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Suitability of Processed Whole Pine Tree as a Substrate Component for Production of Greenhouse Crops ©

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INTRODUCTION

Peat moss is the primary component of growth substrates in the production of greenhouse-grown herbaceous annual crops. Rising transportation costs of peat moss from Canada or Europe is affecting the profitability of many greenhouse operators (personal growth communication). Alternate substrate components have been evaluated in the U.S.A. for use in greenhouse production. Some substrates have been evaluated as additions to reduce the quantities of peat moss in a given substrate and others as replacements for peat moss. A cost-effective sustainable alternative substrate is processed whole pine trees. Gruda and Schnitzler (2004) demonstrated the suitability of wood fiber substrates as an alternative for peat-based substrates in cultivation of greenhouse tomato plants. Wright and Browder (2005) showed that whole chipped pine logs ("clean chips") could be used successfully for nursery crop production with attention to nutrition and irrigation. Substrates composed of whole pine trees have previously been used successfully to produce container-grown vinca (*Catharanthus roseus*) (Fain and Gilliam, 2006). The objective of the research presented here was to evaluate processed whole pine trees as an alternative growth substrate for greenhouse crops.

MATERIALS AND METHODS

Studies were conducted at the Southern Horticultural Laboratory (SHL) in Poplarville, Mississippi. Loblolly pine (*Pinus taeda* L.) at 15 to 20 cm diameter was harvested at ground level from a 12-year-old pine plantation in south Alabama. Entire trees, including needles, were fed through a horizontal grinder. Resulting chips were then further processed using a swinging hammer mill to pass a 6-mm screen, with the resulting material used alone or in combination with Canadian sphagnum peat moss and compared to a standard greenhouse substrate. Substrates (Table 1) were amended per cubic metre with 1.78 kg dolomitic lime, 0.59 kg gypsum, 0.44 kg micromax, 1.78 kg Harrell's 16N–2.6P–9.8K plus (3–4 month formulation), and 1.78 kg Harrell's 16N–2.6P–10.7K (2–3 month formulation). Supplemental quick release starter fertilizer (7N–1.3P–8.2K) was incorporated at 0, 1. 19, 2.37, or 3.56 kg·m $^{-3}$).

On 23 June 2006, 15-cm containers were filled with the trial substrates and four (288 cell) plugs of marigold (*Tagetes patula* 'Hero Spry') or impatiens (*Impatiens walleriana* 'Super Elfin Apricot') were planted into each container. Containers were placed on a greenhouse bench and hand watered as needed. Data collected included substrate electrical conductivity (EC) and pH at 0, 14, and 34 days after potting,

plant growth indices, and or plant shoot dry weight, leaf chlorophyll content, flower number, and root growth (0–5 scale where 0 = no roots present at substrate-container interface; 5 = roots present at all areas of the substrate container interface) at 34 days after potting.

RESULTS

By 34 days after potting, pH had risen on all substrates. The mixes containing the highest amounts of peat moss remained the most acidic (Table 1). The EC was generally higher for substrates with high peat content and at potting and 14 days after potting increased linearly with increasing fertilizer rate for all substrates (Table 1). By 34 days, all ECs were similar except in the peatlite mix at the 3.56 $kg \cdot m^{-3}$ starter fertilizer rate where it was more than twice that of any other treatment at 4.1 $mS \cdot cm^{-1}$.

There were no differences in the number of flowers present at 34 days for any treatment for either species tested (Table 2 and 3). With the peat, perlite, and vermiculite (8 : 1 : 1, by volume) substrate, starter fertilizer rate had no effect on plant shoot dry weight for either species tested (Tables 2 and 3). Growth of impatiens in 100% whole pine tree substrate increased with increasing starter fertilizer rate while there was a quadratic response to fertilizer rate for plants grown in equal parts whole pine tree and peat.

Impatiens grown in the whole-pine-tree substrate that received the 3.56 $kg \cdot m^{-3}$ starter fertilizer rate were similar to other substrate-fertilizer combinations — except the equal parts whole pine tree and peat with 2.37 $kg \cdot m^{-3}$ starter fertilizer.

Marigold also showed a fertilizer rate response for plants grown in whole pine tree substrate alone and the equal parts whole pine tree and peat mix. However, unlike impatiens, there was a fertilizer rate response for plants grown in mixture of whole pine tree and peat (v/v) (WT20P) (Table 3).

CONCLUSION

The results of this experiment indicate that whole pine tree substrates, especially when provided with a starter fertilizer charge and/or combined with peat moss are a potential alternative to conventional greenhouse substrates.

LITERATURE CITED

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Table 1. Effects of starter fertilizer rate and substrate on pH and electrical conductivity.

Substrate	Fertilizer[z] (lbs/yd^3)	0 DAP[y]		14 DAP		34 DAP	
		pH	EC[x]	pH	EC	pH	EC
100% WPT[w]	0	5.8 a[v]	1.45 e	5.7 a	3.04 def	6.8 a	0.23 c
100% WPT	2	5.5 abc	2.15 cde	5.7 a	3.13 def	6.7 a	0.40 bc
100% WPT	4	5.5 abc	2.65 bcde	5.6 ab	4.96 bcdef	6.7 a	0.37 bc
100% WPT	6	5.7 ab	2.89 bcde	5.4 ab	6.12 abcd	6.7 a	0.43 bc
WPT and peat (4 : 1, v/v)	0	5.3 abcd	1.67 de	5.7 a	2.16 f	6.4 abcd	0.50 bc
WPT and peat (4 : 1, v/v)	2	5.3 abcd	3.03 bcd	5.5 ab	3.84 cdef	6.6 ab	0.50 bc
WPT and peat (4 : 1, v/v)	4	5.7 ab	2.46 bcde	5.3 ab	5.59 abcde	6.6 ab	0.43 bc
WPT and peat (4 : 1, v/v)	6	5.2 bcde	3.24 bc	5.1 ab	6.56 abc	6.4 abcd	0.73 bc
WPT and peat (1 : 1, v/v)	0	5.0 cdefg	1.65 de	4.9 ab	2.96 def	6.2 abcde	0.39 bc
WPT and peat (1 : 1, v/v)	2	4.9 defg	2.50 bcde	4.9 ab	4.38 cdef	6.0 cdef	0.79 bc
WPT and peat (1 : 1, v/v)	4	4.9 defg	3.05 bcd	5.0 ab	4.77 bcdef	5.8 def	1.31 bc
WPT and peat (1 : 1, v/v)	6	5.4 abc	3.19 bc	4.7 b	8.64 a	5.8 def	0.96 bc
Peat, perlite, and vermiculite (8:1:1, by vol.)	0	5.2 bcde	2.05 cde	4.9 ab	2.8 ef	5.5 f	1.00 bc
Peat, perlite, and vermiculite (8:1:1, by vol.)	2	4.8 efg	3.42 bc	4.7 b	2.89 def	5.6 f	1.50 bc
Peat, perlite, and vermiculite (8:1:1, by vol.)	4	4.7 fg	3.90 b	4.9 ab	5.84 abcde	5.5 f	1.90 b
Peat, perlite, and vermiculite (8:1:1, by vol.)	6	4.6 g	5.99 a	5.2 ab	7.83 ab	5.4 f	4.10 a

Table 1. Continued

		Fertilizer Rate Response					
100% WPT	0, 2, 4, 6	Q***[u]	L***	NS	L**Q**	NS	NS
WPT and peat (4 : 1, v/v)	0, 2, 4, 6	Q***	L***	L*	L***	NS	NS
WPT and peat (1 : 1, v/v)	0, 2, 4, 6	L**Q**	L***	NS	L***	L*	NS
Peat, perlite, and vermiculite (8:1:1, by vol.)	0, 2, 4, 6	L***	L***	NS	L***	NS	L***Q*

[z]Supplemental starter fertilizer (7N-1.3P-8.2K) incorporated at 0, 2, 4, or 6 lbs per cubic yard (0, 1.19, 2.37 or 3.56 kg·m^{-3}).

[y]Days after potting.

[x]Electrical conductivity (mS/cm) of substrate solution using the pour through method.

[w]WPT = Whole tree substrate made from 12-year-old *Pinus taeda* mechanically processed to pass a 1/4-inch screen.

[v]Means followed by same letter within columns do not differ significantly ($P < 0.05$, Tukey's Honest Significant Difference).

[u]Non-significant (NS), linear (L), or quadratic (Q) response at $P < 0.05$ (*), 0.01 (**), or 0.001 (***) based on single-degree-of-freedom orthogonal contrasts.

Table 2. Effects of whole tree substrate and starter fertilizer rate on *Impatiens walleriana* 'Super Elfin Apricot'.

Substrate	Fertilizer[s] (lbs/yd^3)	LG[y]	Flower (ct)	Growth Index[x] (cm)	Dry Weight[w] (g)
100% WPT[v]	0	45.2 bc[u]	11.0 a	25.7 d	3.3 e
100% WPT	2	43.3 c	10.4 a	26.1 d	3.4 de
100% WPT	4	46.5 abc	9.9 a	27.1 cd	3.8 cde
100% WPT	6	46.6 abc	12.3 a	29.0 bcd	4.4 bcde
WPT and peat (4 : 1, v/v)	0	43.6 c	13.1 a	29.5 bcd	4.6 bcde
WPT and peat (4 : 1, v/v)	2	45.8 bc	10.9 a	30.0 abcd	4.8 abcde
WPT and peat (4 : 1, v/v)	4	46.5 abc	12.3 a	29.5 bcd	4.8 abcde
WPT and peat (4 : 1, v/v)	6	46.9 abc	12.8 a	30.6 abcd	5.2 abc
WPT and peat (1 : 1, v/v)	0	47.6 abc	11.3 a	30.2 abcd	4.7 abcd
WPT and peat (1 : 1, v/v)	2	48.1 abc	15.0 a	32.8 abc	5.2 abcd
WPT and peat (1 : 1, v/v)	4	46.6 abc	15.3 a	35.6 a	6.4 a
WPT and peat (1 : 1, v/v)	6	48.4 abc	13.0 a	31.9 abc	5.2 abcd
Peat, perlite, and vermiculite (8:1:1, by vol.)	0	51.9 a	11.0 a	33.3 ab	5.8 ab
Peat, perlite, and vermiculite (8:1:1, by vol.)	2	50.1 ab	11.9 a	32.0 abc	5.4 abc
Peat, perlite, and vermiculite (8:1:1, by vol.)	4	50.9 ab	8.4 a	27.2 cd	4.1 bcde
Peat, perlite, and vermiculite (8:1:1, by vol.)	6	50.5 ab	12.1 a	30.9 abcd	5.1 abcde

Table 2. Continued

	Fertilizer Rate Response				
100% WPT	0, 2, 4, 6	Q*[t]	NS	L*	L*
WPT and peat (4 : 1, v/v)	0, 2, 4, 6	L*	NS	NS	NS
WPT and peat (1 : 1, v/v)	0, 2, 4, 6	NS	Q*	Q**	Q*
Peat, perlite, and vermiculite (8:1:1, by vol.)	0, 2, 4, 6	NS	NS	Q*	NS

[z]Supplemental starter fertilizer (7N-1.3P-8.2K) incorporated at 0, 2, 4, or 6 lbs per cubic yard (0, 1.19, 2.37, or 3.56 kg·m^{-3}).

[y]Leaf greenness (chlorophyll content) quantified using a SPAD-502 chlorophyll meter (average of 4 leaves per plant).

[x]Growth index = (height + width 1+ width 2) / 3.

[w]Plant shoot dry weight in grams.

[v]WPT = substrate made form 12-year-old *Pinus taeda* mechanically processed to pass a 1/4-inch screen.

[u]Means followed by same letter within columns do not differ significantly ($P < 0.05$, Tukey's Honest Significant Difference).

[t]Non-significant (NS), linear (L), or quadratic (Q) response at $P < 0.05$ (*) or 0.01 (**) based on single-degree-of-freedom orthogonal contrasts.

Table 3. Effects of whole tree substrate and starter fertilizer rate on *Tagetes patula* 'Hero Spry'.

Substrate	Fertilizer[s] (lbs/yd^3)	LG[y]	Flower (ct)	Root Rating[x]	Dry Weight[w] (g)
100% WPT[v]	0	39.4 d[u]	13.4 a	2.9 abcd	3.9 e
100% WPT	2	43.6 bcd	14.5 a	3.0 abcd	5.5 bcd
100% WPT	4	44.6 abcd	13.4 a	3.4 ab	5.8 abcd
100% WPT	6	44.2 abcd	13.0 a	3.5 a	5.3 bcd
WPT and peat (4 : 1, v/v)	0	44.1 abcd	13.9 a	2.7 bcd	5.1 de
WPT and peat (4 : 1, v/v)	2	46.3 abc	16.3 a	3.0 abcd	6.8 abc
WPT and peat (4 : 1, v/v)	4	45.6 abc	14.3 a	3.3 abc	6.5 abcd
WPT and peat (4 : 1, v/v)	6	46.4 abc	14.9 a	3.3 abc	6.3 abcd
WPT and peat (1 : 1, v/v)	0	43.2 cd	11.8 a	3.1 abcd	6.0 abcd
WPT and peat (1 : 1, v/v)	2	46.7 abc	15.6 a	3.1 abcd	7.1 a
WPT and peat (1 : 1, v/v)	4	45.9 abc	11.9 a	2.9 abcd	7.1 a
WPT and peat (1 : 1, v/v)	6	45.0 abcd	10.6 a	3.1 abcd	6.8 abc
Peat, perlite, and vermiculite (8:1:1, by vol.)	0	49.7 a	12.9 a	2.5 d	6.7 abcd
Peat, perlite, and vermiculite (8:1:1, by vol.)	2	48.5 abc	11.9 a	2.8 abcd	7.2 a
Peat, perlite, and vermiculite (8:1:1, by vol.)	4	48.6 abc	12.3 a	2.4 d	6.8 abc
Peat, perlite, and vermiculite (8:1:1, by vol.)	6	49.4 ab	12.6 a	2.6 cd	6.1 abcd

Table 3. Continued

	Fertilizer Rate Response				
100% WPT	0, 2, 4, 6	L**[t]	NS	L*	L**Q*
WPT and peat (4 : 1, v/v)	0, 2, 4, 6	NS	NS	L**	L*
WPT and peat (1 : 1, v/v)	0, 2, 4, 6	NS	NS	NS	Q*
Peat, perlite, and vermiculite (8:1:1, by vol.)	0, 2, 4, 6	NS	NS	NS	NS

[z]Supplemental starter fertilizer (7N-1.3P-8.2K) incorporated at 0, 2, 4, or 6 lbs per cubic yard (0, 1.19, 2.37, or 3.56 kg·m^{-3}).

[y]Leaf greenness (chlorophyll content) quantified using a SPAD-502 chlorophyll meter (average of 4 leaves per plant).

[x]Root rating on a scale of 0 - 5 where 0 = no roots visable at substrate container interface and 5 = roots covering 100%.

[w]Plant shoot dry weight in grams.

[v]WPT = substrate made form 12-year-old *Pinus taeda* mechanically processed to pass a 1/4-inch screen.

[u]Means followed by same letter within columns do not differ significantly ($P < 0.05$, Tukey's Honest Significant Difference).

[t]Non-significant (NS), linear (L), or quadratic (Q) response at $P < 0.05$ (*) or 0.01 (**) based on single-degree-of-freedom orthogonal contrasts.