Evaluation of an Alternative, Sustainable Substrate for Use in Greenhouse Crops

Glenn B. Fain , Charles H. Gilliam[2], Jeff L. Sibley[2] and Cheryl R. Boyer[2]
USDA-ARS Southern Horticultural Laboratory, Poplarville, MS 39470
[2]Auburn University, Department of Horticulture, Auburn, AL 36849
gfain@ars.usda.gov

Index Words: peat moss, pine bark, whole pine tree, greenhouse crops, *marigold petunia lantana*

Significance to Industry: This study evaluated a new substrate for greenhouse production of herbaceous annual crops. Results varied with crop produced but indicated a potential for an alternative substrate composed of processed whole pine trees. This product could prove to be an acceptable and highly economical alternative to traditional peat moss based substrates.

Nature of Work: Peat moss and pine bark are the primary components of growth substrates in the production of greenhouse grown herbaceous annual crops. However, there is concern that the availability of bark for horticultural usage might be limited due to alternative demands (e.g. industrial fuel) and reduced timber production (1, 4). Other factors affecting the future availability of pine bark are reduced forestry production, and increased importation of logs already debarked (5). Also the rising transportation cost of peat moss is negatively affecting the bottom line of many greenhouse operators. A cost effective sustainable alternative substrate is processed whole pine trees. A study by Gruda and Schnitzler (3) demonstrated the suitability of wood fiber substrates as an alternative for peat-based substrates in cultivation of greenhouse tomato plants. A study conducted by Wright and Browder (6) showed that whole chipped pine logs (“clean chips”) could be used successfully for nursery crop production with attention to nutrition and irrigation. A study by Fain and Gilliam (2) successfully used substrates composed of whole pine trees to produce container-grown vinca (*Catharanthus roseus*). Use of these substrates resulted in plants that were similar in size to plants grown in pine bark alone. The objective of our research was to evaluate processed whole pine trees as an alternative growth substrate for greenhouse crops.

Studies were conducted at the Southern Horticultural Laboratory (SHL) in Poplarville, MS and Young’s Plant Farm (YPF) in Auburn, AL. Six to eight inch diameter loblolly pine (*Pinus taeda* L.) were harvested from a 10 year old planted pine plantation in south Mississippi. The entire tree including needles was feed through a drum chipper (Vermeer BC1000XL). Resulting chips were then further processed using a swinging hammer mill (C.S. Bell No. 30) to pass a 3/16”, 1/4”, or 3/8” screen. Substrates (Table 1) were amended per yd^3 with 7 lbs dolomitic lime, 0.75 lbs micromax and 6 lbs Osmocote 15-9-12 Plus (3-4 month formulation). On 14 April 2006 (20 April 2006 for YPF) six inch containers (ITML AZF 0600) were filled with substrates and 4 plugs (288 cell) were planted into each container for begonia (*Begonia* x *semperflorens-cultorum* ‘Prelude Scarlet’), marigold (*Tagetes patula* ‘Little Hero Yellow’), petunia (*Petunia* x *hybrida* ‘Dreams

Pink' and vinca (*Catharanthus roseus* 'Peppermint Cooler'), and 2 plugs (50 cell) for lantana (*Lantana camera* 'Lucky Red Hot Improved').

Containers were placed on a greenhouse bench and watered as needed. All treatments received supplemental liquid fertilization weekly for three weeks at 200 ppm nitrogen the first week and 300 ppm thereafter using 20-10-20 (Peters Peatlite). Data collected included substrate electrical conductivity and pH at 1 and 34 days after potting (DAP) (28 DAP for petunia), plant growth indices, leaf chlorophyll content (SPAD-502 chlorophyll meter), flower number and root rating (0 – 5 scale, 0 = no roots present at substrate container interface to 5 = roots present at all areas of the substrate container interface) at 34 DAT (28 DAP for petunia).

Results and Discussion: Due to publication space constraints, only the data for lantana, marigold and petunia from the SHL tests will be presented. Plants exhibited similar results at both test locations. At 34 DAP there were no differences in flower number for marigold; however, lantana grown in 100% whole tree substrates (1-3) had the fewest flowers (Table 1). Petunias grown in substrate 10, an industry standard peat blend substrate, had over twice the number of flowers than observed on plants grown in other substrates. Leaf chlorophyll content was similar for petunia, but marigold and lantana plants had a general trend of an increase in chlorophyll content with an increase in substrate peat moss content. In general, plants grown in whole tree substrates were smaller than plants in other blends, but plants increased in size with increasing peat moss percentage. At 34 DAP, all marigold plants were considered salable. However, at 28 DAP, petunias grown in substrates 1-6 were significantly smaller and considered un-salable than plants in substrates 7-10. There were no differences for root ratings with any species among treatments with the exception of lantana, which in substrate 1 had a lower root rating than substrates 7-10.

In conclusion the results of this experiment indicate that whole tree substrates, especially when combined with peatmoss are a potential alternative to conventional greenhouse substrates. More research is needed to establish fertilizer practices to address possible N immobilization that might occur with the whole tree substrates. Although there were no differences in tissue N concentration with petunias for any substrate at 28 DAP (data not shown) a nitrogen sink in the whole tree substrates early in the crop cycle could explain the differences in final growth.

Literature Cited:

1. Cole, D.M, J.L. Sibley, E.K. Blythe, D.J. Eakes, and K.M. Tilt. 2002. Evaluation of cotton gin compost as a horticultural substrate. Proc. SNA Res. Con. 47:274-277.
2. Fain, G.B. and C.H. Gilliam. 2006. Physical properties of media composed of ground whole pine trees and their effects on vinca (*Catharanthus roseus*) growth. HortScience 41:510.

3. Gruda, N. and W.H. Schnitzler. 2004. Suitability of wood fiber substrates for production of vegetable transplants II. The effect of wood fiber substrates and their volume weights on growth of tomato transplants. Scientia Horticulturea. 100:333-340.
4. Haynes, R.W., tech. coord. 2003. An analysis of the timber situation in the United States: 1952-2050. Gen. Tech. Rep. PNW-GTR-560. Portland, OR.: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 254p.
5. Lu, W., J.L. Sibley, C.H. Gilliam, J.S. Bannon, and Y. Zhang. 2006. Estimation of U.S. bark generation and implications for horticultural industries. J. Environ. Hort. 24:29-34.
6. Wright, R.D. and J.F. Browder. 2005. Chipped pine logs: a potential substrate for greenhouse and nursery crops. HortScience 40:1513-1515.

Table 1. Effects of processed whole tree substrates on growth of greenhouse grown herbaceous annuals.

	Marigold (34 DAP)				Lantana (34 DAP)				Petunia (28 DAP)			
Substrate treatments	**SPAD[y]**	**Flower #**	**GI[x]**	**RR[w]**	**SPAD**	**Flower #**	**GI**	**RR**	**SPAD**	**Flower #**	**GI**	**RR**
1 - 100% 3/16” whole pine tree	41.3	13.7	18.6	3.8	35.7	11.3	25.7	2.4	41.1	1.7	17.2	3.3
2 - 100% 1/4” whole pine tree	41.	15.0	18.0	3.5	37.	11.2	26.8	2.7	42.0	0.3	15.6	3.3
3 - 100% 3/8” whole pine tree	42.3	12.2	18.3	3.5	39.1	10.7	27.6	3.3	45.8	0.3	15.1	3.9
4 - 4:1 (v:v) 3/16” whole pine tree:peatmoss	42.8	13.0	19.5	3.8	36.7	12.8	26.4	2.8	43.2	2.1	18.0	4.0
5 - 4:1 (v:v) 1/4” whole pine tree:peatmoss	41.9	14.2	20.1	3.8	38.9	14.0	30.4	2.7	41.0	0.6	18.5	3.6
6 - 4:1 (v:v) 3/8” whole pine tree:peatmoss	43.8	14.8	19.7	3.8	40.7	13.2	32.	2.9	43.5	1.4	19.9	4.1
7 - 1:1 (v:v) 3/16” whole pine tree:peatmoss	42.8	14.2	20.1	4.2	40.8	15.0	33.0	3.3	43.0	4.4	24.2	3.6
8 - 1:1 (v:v) 1/4” whole pine tree:peatmoss	46.2	15.2	21.7	4.1	42.0	16.0	39.5	3.3	41.2	4.4	23.8	3.8
9 - 1:1 (v:v) 3/8” whole pine tree:peatmoss	43.7	14.3	22.5	4.0	42.2	16.2	38.1	3.3	43.4	5.9	23.8	4.
10 - 8:1:1 (v:v) peatmoss:perlite:vermiculite	49.6	15.3	22.7	3.9	43.7	19.3	45.5	3.3	44.0	13.0	30.8	3.8
HSD[v]	*4.2*	*5.5*	*2.3*	*0.6*	*6.8*	*6.7*	*7.1*	*0.71*	*7.0*	*4.7*	*3.8*	*1.2*

Days after potting.

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

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

[w]Root rating 0 - 5 scale where 0 = no roots visible at substrate container interface and 5 = roots present in all portions of substrate/container interface.

Tukey’s honest significant difference (= 0.05).