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A New Substrate for Container-Grown Plants: Clean Chip Residual©

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Clean Chip Residual (CCR) is a potential new nursery substrate that is a forestry by-product composed of approximately 50% wood, 40% bark, and 10% needles. This study evaluated CCR as a growth substrate for container-grown nursery crops. Two perennial species were grown in one of eight substrates (100% bark from two sources, two screen sizes of CCR, and the same treatments combined with 20% peat) along with standard nursery amendments. Species tested included *Buddleja* 'Pink Delight' and *Verbena* 'Homestead Purple'. Growth of these species in CCR was, in general, similar to plants grown in typical pine bark substrates. These results indicate that CCR has the potential to be a viable substrate option for the nursery industry.

INTRODUCTION

Aged pine bark with the addition of a percentage of sand and peat moss make up the majority of container substrates used in nurseries throughout the Southern U.S.A. Unfortunately, the future availability of pine bark is declining due to reduced forestry production, increased importation of logs (no bark), and use of pine bark as a fuel source (Lu et al., 2006). It is important to explore alternatives to traditional pine bark substrates; potential substrates must be readily available, sustainable, economical, pest-free, and easily processed.

A new trend in harvesting pine trees occurs with mobile in-field chip operations. This equipment is used to process trees into "clean chips" to be sent to pulp mills. This process produces a residual product composed of about 50% wood, 40% bark, and 10% needles (about 25% of the biomass). This product, "clean chip residual" (CCR), is either sold for boiler fuel or, more commonly, spread across the harvested area. If the processed product is sold for boiler fuel the approximate cost is \$3–4/yd^3. In-field harvesting operations are occurring across the Southeast. Several million acres in the Southeast are currently in forestry production, and CCR has potential to provide a sustainable media resource to meet the continuing needs of the nursery industry.

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One concern among nursery producers is the increased wood content compared to the traditionally used pine-bark substrate. A recent study by Wright and Browder (2005) showed that a 100% wood-fiber substrate could be used successfully for nursery crop production with proper nutrition and irrigation. Studies by Fain and Gilliam (2006), Fain et al. (2006), and Boyer et al. (2006a) successfully used substrates composed of whole pine trees to produce container-grown nursery crops. The percentage of wood in whole tree substrates ranges from 75%–85%. The CCR was tested as a growth substrate for greenhouse-grown annuals (Boyer et al., 2006b). It was reported that use of these substrates resulted in plants that were similar in size to plants grown in pine bark alone. In addition, several 100% wood-fiber products have been introduced in Europe (Worral, 1978; Gruda and Schnitzler, 2003) for use in vegetable production. These studies show that having a larger portion of wood in the substrate may be acceptable for producing nursery crops.

The objective of this work was to evaluate fresh CCR as a substrate for production of container-grown nursery crops.

MATERIALS AND METHODS

The CCR used in this study was obtained from a 10-year-old pine plantation near Evergreen, Alabama. Loblolly pine (*Pinus taeda*) were thinned and processed for clean chips using a total tree harvester. The CCR used in this study was further processed through a horizontal grinder with 4-inch screens. The sample was then run through a hammer mill to pass a 1.9- or 1.3-cm (0.75- or 0.95-inch) screen. These two CCR sizes were used alone or blended 4 : 1 (v/v) with peat and compared with pine bark from suppliers in Mississippi and Alabama. Treatments are listed in Table 1.

This study was initiated at the USDA-ARS Southern Horticultural Laboratory, Poplarville, Mississippi, on 30 March 2006. It was repeated at Auburn University, Alabama; however, due to space restrictions only the Mississippi data is presented. Each substrate was amended per yd^3 with 14 lb 18N–6P–12K (Polyon 9 month), 5 lb dolomitic limestone, and 1.5 lb Micromax (Scotts Co.). Two perennial species, *Buddleja* 'Pink Delight' and *Verbena* 'Homestead Purple', were transplanted from standard 72-cell flats and grown in trade-gallon containers, placed outside in full sun, and overhead irrigated as needed. Plants were arranged by species in a randomized complete block with eight single plant replications. Pour-through extractions were conducted at 15, 32, and 63 days after planting (DAP) to test media pH and electrical conductivity (EC). Leaf chlorophyll content was quantified using a SPAD-502 Chlorophyll Meter (Minolta, Inc.) at 30, 60, and 100 DAP. Growth indices ([height + width1 + width2] / 3) were recorded at 32, 64, and 105 DAP. Flower numbers were counted at 64 and 102 DAP. Media shrinkage was recorded at 7 and 146 DAP. Shoot dry weight was recorded at the conclusion of the study (105 DAP).

RESULTS

With *Buddleja* initial growth differences occurred (Table 1); however, these differences were minor and were likely due to varying irrigation needs among plants in the different substrates. By 64 DAP all *Buddleja* were similar in growth and had similar flower counts and similar color (leaf chlorophyll; data not presented). This trend continued at 102 DAP when all plants were again similar in size. Also, from a visual standpoint, all plants were commercially acceptable for marketing regard-

Table 1. Effects of various substrates on growth of *Buddleja* 'Pink Delight'.

	Growth indices[z]			Flower number		Shoot dry weight
Treatment[y]	32 DAP[x]	64 DAP	102 DAP	64 DAP	102 DAP	105 DAP
100% PB (MS)	19.0[w] c	61.2 a	66.4 a	7.1 a	9.1 cd	50.7 b
100% PB (AL)	31.5 a	55.7 a	66.4 a	7.1 a	14.3 b	49.6 b
100% ¾" CCR	24.5 b	57.4 a	65.1 a	7.5 a	8.6 d	42.7 c
100% ½" CCR	24.6 b	59.9 a	68.3 a	9.1 a	9.6 bcd	42.6 c
4:1 PB:PEAT (MS)	25.4 b	60.3 a	66.5 a	7.1 a	10.1 bcd	49.3 b
4:1 PB:PEAT (AL)	31.3 a	55.2 a	68.9 a	6.1 a	18.8 a	58.1 a
4:1 ¾" CCR:PEAT	30.7 a	56.7 a	69.5 a	7.0 a	13.5 bc	47.7 bc
4:1 ½" CCR:PEAT	26.8 b	63.0 a	67.4 a	7.4 a	10.3 bcd	45.0 bc

[z]Growth indices [(height + width1 + width2)/3] presented in centimeters and shoot dry weight presented in grams.

[y]Treatments were: PB = pine bark (MS = Mississippi source, AL = Alabama source), CCR = clean chip residual, PEAT = sphagnum peat moss.

[x]DAP = days after planting.

[w]Values within column followed by a different letter are significant using Duncan's Multiple Range Test (α =0.05).

less of the substrate source. There were slight differences in flower numbers and shoot dry weights at 102 DAP. The pine bark (Alabama) and peat (4 : 1, v/v) treatment had more flowers at the end of the study than most treatments, which likely contributed to the larger shoot dry weight. Interestingly, plants in treatments with the Alabama pine bark tended to exhibit excellent growth either alone or in combination with peat. In contrast, plants grown in the Mississippi pine bark tended to have the least growth. These results with two different sources of pine bark indicate the variability in physical characteristics that often occurs among pine-bark sources in the industry. Also, these results show that CCR treatments grow plants as well as or better than some pine-bark substrates that are currently used.

Results with *Verbena* were similar to those of *Buddleja* (Table 2). At 32 DAP the greatest growth occurred with plants grown in the Alabama pine bark, either alone or with peat, however, by 64 DAP, all plants were similar in size. At 64 DAP slightly more flowers occurred on plants grown with the Alabama-based pine bark substrate. In general, the CCR-grown *Verbena* had the least flower numbers at 103 DAP, however, the flower numbers were acceptable for commercial sale. All plants were visually rated to be commercially acceptable. Shoot dry weights were similar among all treatments at 105 DAP.

Substrate pH measurements were within acceptable ranges (5.5 to 6.5) for the duration of the study (Table 3). For EC all treatments at 15 DAP were above the recommended range (0.2 to 0.5 mS cm^{-1}) (SNA, 1997). Only two substrates were within the recommended EC levels at 32 DAP: pine bark (4 : 1, v/v) and peat (both Mississippi and Alabama). All other treatments at 32 DAP and all treatments at 63 DAP were below the recommended range.

Shrinkage data showed slight differences in the height of the media surface (cm below the top of the pot) at 7 DAP (data not shown). However, at the conclusion of the study all treatments had the same substrate level, indicating that use of CCR alone or in combination with peat does not significantly increase media settling due to decomposition of the wood in 105 days.

DISCUSSION

Similarities among treatments in this study indicate that CCR is a viable substrate option for containerized plant production in nurseries. Species included in this test showed little or no differences compared to control treatments, indicating that growth in CCR can produce crops that are as marketable as those grown in pine bark. More studies need to be conducted in order to determine appropriate irrigation and fertilizer regimes as well as document the growth responses of other plant species grown in CCR. Adoption of CCR as a substrate for nursery crop production could significantly lower substrate costs for nursery producers.

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Table 2. Effects of various substrates on growth of *Verbena* 'Homestead Purple'.

Treatment[y]	Growth indices[z]			Flower number		Shoot dry weight
	32 DAP[x]	64 DAP	103 DAP	64 DAP	103 DAP	105 DAP
100% PB (MS)	18.4[w] c	50.7 a	83.6 a	15.1 c	20.3 bc	67.5 a
100% PB (AL)	31.1 a	45.7 bc	82.3 a	20.8 ab	19.5 bc	70.8 a
100% ¾" CCR	24.0 b	45.8 bc	85.3 a	15.0 c	16.4 c	63.3 a
100% ½" CCR	24.5 b	42.1 c	86.8 a	12.9 c	19.4 bc	63.7 a
4:1 PB:PEAT (MS)	21.5 bc	48.0 ab	90.8 a	15.9 bc	26.6 a	72.4 a
4:1 PB:PEAT (AL)	33.2 a	46.3 abc	84.8 a	22.1 a	24.5 ab	74.2 a
4:1 ¾" CCR:PEAT	24.6 b	46.6 abc	84.1 a	13.4 c	15.5 c	64.7 a
4:1 ½" CCR:PEAT	26.1 b	49.1 ab	86.8 a	12.5 c	16.9 c	64.8 a

[z]Growth indices [(height + width1 + width2)/3] presented in centimeters and shoot dry weight presented in grams.

[y]Treatments were: PB = pine bark (MS = Mississippi source, AL = Alabama source), CCR = clean chip residual, PEAT = sphagnum peat moss.

[x]DAP = days after planting.

[w]Values within column followed by a different letter are significant using Duncan's Multiple Range Test (α =0.05).

Table 3. Substrate electrical conductivity (EC) and pH for substrate blends in a container-grown perennial study of *Buddleja* 'Pink Delight' and *Verbena* 'Homestead Purple'.

	15 DAP[y]		32 DAP		63 DAP	
Treatment[z]	EC[x]	pH	EC	pH	EC	pH
100% PB (MS)	0.80[w] a	6.4 ab	0.19 b	6.6 a	0.11 a	6.5 ab
100% PB (AL)	1.01 a	6.2 c	0.13 b	6.4 a	0.15 a	6.2 b
100% ¾" CCR	0.88 a	6.5 a	0.18 b	6.6 a	0.15 a	6.6 a
100% ½" CCR	1.03 a	6.5 a	0.19 b	6.7 a	0.12 a	6.6 a
4:1 PB:PEAT (MS)	1.11 a	6.3 bc	0.20 b	6.6 a	0.09 a	6.2 b
4:1 PB:PEAT (AL)	1.07 a	5.9 d	0.32 a	6.2 a	0.09 a	5.7 c
4:1 ¾" CCR:PEAT	1.20 a	6.3 c	0.17 b	6.5 a	0.13 a	6.1 b
4:1 ½" CCR:PEAT	1.04 a	6.4 ab	0.19 b	6.6 a	0.09 a	6.3 ab

[z]Treatments were: PB = pine bark (MS = Mississippi source, AL = Alabama source), CCR = clean chip residual, PEAT = sphagnum peat moss.

[y]DAP = days after planting.

[x]EC = mS/cm.

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