Horticultural Research Institute

Growth of Bedding Plants in Sphagnum Peat and Coir Dust-Based Substrates[1]

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Abstract

Water-holding capacity of substrates increased as the proportion of sphagnum peat and coir increased, and coir-based substrates had greater water-holding capacities than comparable peat-based substrates. There were no significant differences between coir and peat-based substrates with respect to bulk density, percent pore space and percent solids. Air-filled pore space and water-filled pore space decreased and increased, respectively, as the proportion of peat and coir increased. 'Pink Elite' geranium plants grown in coir-based substrates had greater root fresh weights than those grown in sphagnum-peat based substrates. Greatest root fresh weight occurred in an 80% coir and 20% perlite substrate. Days to flower, height, shoot fresh weight and number of axillary shoots were not significantly different between substrates. 'Janie Bright Yellow' marigold and 'Blue Lace Carpet' petunia plants had increased heights and shoot fresh weights when grown in coir-based substrates as compared with sphagnum peat-based substrates. Greatest heights and shoot fresh weights of petunia and marigold occurred in an 80% coir and 20% perlite substrate. Days to flower were reduced for marigold plants grown in coir-based substrates.

Index words: root media, annuals.

Species used in this study: 'Janie Bright Yellow' marigold (*Tagetes patula* L.); 'Pink Elite' geranium (*Pelargonium* x *hortorum* L.H. Bailey) and 'Blue Lace Carpet' petunia (*Petunia* x *hybrida* Vilm.-Andr.).

Significance to the Nursery Industry

The nursery and greenhouse industries use significant quantities of sphagnum peat (peat) in the formulation of artificial substrates for production of bedding plants. Environmental concerns and increasing prices have generated interest in the development of alternatives to peat. Coir-based substrates were found to be a suitable alternative to peat for the formulation of substrates for the production of bedding plants. Under the conditions of this study, the growth and development of 'Janie Bright Yellow' marigold, 'Pink Elite' geranium and 'Blue Lace Carpet' petunia, as measured by root fresh weight, plant heights and shoot fresh weights, was either equivalent to or greater than those produced in sphagnum peat-based substrates.

Introduction

Greenhouses and nurseries use soilless substrates composed of peat moss (peat), bark, perlite, styrofoam, vermiculite or rockwool (4, 10) in the production of bedding plants. Among these materials, peat is one of the most widely used. Environmental concerns (2, 3, 11) and increasing prices have generated significant interest in the development of alternatives to peat. Most research into the development of peat substitutes has focused on the use of municipal or agricultural wastes. However, some of these materials are proving to be unsuitable because of their high degree of variability and their likelihood of containing undesirable materials such as glass, metal fragments and heavy metals. Other materials are not produced in volumes large enough to impact the market. Any potential peat substitute must have suitable physical and chemical properties, and must be available in significant quantities, must be uniform and economically compatible with potential markets. One material that is purported to meet these requirements and is being marketed as a peat substitute is coconut coir dust.

Coir dust is produced from the mesocarp tissue, or husk, of the coconut fruit and originates primarily from Sri Lanka, India, Philippines, Indonesia, Mexico, Costa Rica and Guyana. The husk contains approximately 60 to 70% pith tissue with the remainder being fiber of varying lengths (personal communication, F. Soriano, Soriano Fiber, Philippines). After grinding of the husk, the long fibers are removed and used for various industrial purposes such as rope and mat making. The remaining material, composed of short and medium length fibers as well as pith tissue, is commonly referred to as waste-grade coir. The waste-grade coir may be screened to remove part or all of the fiber, and the remaining product is referred to as coir dust.

Although coconut coir products have been used in tropical countries for the production of some ornamentals (most notably orchids and anthuriums), little published information is available concerning the usefulness of these products as commercial production substrate components. Seeni and Latha (12) reported coconut husks could be used in the production of *Phalaenopsis* hybrid orchids, and Talukdar and Barooah (13) reported coconut fiber moss resulted in 'superior flowering' in *Dendrobium densiflorum*. Lokesha et al. (8) found that average root length and mass was greater for *Acalypha* when grown in coir dust than in a soil-based substrate, and the percentage of *Bougainvillea* cuttings rooting in coir dust was 56% while rooting in sand was only 7%. Erwiyono and Goenadi (6) used coir dust as a production substrate for cocoa seedlings and found the best substrate was a combination of 25% coconut husk and 75% sand.

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The objective of this research was to compare the growth and development of bedding plants produced in sphagnum peat and coir-based substrates.

Materials and Methods

Substrates were formulated to contain 20, 40, 60 or 80% (by vol) sphagnum peat or coir dust with the remainder being perlite. The slow-release fertilizer Sierra 17N–2.6P–10K (17–6–12) with microelements (Scotts, Marysville, OH) was incorporated at a rate of 5 grams per container. Prior to formulation of substrates, dolomitic limestone was added (4.15kg/m^3) to the sphagnum peat (peat) to increase the pH to 5.1. The initial pH of the coir dust was 5.2. Both peat and coir dust were pasteurized at 140F (60C) for 30 minutes.

The physical properties of the substrates were determined prior to planting. The air-filled pore space at container capacity (%v/v), water-filled pore space at container capacity (%v/v), total pore space (%v/v), total solids (%v/v), water-holding capacity at container capacity (%w/w) and bulk density (g/cm^3) were determined using loose-packed cores and methods adapted from Byrne and Carty (5). In this study, however, cylinders that were 7.5 cm (3 in) tall with a 7.5 cm (3 in) inside diameter and volumes of approximately 345 ml (11.7 oz) were used.

'Janie Bright Yellow' marigold, 'Pink Elite' geranium and 'Blue Lace Carpet' petunia seed were sown in flats (52 × 26 × 3cm) filled with a peat: perlite: loam (5:3:2 by vol) substrate amended with dolomitic limestone to a pH of 5.5. After 10 days for marigold and geranium and 15 days for petunia, seedlings were transplanted into plug trays (#273 with 5 ml vol) filled with the same substrate used for germination. After an additional 14 days, plugs were planted into 10 cm (640 ml volume) containers filled with the respective experimental substrates. Plants were grown in a glass-glazed greenhouse. Ambient light levels averaged 650 µmol/m^2/ s^1, at 1200 HR and the temperatures ranged from 67F (19C) to 86F (30C). Water was supplied using drip tube irrigation supplying 120 ml of water daily.

At the end of the experiment, days to first flower, shoot fresh weights and plant heights were taken for all species. Root fresh weights, number of axillary shoots and number of inflorescences were recorded for geranium. The experimental design was a randomized complete block with 7 blocks. An analysis of variance was conducted to determine if substrate significantly affected growth. Contrasts were performed to compare equivalent sphagnum peat and coir substrates.

Results and Discussion

For peat and coir-based substrates, air-filled pore space decreased as the percentage of peat or coir increased (Table 1). Water-filled pore space, water-holding capacity and bulk density increased as the percentage of peat or coir increased. Total pore space increased and percent solids decreased as the percentage of peat or coir increased. Substrates with 20% coir had a greater air-filled pore space than 20% peat substrates, but 80% coir substrates had significantly less air-filled pore space than comparable peat-based substrates. The substrates containing 20% coir had significantly less water-filled pore space than the 20% peat substrate. As the percentage of coir or peat increased, the water-holding capacity of the substrate increased. Substrates containing 60 and 80% coir had significantly greater water-holding capacities than comparable peat-based substrates, and overall, coir substrates had greater water-holding capacities than peat-based substrates. Bulk densities did not differ significantly between the substrates. For coir and peat-based substrates, total pore space increased and total solids decreased as the percentage of coir or peat increased. Comparable peat and coir-based substrates did not differ significantly with respect to total pore space or percent solids.

Substrate did not significantly affect days to flower, height, shoot fresh weight, number of axillary branches or number of inflorescences in geranium (Table 2). Root fresh weights increased as the percentage of coir and peat increased, and overall, root fresh weights were greater for plants grown in

Table 1. Physical characteristics of sphagnum peat and coir-based substrates used in production of bedding plants.

		Air-filled pore space (%vol)	Water-filled pore space (%vol)	Water-holding capacity (%wgt)	Bulk density (g/cm^3)	Total pore space (%vol)	Percent solids (%vol)
Substrate (coir:peat:perlite, by vol)							
20:0:80		19.1	55.6	616	0.07	74.8	25.2
40:0:60		12.2	62.0	719	0.07	74.2	25.7
60:0:40		12.4	66.3	977	0.09	78.7	21.3
80:0:20		7.9	72.6	1088	0.09	80.6	19.4
0:20:80		13.3	61.1	618	0.07	74.3	25.7
0:40:60		12.3	63.6	737	0.08	75.9	24.1
0:60:40		11.5	66.8	805	0.09	78.3	21.7
0:80:20		11.6	70.7	964	0.09	82.3	17.7
Source	df						
Substrate	7	***[z]	***	***	NS	***	***
20 vs 20[y]	1	***	**	NS	NS	NS	NS
40 vs 40	1	NS	NS	NS	NS	NS	NS
60 vs 60	1	NS	NS	***	NS	NS	NS
80 vs 80	1	***	NS	***	NS	NS	NS
coir vs peat	1	NS	NS	**	NS	NS	NS

[z]NS, *,**, *** indicate nonsignificant or significant at the 0.05, 0.01 or 0.001 level, respectively.

[y]Indicates contrast between percent coir and sphagnum peat.

Table 2. **Growth of geranium in coir and sphagnum peat-based substrates.**

	df	Days to flower	Height (cm)	Shoot fresh weight (g)	Number of axillary shoots	Number of inflorescences	Root fresh weight (g)
Substrate (coir:peat:perlite, by vol)							
20:0:80		92	17.7	62.7	19.0	1.0	15.1
40:0:60		91	18.3	65.6	19,9	0.4	17.2
60:0:40		92	18.8	76.7	18.3	1.1	22.6
80:0:20		93	20.1	91.3	19.2	0.9	26.9
0:20:80		94	17.8	70.4	16.6	1.0	15.3
0:40:60		92	18.0	69.1	18.3	0.8	16.7
0:60:40		93	19.8	85.3	18.7	0.8	16.3
0:80:20		91	18.0	69.6	16.3	0.8	19.1
Source	df						
Substrate	7	NS[z]	NS	NS	NS	NS	***
Block	6	NS	NS	NS	NS	NS	NS
20 vs 20[y]	1	NS	NS	NS	NS	NS	NS
40 vs 40	1	NS	NS	NS	NS	NS	NS
60 vs 60	1	NS	NS	NS	NS	NS	*
80 vs 80	1	NS	NS	NS	NS	NS	*
coir vs peat	1	NS	NS	NS	NS	NS	*

[z]NS, *, *** indicate nonsignificant or significant at the 0.05 or 0.001 level, respectively.

[y]Indicates contrast between percent coir and sphagnum peat.

coir substrates as compared to plants grown in peat substrates. Specifically, root fresh weights were significantly increased for plants grown 60 and 80% coir as compared with comparable peat substrates, but root fresh weights were not significantly different when grown in 20 or 40% coir or peat.

Marigold plants grown in 20 and 40% peat were delayed in flowering as compared with comparable coir-based substrates, but plants grown in 60 and 80% coir or peat were not significantly different with respect to days to flower (Table 3). Overall marigold plants flowered sooner in coir-based substrates than peat-based substrates. Marigold plants grown in 40% coir were taller than those grown in 40% peat. As the percentage of peat and coir increased, height of marigold plants increased significantly. Marigold plants grown in 40, 60 and 80% coir had significantly greater shoot fresh weights than those produced in comparable peat-based substrates. Overall, marigold plants in coir substrates had greater shoot fresh weights than marigold plants grown in peat substrates.

Substrate did not significantly affect days to flower for petunia (Table 3). Petunia plants produced in 40 and 80% coir were taller than plants produced in comparable peat-based substrates, and, overall, petunia plants grown in coir-

Table 3. **Growth of marigold and petunia in coir and sphagnum peat-based substrates.**

		Marigold			Petunia		
	df	Days to flower	Height (cm)	Shoot fresh weight (g)	Days to flower	Height (cm)	Shoot fresh weight (g)
Substrate (coir:peat:perlite, by vol)							
20:0:80		39.3	11.6	12.6	34.8	13.6	31.8
40:0:60		39.3	13.4	17.2	33.3	17.2	44.3
60:0:40		41.0	13.1	19.6	31.8	16.1	38.9
80:0:20		39.6	13.0	21.6	36.0	17.6	47.2
0:20:80		42.0	11.2	11.7	34.8	15.4	34.5
0:40:60		42.1	12.0	14.0	34.0	11.7	24.2
0:60:40		41.9	12.4	17.2	26.0	14.8	31.1
0:80:20		40.4	13.4	19.8	30.0	14.2	31.2
Source	df						
Substrate	7	NS[z]	**	***	NS	*	**
Block	6	*	**	**	NS	NS	NS
20 vs 20[y]	1	*	NS	NS	NS	NS	NS
40 vs 40	1	*	*	*	NS	**	***
60 vs 60	1	NS	NS	***	NS	NS	***
80 vs 80	1	NS	NS	***	NS	*	***
coir vs peat	1	**	NS	*	NS	*	***

[z]NS, *, **, *** indicate nonsignificant or significant at the 0.05, 0.01 or 0.001 level, respectively.

[y]Indicates contrast between percent coir and sphagnum peat.

based substrates were taller than those produced in peat-based substrates. Petunia grown in 40, 60 and 80% coir-based substrates had significantly greater shoot fresh weights than those grown in comparable peat-based substrates. Overall, petunia plants grown in coir-based substrates had greater shoot fresh weights than those produced in peat-based substrates.

Increased geranium root growth in coir, and heights and shoot fresh weights in marigold and petunia, were inversely correlated with air-filled pore space but positively correlated with water-holding capacity of the substrate. Regardless of substrate, all plants were provided the same amount of water daily. Although plants were not observed to have wilted during the study, the water-holding capacity was different for different substrates. The greater the water-holding capacity of the substrate, whether coir or peat-based, the greater the root fresh weight of geranium and the greater the heights and shoot fresh weights of petunia and marigold. These results are similar to those of Karlovich and Fonteno (7) who demonstrated increased plant heights, fresh weights dry weights and flower number as the substrate water-holding capacity increased. Tilt et al. (14) also demonstrated a positive correlation between water-holding capacity and increased top growth in several landscape species. Therefore, increased growth observed in coir-based substrates may have been a function of the water-holding capacity.

Another possible explanation for increased root growth in geranium is the presence of phenolic compounds in the coir dust. Lokesha et al. (8) postulated that the release of phenolic compounds by the coir dust may have contributed to the increased rooting observed in bougainvillea. Phenolic compounds such as the phytoalexins ipomeamarone, orchinol, pisatin, phaseolin and rishitin have significant antipathogenic properties (1, 9). Phenolics in coir may have either promoted root development or inhibited loss of roots to disease-causing pathogens.

Based on results from these experiment, coir dust is a suitable alternative to peat for the formulation of substrates for the production of annuals. Under the conditions of this study, the growth and development of the species tested was either equivalent to or greater than those produced in peat-based substrates.

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