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Influence of Coir Dust on Plant Growth of Shoe Flower (*Hibiscus rosa-sinensis*) Stem Cuttings

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Summary

This study aimed to assess the influence of coir dust (CD) on the growth of stem cuttings of *Hibiscus rosa-sinensis* (shoe flower) and also to select the suitable proportion of CD and potting mixture (PM). Polybags were filled with different proportions (1:0 as a control, 3:1, 6:1, 9:1, 12:1) of PM and CD. PM was incorporated with sand: red soil: cow manure (1:1:1, v/v/v). A single node cutting was planted in each bag and kept in a net house. Growth parameters were measured at regular intervals. The addition of CD to soil improved plant growth characteristics such as the number of leaves, shoot length, leaf area, root length and weight of developed plant parts in PM:CD at 9:1. Soil pH and moisture content were low in the control but high in PM:CD at 12:1 and 3:1, respectively before and after the 6th and 12th weeks of planting cuttings. CD evidently absorbed a large amount of water thus increasing the moisture content of soil considerably. At the end of the 12th week, PM:CD at 9:1 resulted in best growth.

Key words. coir dust – stem cutting – potting medium – shoe flower

Introduction

Apart from the ornamental value of the shoe flower (*Hibiscus rosa-sinensis* L.), an evergreen shrub, this species is well known for its medicinal properties (Joy et al. 2001). An increase in the production of shoe flower will require an increase in the productivity of soils which can be increased by increasing soil nutrients and improving soil properties. Soil contains organic matter and nutritive elements in various amounts. Variation in chemical and physical properties of media and differences in plant sensitivity to a defined root environmental condition might have contributed to the marked differences in some ornamental plant development (Yahya and Razi 1996). Because of the decomposition of organic matter, nutritive elements become available to plants, although these elements usually become insufficient when the soil is continuously utilized. Therefore it should be supplemented with ecologically friendly organic materials.

Various types of agricultural wastes can be utilized as organic manures to improve the soil. In developing countries, large quantities of cow manure and green manures are used in the field as organic manures. Even though coir dust (CD) and paddy husk are manures and accumulate in large quantities as an industrial by-product, these materials have not been adequately used to improve the soil nutrient status. Awang et al. (2009) stated that coconut CD, also known as cocopeat, is considered as a good growing media component with acceptable pH, electrical conductivity and other chemical attributes but it has been recognized to have high water holding capacity which causes poor air-water relationship, leading to low aeration within the medium, thus affecting the oxygen diffusion to the roots and incorporation of coarser materials into cocopeat could improve the aeration status of the media. CD is typically processed from ripe coconut husks and it could be used as a mulch or organic manure. Growth medium is known to have a large effect on the value of potted ornamental plants (Vendrame et al. 2005).

Peat used in soil-less container media for commercial plant production is harvested from wetland ecosystems (Barber 1993). Demand for peat for use in greenhouses is high but the environmental damage caused by surface mining of peat became a big issue after which CD was considered as a substitute for natural peat in potting media (Bragg 1991). Water-holding capacity of substrates increased as the proportion of sphagnum peat and coir increased and coir-based substrates had greater water-holding capacity than comparable peat-based substrates and also there were no significant differences between coir- and peat-based substrates with respect to bulk density, percent pore space and percent solids (Abad et al. 2002). Evans and Stamps (1996) mentioned that CD is a suitable alternative to peat in the formulation of substrates for the production of annuals.

CD, which is a major by-product of the coconut fiber industry, is usually burnt or piled up in large quantities near fiber mills and is considered a waste. It has a high water holding capacity and has traditionally been used to improve the physical and chemical properties of soils (Savithri and Khan 1993). The maximum water holding capacity of CD is 82.3 % and addition of 2 % of the dust to sandy soil increases the moisture holding capacity by 40 % (Savithri and Khan 1993). Nowadays there is great

demand for CD which can be used as an organic manure to maintain and improve the organic matter content of depleted soils. CD contains 0.3 % N, 0.5 % P_2O_5 and 0.9 % K_2O (JOACHIM 1930). CD has high sodium and potassium levels compared to other peats; however, sodium is leached readily from the material under irrigation (HANDRECK 1993). The high level of potassium present in CD may give more benefit than any detriment to plant growth. CD might also be used to correct many of the known nutrient deficiencies in depleted soil. Therefore, this experiment was performed to identify the most suitable ratio of potting mixture (PM) and CD for vigorous growth of shoe flower cuttings.

Materials and Methods

Location of experiment

This experiment was conducted at the net house of Eastern University, Sri Lanka. The attitude of this site is about 100 m above mean sea level and it falls under the Agro-ecological zone of the low country dry zone of Sri Lanka. The annual mean rainfall of the district ranges from 1600 to 2100 mm. The average temperature varies from 28 to 32 °C and the humidity ranges from 60 to 90 %.

Plant material and experimental description

Soft-wood cuttings (var. 'Pink') were collected in the morning from vigorous lateral shoots for the purpose of propagating shoe flower; thereafter, cuttings were immediately kept in polythene bags to avoid wilting. Ten cuttings were excised per 2-year-old mother plant at 6 am in the rainy season. Excessively vigorous shoots and those with weak growth were not considered. Cuttings (8 cm long) with a single node were prepared after removing the leaves and buds from the lower half of the cuttings and planted in growth media and then sprayed by hand with water (approx. 10 ml per cutting), four times daily, at 7 and 11 am and at 2 and 5 pm. Weeding was done manually at two-week intervals after planting and continued periodically as and when necessary until transplanting. After establishment of cuttings, they were regularly observed and measurements were recorded at regular intervals as indicated next.

Experimental design

All five treatments were arranged in a complete randomized design (CRD) with four replicates. Each replicate had four cuttings. This experiment was repeated twice. Different ratios (v/v) of PM (sand: red soil: cow manure at the rate of 1:1:1, v/v/v) and CD as a growth medium were tested to select for the most suitable medium in this experiment. Each individual component of PM was not tested. Treatments are shown in Table 1.

Preparation of growth medium

Common PM was prepared with sand: red soil: cow manure in a 1:1:1 ratio. One part of CD was incorporated into different proportions of PM as shown in Table 1. Thereafter this mixture (growth medium) was filled into a polythene bag (10 × 15 cm) and bags were arranged randomly in the net house for one week before planting shoe flower cuttings.

Plant and soil parameters

Shoot length, number of branches and number of leaves were counted at regular intervals. Root length, leaf area and weight of plant parts (wet and dry basis) were measured at 6th and 12th weeks after planting by destructive sampling. Leaf area and plant weight were measured with a leaf area meter (LI 3100, LI-COR Inc., Lincoln, USA) and electronic balance, respectively.

Soil (10 g) (i.e., CD:PM combination) was dried in an oven at 105 °C for 24 h till constant weight. Moisture content was calculated, before and after planting, as follows (DAS 2004):

$$\text{Moisture \% (dry basis)} = \frac{M_F - M_D \times 100}{M_D}$$

where M_F = weight of fresh soil sample and M_D = weight of oven-dried soil sample.

The results were expressed as a percentage on a dry weight basis. In each treatment, the percentage of soil moisture was recorded before and after planting (week 6 and 12). The pH was measured with an Electro Ethemical Analyzer (Jenway 3405, Eutech Instruments Pvt. Ltd., Singapore) and medium temperature of each treatment was measured with a soil thermometer under net house conditions.

Statistical analysis

All data were analysed statistically using SAS software. Data were first normalized with the Shapiro-Wilk test at P=0.05 before analysis of variance (ANOVA). Square root transformation was used to express percentage values while soil pH and root length data was log transformed. Significant differences between means were estimated at α=0.05 using Duncan's multiple range test (DMRT).

Results and Discussion

The objective of this study was to select the most suitable ratio of PM and CD for the most vigorous growth of cuttings of shoe flower in sandy soil. CD, which has a high

Table 1. Different ratios of potting mixture incorporated with coir dust used in this experiment.

Treatment	Growth medium		
	Potting mixture[1)]	Coir dust	Ratio (v/v)
T1 (control)	1 part	0 parts	1:0
T2	3 parts	1 part	3:1
T3	6 parts	1 part	6:1
T4	9 parts	1 part	9:1
T5	12 parts	1 part	12:1

[1)] Potting mixture contained sand: red soil: cow manure (1:1:1, v/v/v)

water holding capacity, is a by-product of the coconut fiber milling industry and is widely used in foliage pot plant production (Mazeen et al. 2002). The application of waste materials to soil has beneficial effects on soil nutrients, soil physical conditions, soil biological activity and crop performance (Hadas et al. 2004). Plant performance is dependent on the root system. Hence a suitable growing medium is an important factor for producing ornamental plants and it influences the growth and development of a plant directly.

Number of leaves

The number of leaves was maximum in PM:CD at 9:1 followed by 12:1. Growing media had a significant effect on the number of leaves from the 4th week onwards. The mean number of leaves at 12th week ranged from 10.75 to 12.12 (Table 2). Highest leaf number was recorded in PM:CD at 9:1 at the 12th week and lowest in PM. Chaturani and Subasinghe (2006) also noted more new leaves when CD medium was used and an overall highly favourable appearance of plantlets when *in vitro* rooted stem cuttings were grown in four different potting media: soil, CD, sand:CD (1:1) and soil: sand (1:1). The most likely reason may have been the high porosity and nutrient content of growing medium containing CD than in the control. The nutrient content in the growing medium depends on the composition of the materials used which in turn determines the rate of decomposition of organic matter to release the required nutrients surrounding the root system. Coir pith applied to agricultural soils improved the moisture retention capacity and increase available nutrient content, infiltration rate, total porosity and hydraulic conductivity of that soil: the benefits of pith mixed with inorganic fertilizer has been established for many crops (Savithri and Khan 1993).

Leaf area

The growing medium had a significant ($P<0.05$) impact on leaf area 6 and 12 weeks after planting (Table 3). PM:CD at 9:1 gave highest leaf area. Riaz et al. (2008) stated that a mixture of silt + leaf manure + coconut compost (1:1:1) gave the highest values of growth parameters of *Zinnia elegans* cv. 'Blue point' such as number of leaves per plant and plant height, which were significantly higher than four other media, namely coconut compost (soil: coconut coir at 1:1), silt, soil and leaf manure. In general, the number of leaves per plant is positively correlated with leaf area per plant. Awang et al. (2009) reported that leaf area of *Celoia critata* cv. 'Kurume gold' grown in a mixture of 70 % cocopeat and 30 % burnt rice husk was higher (463.31 cm^2) than that in 100 % cocopeat (410.00 cm^2) at day 42 after transplanting of 12-days-old seedlings.

Shoot length

Shoots elongated rapidly after the 2nd week of planting in all growth media. A highly significant ($P<0.01$) difference was found between growth in media at the 2nd week and consistently significant variation in shoot length from the 2nd week onwards. PM:CD at 9:1 gave significantly highest values (63.69 mm) at the 12th week than other media except for PM:CD at 6:1; PM resulted in the

Table 2. Mean number of leaves per cutting and mean length of shoots that emerged from cuttings over several weeks in each treatment.

Treatment	2nd week	4th week	6th week	8th week	10th week	12th week
			Mean number of leaves per cutting			
T1 (control)	1.62	3.25 c	4.94 c	6.12 d	8.31 c	10.75 c
T2	1.94	3.37 c	5.12 c	7.17 c	10.00 b	11.81 b
T3	1.76	4.00 b	5.75 b	7.75 bc	09.94 b	11.56 b
T4	1.81	4.50 a	6.42 a	8.19 a	11.06 a	12.12 a
T5	1.62	4.00 b	5.91 b	7.81 b	10.76 ab	11.87 ab
F test	ns	*	**	**	**	*
CV (%)	15.07	8.70	8.74	10.15	7.41	00.9
			Mean shoot length (mm)			
T1 (control)	4.62 c	13.94 c	24.06 c	32.81 b	42.00 b	51.84 b
T2	6.09 a	15.75 ab	27.19 b	33.75 b	43.69 b	52.81 b
T3	5.62 ab	15.55 ab	27.69 ab	41.00 a	50.22 ab	60.05 ab
T4	5.32 b	16.01 a	29.75 a	43.08 a	52.20 a	63.69 a
T5	4.87 bc	14.75 b	26.62 b	36.50 b	44.35 b	54.97 b
F test	**	*	*	*	*	*
CV (%)	8.86	12.29	10.49	10.48	10.61	10.49

Values represent mean ± standard error of three independent experiments, each with 80 samples. * $P < 0.05$ according to F test. Means followed by the same letter in each column are not significantly different according to DMRT at $\alpha = 0.05$.

Table 3. Leaf area and root length at 6th and 12th weeks after planting.

Treatment	Leaf area (cm^2)		Root length (cm)	
	at 6th week	at 12th week	at 6th week	at 12th week
T1 (control)	52.63 ± 5.45 b	357.68 ± 16.44 b	5.04 ± 0.52 c	12.40 ± 0.27 c
T2	56.63 ± 2.84 b	363.16 ± 13.61 b	6.46 ± 0.24 a	14.19 ± 0.21 a
T3	63.09 ± 2.35 a	393.35 ± 18.54 ab	6.30 ± 0.28 a	13.96 ± 0.29 a
T4	68.85 ± 3.53 a	418.59 ± 14.50 a	6.10 ± 0.31 ab	13.70 ± 0.26 ab
T5	59.08 ± 5.36 ab	373.26 ± 17.11 b	5.71 ± 0.32 b	13.31 ± 0.32 b
F test	*	*	*	*
CV (%)	10.33	11.06	10.11	04.27

Values represent mean ± standard error of three independent experiments, each with 80 samples. * $P < 0.05$ according to F test. Means followed by the same letter in each column are not significantly different according to DMRT at $\alpha = 0.05$.

shortest shoots (51.84 mm) in the same period (Table 2). Rubasinghe et al. (2009) reported that softwood cuttings of an endemic plant, *Chirita moonii* planted in sand and CD medium had longer shoots than cuttings grown on sand alone medium. Swaby (1968) stated that CD has a high C:N ratio due to its low nitrogen content; when the C:N ratio is high, it takes a long time to decompose and will temporally immobilized soil nitrogen. This might explain the variation in shoot length. Therefore, CD should be mixed with materials containing high nitrogen content before incorporating into the soil for better shoot growth, in this study, cattle manure.

Root length

There was a significant ($P<0.05$) difference in root length at the 6th and 12th week after planting; this difference increased as the ratio of CD increased in the medium (Table 3). PM:CD at 3:1 produced longest roots (6.46 and 14.19 cm) at the 6th and 12th week, respectively. Rubasinghe et al. (2009) also noted significantly higher ($P<0.05$) root fresh weight, root length and root vigour in cuttings of *Chirita moonii* plants grown on sand and CD (1:1) medium treated with 150 mg l^{-1} α-naphthalene acetic acid, although this finding is in itself not a surprising result. The structure of the growing medium containing CD is porous as a result roots can easily penetrate into the medium which provides anchorage, available water and nutrient contents to the root system.

Leaf weight

Medium had a significant effect on fresh and dry weights of newly formed leaves. There was a marked different between media in respect to leaf weight (Table 4). It was noted that PM: CD at 9:1 had significantly ($P<0.5$) higher dry weight (1.92 g) of leaves than other media at the 12th week. At the 6th week, there was no remarkable variation in dry weight of leaves between PM:CD at 9:1 and 12:1. Leaf weights increased with the addition of CD to the media more than in medium without CD. Most of the N, S and P in soil exist in organic form. When they are converted to inorganic forms, only plants can absorb them. Conversion of the organic to the inorganic form is a slow process. CD is slowly-decomposing organic matter, thus controlling to some extent the uptake of these nutrients by plants (Acharya 1935). Incorporation of additives like rock phosphate and CD accelerated the rate of decomposition (Amlan and Devi 2001). The rate of decomposition of organic matter depends on the composition of the growing medium. In the present study, CD was added to the all media. Characteristics of the growth medium have a substantial effect on growth of plants in terms of leaf weight (Di Benedetto 2007).

Shoot weight

Fresh weight of the stem was remarkably ($P<0.05$) higher in CD-containing medium than in the control at the 6th week although variation was not significant by the 12th week (Table 4). Dry weight was also not significant different between media but was greater in PM:CD at 9:1 than in other media. Fresh and dry weights of shoots in CD media were not higher than in the control. Dry weights ranged from 0.03 to 0.05 g at the 6th week and from 0.63 to 0.92 g at the 12th week. The composition of growing medium also influenced aspects of plant marketability and quality including leaf greenness, plant form (e.g., number of leaves per shoot and partitioning of biomass (e.g., root to shoot ratio). Most cultivars or species growing in coir-amended medium had higher production or accumulation of proteins and amino acids in stems than plants growing in peat-amended medium (Lokesha et al. 1988). Coir is thus a suitable medium amendment for growing plants and may have beneficial effects on plant performance (Scagel 2003).

Root weight

There was significant ($P<0.05$) variation in fresh and dry weights of roots between media at the 6th and 12th week after planting (Table 4). PM:CD at 9:1 had the highest fresh root weight (3.99 g) and dry weight (2.13 g) at the 12th week. Scagel (2003) also reported that leaf and stem dry weight, the number of leaves and stems, total stem length increased with increasing proportion of coir in the medium while root dry weight either increased (*Kalmia latifolia*), decreased (*Rhododendron*, *Gaultheria*) or was not influenced by increasing the proportion of coir in the medium.

Table 4. Fresh and dry weights of leaves and roots at 6th and 12th weeks after planting.

Treatment	At 6th week		At 12th week	
	Fresh wt (g)	Dry wt (g)	Fresh wt (g)	Dry wt (g)
		Leaves		
T1 (control)	0.67 ± 0.03 c	0.10 ± 0.02 b	5.24 ± 0.23 c	1.53 ± 0.02 c
T2	0.74 ± 0.08 b	0.10 ± 0.04 b	5.49 ± 0.20 b	1.57 ± 0.05 bc
T3	0.78 ± 0.10 b	0.11 ± 0.01 b	5.78 ± 0.36 ab	1.68 ± 0.10 b
T4	0.95 ± 0.06 a	0.14 ± 0.02 a	6.24 ± 0.29 a	1.92 ± 0.08 a
T5	0.84 ± 0.04 ab	0.12 ± 0.01 ab	5.89 ± 0.25 ab	1.70 ± 0.07 b
F test	*	*	*	*
CV (%)	12.47	11.31	09.98	10.02
		Stems		
T1 (control)	0.36 ± 0.06 c	0.03 ± 0.01	3.22 ± 0.22	0.63 ± 0.19
T2	0.45 ± 0.09 ab	0.04 ± 0.01	3.36 ± 0.20	0.76 ± 0.08
T3	0.48 ± 0.07 ab	0.04 ± 0.01	3.56 ± 0.33	0.89 ± 0.15
T4	0.53 ± 0.04 a	0.05 ± 0.00	3.89 ± 0.34	0.92 ± 0.17
T5	0.44 ± 0.03 b	0.04 ± 0.01	3.48 ± 0.25	0.82 ± 0.09
F test	*	ns	ns	ns
CV (%)	12.60	11.76	14.62	12.27
		Roots		
T1 (control)	0.09 ± 0.07 c	0.02 ± 0.00 b	3.20 ± 0.12 c	1.83 ± 0.18 b
T2	0.13 ± 0.01 b	0.02 ± 0.00 b	3.49 ± 0.21 b	1.80 ± 0.11 b
T3	0.15 ± 0.01 ab	0.04 ± 0.00 ab	3.67 ± 0.14 b	1.96.± 0.08 b
T4	0.19 ± 0.03 a	0.05 ± 0.01 a	3.99 ± 0.13 a	2.13 ± 0.07 a
T5	0.14 ± 0.02 ab	0.04 ± 0.00 ab	3.73 ± 0.15 ab	1.99 ± 0.08 ab
F test	*	ns	*	*
CV (%)	12.60	11.76	08.88	07.47

wt = weight
Values represent mean ± standard error of three independent experiments, each with 80 samples. * $P < 0.05$ according to F test. Means followed by the same letter in each column are not significantly different according to DMRT at $\alpha = 0.05$.

Soil pH

Before and after planting cuttings, soil pH showed significant ($P<0.01$) variation between the media. Before planting, PM had a significantly higher pH (7.83) than other treatments and PM:CD at 3:1 had a lower pH (7.25). After planting, pH gradually decrease in all media and PM had the higher pH of 5.92 and PM:CD at 3:1 had the lower soil pH of 5.14 after 12th week (Table 5). When the amount of CD increases, there was decrease in pH of medium. Abad et al. (2002) stated that pH of CD is slightly acidic. After the addition of CD, the soil pH changed slightly. Before planting, medium was slightly alkaline but after planting, soil pH decreased. This may be due to the respiration of roots of cuttings which produced CO_2 gas and also due to the decomposition of organic materials which may produce some acids (Alam and Chong 2006). Lumis (1982) reported that bicarbonate (HCO_3^-) ions and other organic anions are released by roots during the uptake of anions such as nitrate (NO_3^-) and sulphate (SO_4^{2-}).

Soil with decomposed waste material tends to show lower pH values than soil without waste material soil and waste material soils generate little CO_2 in a dry condition and more in a wet condition (Chaisit et al. 2006). The activity of microorganisms is affected by soil reactions. According to Larson (1980) the best planting media must have a pH conducive to plant growth, a structure that will permit gaseous exchange to provide aeration for the roots and permit water infiltration and movement. Swaby (1968) reported that the optimum pH range for mineralization is between 5.5 and 8.0, which favours soil fauna and flora. Change in soil pH thus brings about a significant effect on decomposition.

Soil temperature

Before planting, PM (control) had the maximum temperature (31.8 °C) than other treatments and PM:CD at 3:1 had the minimum temperature (28.3 °C) (Table 5). After 12 weeks of planting, PM reached 30.7 °C and PM: CD at 3:1 was 28.1 °C. As the temperature of medium decreases, the moisture content of medium increases due to the increasing amount of CD. Temperature is also one of the most important environmental factors that influence the rate of mineralization of organic matter in soils and the heat thus produced has profound effects on the microbial

Table 5. The pH, temperature and moisture of medium in each treatment before and after planting.

Treatment	Before planting	After 6th week	After 12th week
		Soil pH	
T1 (control)	7.83 ± 0.01 a	6.83 ± 0.01 a	5.92 ± 0.01 a
T2	7.25 ± 0.04 c	5.72 ± 0.01 d	5.14 ± 0.02 e
T3	7.31 ± 0.11 c	6.51 ± 0.01 c	5.35 ± 0.01 d
T4	7.51 ± 0.02 b	6.54 ± 0.01 c	5.63 ± 0.01 c
T5	7.61 ± 0.03 ab	6.63 ± 0.02 b	5.83 ± 0.01 b
F test	*	*	*
CV (%)	1.47	0.49	0.57
		Soil temperature (°C)	
T1 (control)	31.80 ± 0.22 a	29.67 ± 0.20 a	30.70 ± 0.11 a
T2	28.30 ± 0.17 d	28.55 ± 0.18 c	28.12 ± 0.13 c
T3	29.85 ± 0.19 c	29.10 ± 0.11 b	29.07 ± 0.10 d
T4	31.02 ± 0.20 b	29.35 ± 0.12 ab	29.45 ± 0.13 c
T5	31.32 ± 0.19 ab	29.45 ± 0.19 ab	30.32 ± 0.11 b
F test	*	*	*
CV (%)	1.28	1.14	0.79
		Moisture content (%)	
T1 (control)	6.41 ± 0.03 e	7.34 ± 0.09 e	7.31 ± 0.07 e
T2	20.59 ± 0.16 a	20.16 ± 0.24 a	18.27 ± 0.19 a
T3	18.07 ± 0.12 b	17.57 ± 0.14 b	14.19 ± 0.25 b
T4	12.54 ± 0.16 c	11.67 ± 0.14 c	09.68 ± 0.05 c
T5	09.98 ± 0.17d	09.04 ± 0.04 d	08.04 ± 0.04 d
F test	**	**	**
CV (%)	2.14	2.23	2.09

Values represent mean ± standard error of 24 measurements. * P < 0.05 according to F test. Means followed by the same letter in each column are not significantly different according to DMRT at $\alpha = 0.05$.

populations involved in the decay process (Russel 1973). The increase in soil temperature reduces the time requirement for decomposition of organic matter.

Soil moisture

The ANOVA indicates that different media had significant (P<0.01) effect on moisture content (%), as shown in Table 5. Before planting, PM:CD at 3:1 showed higher moisture content (20.59 %) and PM exhibited a lower moisture content (6.41 %). Moisture content was maximum in PM: CD at 3:1 which had statistically higher values than other treatments before planting and after 6 and 12 weeks. The amount of CD in the medium was positively correlated with moisture content of the medium. The moisture content decreased as the amount of CD in the medium decreased. This is due to the CD added to the medium that influenced moisture content. Before and after planting, a significant increase in moisture content was found in all media containing CD compared to the control. The higher organic matter content of CD is the obvious cause for such a tendency.

Even though CD is effective in retaining moisture and nutrients it tends to be wider the C:N ratio of soils which is 117 (Aini et al. 2005). Hence CD undergoes slow decomposition in soil. Usually organic matter with higher N content and a low C/N ratio undergoes faster decomposition than that with a poor N content (Amlan and Devi 2001). Therefore, an additional amount of N is needed for the effective use of CD. In the present study CD was incorporated to the growing medium to hasten the rate of decomposition of organic matter. CD and other organic media are biologically active. In addition to providing an environment to plant roots, they also support a diverse population of microorganisms, and growing medium containing CD has high water holding capacity (Mazeen et al. 2002; Awang et al. 2009).

In the present study, significant differences in most growth parameters (number of leaves, leaf area, root length, shoot length, dry weight of leaves and roots) and soil pH, temperature and moisture content occurred when CD was used as the rooting medium for shoe flower (*Hibiscus rosa-sinensis*) stem cuttings. The recommended PM:CD ratio is 9:1.

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