After 4th Week, no significant differences were observed among treatments. However, treatment 4 recorded the highest value (96mm) while treatment 3 recorded the lowest value (78mm).

During week 6, treatment 2 recorded the highest value (133mm) followed by T3, T1 and T4 and was significantly different from T4 which recorded the lowest value (100mm). After 8 and 10 week no significant differences were observed among treatments for shoot length. During the 8th week, treatment 1 recorded the highest value (153mm) while the lowest value (126mm) was recorded by treatment 3. In the 10th week, treatment 3 recorded the highest value (183mm) while the treatment 1 recorded the lowest value (155mm).

Table 5. Shoot length of *Polyscias filicifolius* recorded at 2, 4, 6, 8 and 10, weeks after planting

Treatment	Shoot Length (mm)				
	W2	W4	W6	W8	W10
T1	26^{b}	93^{a}	112^{ab}	153^{a}	155^{a}
T2	27^{b}	79^{a}	133^{a}	138^{a}	160^{a}
T3	30^{b}	78^{a}	120^{ab}	126^{a}	183^{a}
T4	44^{a}	96^{a}	100^{b}	128^{a}	175^{a}
LSD	7.51	23.09	26.07	27.08	36.74
CV	12.50	14.15	11.89	10.54	11.58

Treatment means in a column having common letters are not significantly different at least Significant difference test (LSD) 5%, W=Weeks after planting

iv. Survival percentage

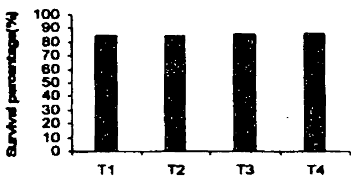

Figure 1. Survival Percentage of *Polyscias filicifolius* 10 weeks after planting.

According to the results no significant differences among treatments were observed in survival percentage ($P<0.05$)10 weeks after planting. All treatments exhibited over 80% survival rate and it is evident that all the treatments could be used successfully for the propagation of *Polyscias filicifolius* (Figure 1).

2b. *Dracaena godseffiana*

i. Root dry weight

After the 6th week of planting significant differences were observed among treatments for root dry weight (Table 6). Treatment 2 exhibited the highest root dry weight (0.025g) followed by T1, T3 and T4 and was significantly different from T1, T3 and T4. Treatment 4 (Control) gave the lowest value (0.0024g) and was significantly different from T1, T2 and T3.

During week 8, highest value (0.0629g) was recorded by treatment 4 (control) followed by T2, T3 and T1. All the treatments were significantly different from each other. After 10th week, highest value (0.0789g) was achieved by treatment 2 and was significantly different from T1 and T3. The lowest (0.0202g) was recoded by treatment 1 and was significantly different from T2, T3 and T4. After the 12th week, treatment 2 recorded the highest value (0.0789g) and was significantly different from T1 and T3. After the week 14, no significant differences were observed among T2, T3, and T4, but were significantly different from treatment 1, which recorded the lowest value (0.0465g).

Table 6. Root Dry Weight of *Dracaena godseffiana* recorded at 6, 8, 10, 12 and 14 Weeks after planting

Treatment	Root dry weight(g)				
	W6	W8	W10	W12	W14
T1	0.0107^{b}	0.0150^{d}	0.0202^{c}	0.0425^{b}	0.0465^{b}
T2	0.0250^{a}	0.0508^{b}	0.0719^{a}	0.0789^{a}	0.0805^{a}
T3	0.0099^{a}	0.0332^{c}	0.0380^{b}	0.0425^{b}	0.0809^{a}
T4	0.0024^{c}	0.0629^{a}	0.0663^{a}	0.0696^{a}	0.0859^{a}
LSD	0.0013	0.0114	0.0108	0.0166	0.0178
CV	5.9519	14.9915	11.6314	15.0036	12.8716

Treatment means in a column having common letters are not significantly different at least Significant difference test (LSD) 5%, W=Weeks after planting

ii. Shoot dry weight

After 8 weeks of planting significant differences were observed among treatments for shoot dry weight (Table7). Treatment 2 recorded the highest value (0.0059g) followed by T3, T4 and T1, which were significantly different from each other. Treatment 1 recorded the lowest value (0.0012g) and was significantly different from each other. After 10th week, treatment 2 recorded the highest value (0.0066g) and was significantly different from T3 and T4. The lowest (0.0046g) was recoded by T4 which was significantly different from T2. In week 12, highest value (0.0562g) was achieved by T3 and was significantly different from T1, T2 and T4 while the lowest (0.0089g) recorded by T2 and was significantly different from T3 and T4.

After the 14th week, treatment 3 recorded the highest value (0.0664g) and was significantly different from T1, T2 and T4. The lowest value (0.0089g) recorded by T2 and was significantly different from T1, T2 and T4. These results clearly indicate that treatment 3 has enhanced shoot growth significantly in *Dracaena godseffiana* during the initial 14-week period over the other treatments.

Table 7. Shoot Dry Weight *of Dracaena godseffiana* recorded at 8, 10, 12, and 14 Weeks after planting

Treatment	Shoot dry weight(g)			
	W8	W10	W12	W14
T1	0.0012^{d}	0.0056^{ab}	0.0161^{c}	0.0370^{b}
T2	0.0059^{a}	0.0066^{a}	0.0089^{c}	0.0089^{c}
T3	0.0041^{b}	0.0048^{b}	0.0562^{a}	0.0664^{a}
T4	0.0024^{c}	0.0046^{b}	0.0323^{b}	0.0423^{b}
LSD	0.0007	0.0012	0.0081	0.0095
CV	10.8866	12.2183	15.1066	13.0957

Treatment means in a column having common letters are not significantly different at least Significant difference test (LSD) 5%, W=Weeks after planting

iii. Shoot length

During the 10 weeks after planting no significant differences were observed among treatments for shoot length (Table 8). After 12th week, treatment 2 recorded the highest value (111.67mm) and was significantly different from T1, T3 and T4. Treatment 1 recorded the lowest value (59mm) and was significantly different from T1 and T2. After the14th week, treatment 3 recorded the highest value (136.67mm) and was significantly different from T1 and T4. Treatment 4 (control) recorded the lowest value (86.67mm) and was significantly different from T1, T2 and T3.

Table 8. Shoot Length of *Dracaena godseffiana* recorded at 8, 10, 12, 14, Weeks after planting

Treatment	Shoot Length (mm)			
	W8	W10	W12	W14
T1	10.00^{a}	12.33^{a}	59.00^{c}	100.00^{bc}
T2	10.67^{a}	12.33^{a}	111.67^{a}	118.33^{ab}
T3	11.33^{a}	12.66^{a}	83.33^{b}	136.67^{a}
T4	11.67^{a}	11.67^{a}	66.67^{bc}	86.67^{c}
LSD	2.10	3.69	20.80	19.97
CV	10.24	15.98	13.78	9.72

Treatment means in a column having common letters are not significantly different at least Significant difference test (LSD) 5%, W=Weeks after planting

iv. Survival percentage

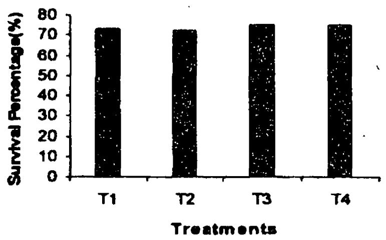

Figure 2. Survival Percentage of *Dracaena godseffiana* 14 weeks after planting.

According to the results no significant differences among treatments have been observed in survival percentage ($P<0.05$) at the end of 14 weeks. All treatments have shown over 70% survival rate and it is evident that all the treatments could be used successfully for the propagation of *Dracaena godseffiana* (Figure 2).

DISCUSSION

Variation in expansion with time

According to the results of this study, no significant differences were observed among treatments for expandable height up to 12 weeks after production. However, the expandable height gradually decreased with time within the range of 45-37mm, with retted pith showing the maximum expandable rate. Between 14-22 weeks, significant differences were observed among treatments. Coir pith from retted pith (T3) exhibited the highest value followed by coir pith from brown husk (T2), fresh husk (T1) and control (T4). Pellets from current production (T4) showed the lowest height out of all treatments, having a value below 30mm.

It was clear that the pellets made out of retted pith had an advantage in expandable ability over time when compared with other treatments. The expandable ability depends on the age of raw material, fiber and pith content and initial moisture content of the material (Anon, 2005b). This clearly indicates that physical properties of the raw materials used for making the pellets would have affected this character.

Growth performance of Polyscias filicifolius and Dracaena godseffiana

Polyscias filicifolius

When considering growth parameters recorded (root dry weight, shoot dry weight, shoot length) significant differences were observed among treatments from the 2nd week of planting. However, no significant differences were observed among treatments for survival percentage.

In the case of root dry weight, coir pith from brown husk showed the lowest value throughout the experiment period. At end of experiment, no significant differences were observed for shoot dry weight and shoot length but in the case of root dry weight, coir pith from retted husk recorded the highest value followed by coir pith from green husk, control and coir pith from brown husk. These results indicated that coir pith from retted husk showed equal performance for all growth indices with other treatments but recorded the best performance for root dry weight at the end of experimental period.

Dracaena godseffiana

When considering growth parameters recorded (root dry weight, shoot dry weight, shoot length) significant differences were observed among treatments after 8 weeks of planting. However, no significant differences were observed for survival percentage. According to the data gathered there were variations among treatments for growth parameters. However, at the end of the experiment coir pith from retted husk recorded the highest values for most of growth indices.

The chemical properties of coir pith can vary widely from source to source (Evans *et al.*, 1996). When first produced, coir pith contain high level of pH, Chloride ion and EC (Meerow, 1997).Therefore when producing jiffy 7-C pellets, the chemical properties of raw materials are standardized by adding tailor made fertilizers and other chemicals according to Jiffy standards. All treatments showed a slight variation in growth for both plants throughout the experimental period. It is evident that standardization of raw coir pith materials would have affected this character. However, coir pith from retted husk showed better performance at the end of the experimental period.

CONCLUSIONS

For both crops, retted pith proved to be a better treatment than the others. It was evident that shoot and root growth were superior in that medium. Vigorous root and shoot growth at initial growth stage would help plant to establish well and absorb more nutrients from the medium as well as increase photosynthetic rate from increased leaf area, respectively. Therefore, retted pith will be a better treatment than others for initial establishment of these crops. For variation in expansion, retted pith also recorded the highest expanded height followed by coir pith from brown husk. Further studies need to be carried out in long-term basis with other coir pith materials and crops as well.

ACKNOWLEDGEMENTS

The authors wish to thank Dr. B. Ranaweera, Head, Department of Horticulture and Landscape Gardening for his advice and encouragement. Mrs. N.R. Abenayake, Lecturer, and Mr.K.H.M.I. Karunarathna Computer Instructor at the Computer Services Unit for their assistance and guidance in statistical analysis. Sincere thanks are also due all the staff members of Jiffy product Sri Lanka (Pvt) Ltd and Mr. Nalin Uthurawala, coir processing mill, Madampalla. for providing coir pith samples and processing equipments. Authors are also grateful to Mrs.Padmika Surangi, Omega green (Pvt) Ltd. and Mr.R.M.N.P.K.Ranathunga, Sunflower Lanka (Pvt) Ltd., for providing Planting materials and other guidance. Finally, the help given by Mr. Padmasiri, Technical Officer and the staff of the Department of Horticulture and Landscape Gardening is greatly appreciated.

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