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Growth of Two Subtropical Ornamentals Using Coir (Coconut Mesocarp Pith) as a Peat Substitute

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Abstract. **Growth of *Pentas lanecolata* (Forssk.) Deflers 'Starburst Pink' and *Ixora coccinea* L. 'Maui' was compared in container media using sphagnum peat, sedge peat, or coir dust as their peat components. Growth index and top and root dry weights of both crops were significantly better in coir-based medium than sedge peat-based medium. *Pentas* grew equally well in coir- and sphagnum peat-based medium. Growth index and top dry weight of *Ixora* were significantly lower in the coir-based than the sphagnum peat-based medium, although root dry weights were equal. This difference was not apparent and may have been caused by N drawdown in the coir-based mix. The sedge peat-based medium had the highest air porosity and the lowest water-holding capacity of the three media at the initiation of the trials, but at the termination of the study, it showed a reversal of these characteristics. The coir-based medium showed the least change in these attributes over time. Coir dust seems to be an acceptable substitute for sphagnum or sedge peat in soilless container media, although nutritional regimes may need to be adjusted on a crop-by-crop basis.**

Peat used in soilless container media for commercial plant production is harvested from wetland ecosystems at rates considered nonsustainable by wetland ecologists (Barber, 1993; Barkham, 1993; Buckland, 1993). Although the peat industry argues that peatlands can be managed at sustainable levels (Robertson, 1993), it recognizes that alternatives to peat must be developed to meet consumers' environmental concerns and to contend with increased regulation of peatland exploitation (Bragg, 1990; Robertson, 1993). Sphagnum and sedge are the most common types of peat used in horticulture, with sedge peat regarded as the inferior material due to its lack of uniformity and tendency to lose volume when wet (Bunt, 1988; Cresswell, 1992). In the last decade, the superior (and more expensive) sphagnum peat has shown wide swings in price and availability (personal observation).

Coir is the name given to the fibrous material that constitutes the thick mesocarp (middle layer) of the coconut fruit (*Cocos nucifera* L.). The long fibers of coir are extracted from the coconut husk and used in manufacturing industrial products (Balick and Beck, 1990). Traditionally, the short fibers and dust left behind have accumulated as a waste product for which no industrial use has been discovered.

Coir pith is similar to peat in appearance. It is light to dark brown and consists primarily of lignin and cellulose particles ranging from 0.2 to 2.0 mm (75% to 90%) in size (Table 1). Unlike sphagnum peat, it contains no sticks or other extraneous matter. Coir pith is hydrophilic relative to sphagnum peat and rehydrates readily (Cresswell, 1992).

Coir pith has several qualities that recommend it as a peat substitute (Cresswell, 1992): 1) high water-holding capacity, equal or superior to sphagnum peat; 2) excellent drainage, equal to sphagnum peat; 3) absence of weeds and pathogens; 4) more physically resilient (withstands compression of baling better) than sphagnum peat; 5) renewable resource, with no ecological drawbacks to its use; 6) slower decomposition than sedge or sphagnum peat; 7) acceptable pH, cation exchange capacity (CEC) and electrical conductivity (EC); and 8) easier wetability than peat.

In Australia and Europe, initial tests indicated that coir dust could function well as a substitute for various peat products in soilless container media for plant growth (Bragg, 1990; Pryce, 1991; Reynolds, 1973). Several Dutch companies have been using coir pith in production media since the 1980s (T. Green, EZ Soil Co., Idabel, Okla.). The Royal Botanic Gardens at Kew is currently shifting most of its plant production into coir-based media (Anonymous, 1992; Coghlan, 1992). Sri Lanka, which processes >2.5 billion coconut fruit each year, has become the leading processor of coir pith into a form suitable for horticultural use (Handreck, 1993).

To my knowledge, few published reports have assessed the performance of coir dust as a plant growth medium (Handreck, 1993). The purpose of my study was to assess the comparative growth of two common, subtropical ornamentals in container media based on coir pith and sphagnum and sedge peats.

Materials and Methods

In the first experiment, 30 liners of *Ixora coccinea* 'Maui' and *Pentas lanceolata* 'Starburst Pink' were potted into 3.7-liter containers of 5 noncomposted pine bark : 4 sedge peat or coir pith : 1 sand (by volume) on 13 Apr. 1993. In the second experiment, 15 liners of the same species were potted into 3.7-liter containers of 5 noncomposted pine bark : 4 sphagnum peat or coir pith : 1 sand (by volume) on 8 Aug. 1993. The coir dust used for this study (EZ Peat; EZ Soil Co.) originated in Sri Lanka and was received as highly compressed bricks ≈20 × 10 × 5 cm. These were rehydrated according to the manufacturer's instructions before incorporating into media. All media were amended with (kg·m^{-3}) 9.5 Osmocote 17N–2.3P–10K (10- to 14-month duration; Grace Sierra Chemical Co., Milpitas, Calif.), 4.16 dolomite, and 1.2 Micromax [(12% Fe, 2.5% Mn, 1.0% Zn, 0.5% Cu, 0.1% B, 0.05% Mo, 15% S) Grace Sierra Chemical Co.]. Of each treatment, 30 and 15 replicate plants for the two experiments, respectively, were arranged in a completely randomized design in full sun (maximum photosynthetic photon flux = 2100 μmol·m^{-2}·s^{-1}) with daily irrigation (rainfall supplemented with overhead irrigation). For each replication, height and width measurements were taken at inception and again at termination, from which a growth index was calculated (net change in height + net change in width). At termination, tops and roots were harvested, dried, and weighed. The first trials were terminated on 27 July 1993 (*Pentas* no. 1, 3.5 months elapsed) and 7 Sept. 1993 (*Ixora* no. 1, 5 months elapsed); the second on 8 Nov. 1993 (*Pentas* no. 2, 5 months elapsed) and 4 Jan. 1994 (*Ixora* no. 2, 3 months elapsed). Data were analyzed by analysis of variance. For three replicate samples of each medium exposed to the same conditions as the plants but in which no plant was grown, physical characteristics, pH, and media EC were determined at inception and again at termination. Measurement of pH and EC was by saturated paste extract method (Bunt, 1988). Physical attributes were determined in 3.7-liter containers (column height = 12.5 cm) using protocols from Ingram et al. (1990).

Results and Discussion

Pentas and *Ixora* grown in coir-based media were superior in all growth variables measured to those grown in sedge peat-based medium (Table 2). The results were highly significant ($P \leq 0.0001$). The *Ixora*, in particu-

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Table 1. Properties of various coir dusts.

Source[y]	Property[z] pH	WHC (%)[x]	TPS (%)[x]	AS (%)[x]	CEC	EC (dS·m^{-1})	TOM (%)	OC (%)	C : N	L (%)	C (%)
1	4.97	---[w]	---	---	---	1.30	---	---	---	---	---
	4.98	---	---	---	---	1.30	---	---	---	---	---
2	4.9	64.5	79.8	15.3	83.7[v]	0.87	---	---	---	---	---
	5.0	66.1	81.7	15.6	85.4[v]	1.43	---	---	---	---	---
3	4.8	---	---	---	---	1.80	---	---	---	---	---
4	5.4–6.8	8–9× dry wt	94–96	10–12	60–130[v]	2.5 max	94–98	45–50	80:1	65–70	25–30
5	5.5	---	---	---	21[u]	0.8	---	---	---	---	---
	5.7	---	---	---	30[u]	1.9	---	---	---	---	---

[z]WHC = water-holding capacity, TPS = total porosity, AS = air space, CEC = cation exchange capacity, EC =electrical conductivity, TOM = total organic matter (w/w, dry basis), OC = organic carbon (w/w, dry basis), C : N = carbon : nitrogen ratio, L = lignin, C = cellulose.
[y]1 = Auburn Univ. Soil Testing Laboratory (Auburn, Ala.), 7 June 1991; 2 = A&L Laboratories (Memphis, Tenn.), 19 June 1991; 3 = Univ. of Arkansas Soil Testing Laboratory (Fayetteville), 1 May 1992; 4 = EZ Soil Co. (Idabel, Okla.) data; 5 = Handreck (1993). All data, except Handreck (1993), based on the EZ peat coir used in this study.
[x]Column height not reported.
[w]Not reported.
[v]meq/100 g, dry basis.
[u]meq/liter.

lar, averaged almost a four-, six-, and five-fold increase in growth index and top and root dry weights, respectively, in the coir-based medium compared to sedge peat. There were no significant differences in growth or top dry weight of *Pentas* grown in coir- and sphagnum peat-based media, but root dry weight was higher for coir-grown plants (Table 3). The *Ixora* had significantly more growth and higher top dry weight in the sphagnum peat-based medium than in coir, but root dry weights were similar (Table 3). Where differences existed, they were not as profound as those observed between coir and sedge peat.

Table 2. Growth of *Penatas lancelota* 'Starburst Pink' and *Ixora coccinea* 'Maui' in coir- and sedge peat-based media.

Cultivar	Medium	Growth index (cm)	Top dry wt (g)	Root dry wt (g)
Starburst Pink	Coir	72.9***	51.2***	10.4***
	Sedge	61.0	28.2	5.1
Maui	Coir	62.5***	44.2***	11.1***
	Sedge	17.9	7.6	2.5

***Significant at $P \leq 0.0001$.

Table 3. Growth of *Pentas lanceolata* 'Starburst Pink' and *Ixora coccinea* 'Maui' in coir- and sphagnum peat-based media.

Cultivar	Medium	Growth index (cm)	Top dry wt (g)	Root dry wt (g)
Starburst Pink	Coir	59.4[NS]	46.1[NS]	7.0[NS]
	Sphagnum	55.7	43.8	6.2
Maui	Coir	40.4**	24.9**	7.0[NS]
	Sphagnum	54.9	31.9	7.0

[NS], **Nonsignificant or significant at $P \leq 0.005$, respectively.

The sedge peat-based medium had the highest percent air space and the lowest water-holding capacity of the three media at the initiation of the trials but showed almost the reverse at termination (Table 4). The coir-based medium changed the least in these characteristics over time.

Early published reports on using coir dust as a container medium amendment have reported good results (Donelan, 1979; Reynolds, 1973) or toxicity (Radjagukguk et al., 1983). Excess Cl has been reported in coir dust from sources other than Sri Lanka (Cresswell, 1992; Handreck, 1993). Coir tends to be high in Na and K (Handreck, 1993) (Table 5) compared to the other peats, but Na is leached readily from the material under irrigation (Handreck, 1993). I found no evidence of Cl or Na toxicity on the plants grown in the coir-based medium.

Trials in England with several woody ornamentals and greenhouse crops in various coir–bark blends indicated that coir pith performance was similar to that of sphagnum peat (Labey, 1991; Smith, unpublished data; Wehl, unpublished data). Cresswell (1992) anecdotally reported germination and early growth of tomato [*Lycopersicon lycopersicum* (L.) Karst.

Table 4. Physical characteristics, pH, and electrical conductivity (EC) of coir-, sedge peat-, and sphagnum peat-based media. Mean of three samples (SD).

Medium	Air space[z] (%) Initial	Air space[z] (%) Final[y]	Water-holding capacity (%)[z] Initial	Water-holding capacity (%)[z] Final[y]	pH Initial	pH Final[y]	EC (dS·m^{-1}) Initial	EC (dS·m^{-1}) Final[y]
Coir	13.7 (0.7)	11.0 (0.2)	35.7 (1.2)	39.2 (1.0)	5.6 (0.1)	6.3 (0.1)	3.1 (1.3)	1.6 (0.6)
Sedge	23.1 (2.7)	9.7 (1.0)	29.8 (1.4)	45.4 (2.0)	5.6 (0.2)	6.6 (0.3)	2.4 (1.5)	1.7 (1.2)
Sphagnum	14.5 (1.5)	8.5 (0.8)	36.9 (1.1)	43.4 (0.6)	4.9 (0.1)	6.1 (0.0)	2.6 (0.9)	1.4 (0.9)

[z]Percentage of total volume.
[y]After 5 months.

Table 5. Chemical properties of various coir dusts [diethylenetriaminepentaacetic acid (DPTA) extractions of saturated media extract, parts per million].

Source[z]	Element N (NO_3)	N (NH_4)	P	K	Ca	Mg	S	Mn	Fe	B	Zn	Cu	Cl–	Na	Al
1	2.22	---[y]	10	308	3	4	---	---	---	---	---	---	---	---	---
	2.46	---	10	290	2	4	---	---	---	---	---	---	---	---	---
2	2	2	8	172	4	3	33	0.1	0.5	1.0	0.07	0.03	---	61	<1
	1	2	6	271	2	4	10	0.1	0.4	0.1	0.11	0.04	---	104	<1
3	10.4	---	8.5	319	3.9	4.6	---	---	0.9	---	0.3	0.1	---	105	---
4	0	0	17	720	15	28	8	1.5	5	0.18	1.3	0.22	886	110	---
	9	0	8	304	6	8	2	1.1	7	0.12	0.7	0.17	250	114	---

[z]1 = Auburn Univ. Soil Testing Laboratory (Auburn, Ala.), 7 June 1991; 2 = A&L Laboratories (Memphis, Tenn.), 19 June 1991; 3 = Univ. of Arkansas Soil Testing Laboratory (Fayetteville), 1 May 1992; 4 = Handreck (1993). All data, except Handreck (1993), based on the EZ peat coir used in this study.
[y]Not reported.

ex Farw.], lettuce (*Lactuca sativa* L.), and broccoli (*Brassica oleracea* L. var. *botrytis* L.) in 1 vermiculite : 1 sphagnum, sedge peat, or coir dust (v/v) media. Seed of all three crops germinated earliest in the coir mix, and these seedlings reportedly were larger after 5 weeks than those grown in the other media. Handreck (1993) tested growth of *Petunia* ×*hybrida* Hort. 'Celebrity Salmon' in 5 Malaysian coir : 6 Sri Lankan coir or a peat from Sakhalin, Russia (type not reported, presumably sphagnum) : 1 silica sand (by volume). He reported equal growth when all three mixes were adjusted to pH 6 and total plant nutrients were supplied, but performance varied with changes in nutrient regime. He concluded that plants in coir-based media require more Ca, S, Cu, and Fe, but less K, than those grown in peat. He also reported greater immobilization of soluble N with coir than peat, an observation confirmed by Cresswell (1992). In my experiment, this N drawdown by coir dust may have caused the difference in the top growth of *Ixora* (Table 3).

Coir pith has a higher pH than sphagnum (Cresswell, 1992; Handreck, 1993) (Tables 1 and 4) and, thus, may require less liming for use in media. There was no difference in pH between the sedge- and coir-based media used in this study (Table 4).

Five independent analyses of the coir pith used in this study were performed from 1991 to 1992 at Auburn Univ., Auburn, Ala.; Univ. of Arkansas, Fayetteville; and A&L Analytical Laboratories, Memphis, Tenn. These results are summarized in Tables 1 and 5, along with data from Handrick (1993) and the manufacturer of the product. Handreck (1993) reported low CEC (meq/liter) of coir dust (21 to 30, varying with source) relative to peat (78), but Cresswell (1992) found a higher CEC for coir (35.5) compared to sphagnum (25.2) or sedge (9.1). The difference in the performance of *Ixora* and *Pentas* in coir dust vs. sedge peat may reflect in part a higher CEC for coir.

Based on my results, coir dust seems to be an acceptable substitute for sphagnum or sedge peat in soilless container media, although nutritional regimes may need to be adjusted on a crop-by-crop basis. For most plant producers in the United States, the primary decision on whether to use coir dust as a substitute for peat likely will be economic, and the secondary decision, environmental. Despite its disadvantages, sedge peat is inexpensive compared to sphagnum. Current Florida wholesale price for sedge peat is about \$18.00/m^3 (though less expensive sources can be found outside of commercial container media vendors) and about \$24.00/m^3 for sphagnum peat and coir dust (M. Corman, Lantana Peat and Soil Co., Boynton Beach, Fla.; personal communication). If high-quality coir dust can be brought into the United States consistently at a price competitive with sphagnum peat, it should find a ready market among users of the latter.

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