Growth of Woody Plants in Clean Chip Residual Substrate

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ABSTRACT

Clean Chip Residual (CCR) is a potential replacement for pine bark (PB) in nursery crop substrates. It is a by-product of in-field forestry harvesting practices and has been shown to produce annual plants and perennials similar in size to plants grown in pine bark (PB). This study evaluated the growth of woody plants grown in CCR or PB over the course of one year. Three species were tested; *Buddleia davidii* 'Black Knight', *Lagerstroemia indica* 'Hopi', and *Rhododendron* x 'Fashion'. Data for all species show that plants grown in CCR had similar or greater growth than plants grown in PB. Plant growth indices, leaf chlorophyll content, and inflorescence number showed very few differences over the course of the year. Percent rootball coverage was also generally similar among treatments though those grown in PB had the greatest coverage in buddleia and azalea. These results indicate that CCR can produce woody plants similarly to PB and is a viable option for the nursery industry.

INTRODUCTION

A recent trend in substrate research has identified Clean Chip Residual (CCR), a forest in-field harvesting residual material, as a possible replacement for pine bark-based substrates (Boyer et al., 2006, 2007a, 2007b). Clean Chip Residual is composed of a high percentage of wood-fiber (about 50%) though it also contains about 40% bark and roughly 10% foliage and other material (pine cones, etc.). This high wood-fiber content is a departure from traditional pine bark substrates which contain less than 5% wood-fiber. Clean Chip Residual is obtained from total tree harvester machines which processes small-caliper trees to produce clean chips (for pulp mills) in the forest.

Growth of nursery crops in high wood-fiber content substrates has been evaluated previously. Wright and Browder (2005) evaluated 100% wood-fiber and showed that marigold (*Tagetes*) could be grown successfully with a note that substrate fertility needed to be further evaluated. Fain et. al (2006) reported *WholeTree* could be successfully used as a growth substrate for annual vinca. *WholeTree* is composed of the entire shoot portion of trees, but has a slightly higher (about 80%) wood-fiber content than CCR. Fain also reported that annual vinca grown in *WholeTree* were similar in size to those grown in a pine bark substrate. Boyer et al. (2006) demonstrated that *Ageratum* and *Salvia* grown in CCR or combinations of CCR and peat produced similarly sized plants when compared to a traditional pine bark substrate. Later, Boyer et al. (2007a) evaluated perennials (*Buddleia* and *Verbena*) in CCR and reported similar results among all treatments. A further study indicated that use of supplemental nitrogen was not necessary for growth of *Buddleia* (Boyer et al., 2007b). No tests have evaluated long-term container-grown woody crops with CCR. The objective of this work was to evaluate fresh CCR as a substrate for production of container-grown woody crops over the course of one year.

MATERIALS AND METHODS

CCR used in this study was obtained from a 10-year-old pine plantation near Evergreen, Ala. A Loblolly pine (*Pinus taeda* L.) plantation was being thinned and processed for clean chips using a total tree harvester, further processing occurred through a horizontal grinder with 4-inch screens before being sold to a pulp mill for boiler fuel, which was the production point our CCR was obtained. CCR material obtained for this study was processed again through a swinging hammer mill to pass either a 1¼-, ¾-, ½- or ⅜-inch screen. These four CCR particle sizes were used alone and compared with a standard control, PB (Table 1).

This study was conducted at Paterson Greenhouse, Auburn University, Auburn, Ala. (6 June 2006). Each substrate blend was pre-plant incorporated with 14 lb/yd^3 18-6-12 Polyon (Harrell's Fertilizer, Inc., Sylacauga, Ala.) control release fertilizer (9 month); 5 lb/yd^3 dolomitic limestone and 1.5 lb/yd^3 Micromax (The Scotts Co.). Three woody ornamental species, *Buddleia davidii* 'Black Knight', *Lagerstroemia indica* 'Hopi', and *Rhododendron* x 'Fashion' were transplanted from standard 72-cell flats into #1 containers, placed outdoors on a gravel container pad and overhead irrigated twice daily (0.25 in. twice). Plants were arranged by species in a randomized complete block with eight single plant replications. Containers were top-dressed with 7 lb per yd^3 19-6-12 (Harrell's Fertilizer, Inc., Sylacauga, Ala.) control release fertilizer (6 month) on February 23, 2007. The study was terminated 18 June 2007.

Substrate pH and electrical conductivity (EC) were determined at 16, 31, 59, 92, 141, 258 and 377 days after planting (DAP) using the PourThru technique (Wright, 1986). Media shrinkage (cm below the top of the container) was measured at 7 and 373 DAP. Leaf chlorophyll content was quantified using a SPAD-502 Chlorophyll Meter (Minolta Camera Co., Ramsey, N.J.) near 60, 90, 120 and 365 DAP. Growth indices ([height + width + perpendicular width] / three (cm)) were recorded near 60, 90, 120 and 365 DAP. Flower counts were conducted at 62 and 92 DAP for buddleia. Root ratings (percent coverage of the rootball) were conducted at 377 DAP. Shoot dry weights (SDW) were recorded at the conclusion of the study (377 DAP) by drying in a forced air oven at 70 °C for 48 h. Data were analyzed using Waller-Duncan k ratio t tests ($P \leq 0.05$) using a statistical software package (SAS Institute, Cary, N.C.).

RESULTS AND DISCUSSION

Substrate pH and EC remained relatively constant over the course of the year (Table 1). Substrate pH of PB was consistently lower than that of CCR substrates by about a half a point. In general, the pH was around 6.3 which is acceptable for plant growth. Electrical conductivity (EC) also remained relatively constant over the course of the year. A steady EC decline from 0.36 mS/cm at 16 DAP to a low of about 0.13 mS/cm at 258 DAP existed. EC went back up to 16 DAP levels at 377 DAP after topdressing in February of 2007.

Growth indices of buddleia were similar among treatments for all rating dates except 92 DAP (Table 2). At 92 DAP, PB was larger than other treatments (80.8 cm), though ½- and ⅜-inch CCR were similar. These differences were not present at 141 or 373 DAP. Leaf chlorophyll content and number of inflorescences was similar among all treatments at all rating dates. Percent rootball coverage at 373 DAP was greatest in PB (93.1%) and ⅜-inch CCR (90.0%), though ½-inch CCR was similar (85.0%). There were no differences in SDW at 377 DAP.

There were no differences in crapemyrtle for GI, leaf chlorophyll content, percent rootball coverage or SDW at any rating date (Table 3).

Azalea plants had similar GI and leaf chlorophyll content at all rating dates (Table 4). At the conclusion of the study (373 DAP) plants grown in PB had greater percent rootball coverage (93.8%) than all other treatments (66.3-71.3%). There were no differences in azalea SDW at 377 DAP.

Buddleia, crapemyrtle, and azalea plants grown in this study showed few differences among CCR and PB treatments. The larger particle size CCR material had more substrate shrinkage than other treatments indicating that they may not be the best option for #1 containers. There was also a trend for the smaller particle size media to have the best root growth. Consistency among pH and EC levels suggest that CCR will be a dependable substrate comparable to pine bark. Similarly, nutrient analysis shows that plant response is similar whether plants were grown in pine bark or CCR. These data demonstrate that buddleia, crapemyrtle and azalea can be successfully grown in CCR as a replacement for PB.

LITERATURE CITED

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Table 1. Substrate electrical conductivity (EC) and pH (median) for substrate blends in a greenhouse container study.

Substrate[z]	EC[x]	pH[w]	EC	pH	EC	pH	EC	pH	EC	pH	EC	pH	EC	pH
	16 DAP[y]		31 DAP		59 DAP		92 DAP		141 DAP		258 DAP		377 DAP	
1¼ inch CCR	0.30 a[v]	6.4 a	0.42 a	6.3 a	0.47 a	6.0 a	0.41 a	6.3 b	0.23 a	6.4 ab	0.15 a	6.4 a	0.34 a	6.3 a
¾ inch CCR	0.39 a	6.4 a	0.38 a	6.4 a	0.48 a	5.8 a	0.31 a	6.5 a	0.22 a	6.4 a	0.14 a	6.4 a	0.31 a	6.3 a
½ inch CCR	0.44 a	6.4 a	0.52 a	6.3 a	0.44 a	5.9 a	0.33 a	6.4 a	0.21 a	6.3 b	0.11 b	6.3 a	0.34 a	6.1 a
⅜ inch CCR	0.36 a	6.4 a	0.45 a	6.4 a	0.43 a	5.3 b	0.32 a	6.4 a	0.20 a	6.3 ab	0.11 b	6.3 a	0.46 a	6.0 ab
PB	0.38 a	5.9 b	0.52 a	5.0 b	0.55 a	4.8 c	0.34 a	6.0 c	0.18 a	5.9 c	0.11 b	5.8 b	0.28 a	5.7 b

[z]Treatments were: PB = pine bark, CCR = clean chip residual, PEAT = sphagnum peat moss.

[y]DAP = days after planting.

[x]EC = mS/cm.

[w]pH = a measure of the activity of hydrogen ions (H+) in a solution and, therefore, its acidity or alkalinity. The pH value is a number without units, between 0 and 14, that indicates whether a solution is acidic (pH 0-7), alkaline (pH 7-14) or neutral (pH 7).

[v]Meanss within column followed bythe same letter are not signifantly different based on Waller-Duncan k ratio t tests (α =0.05, n = 4).

Table 2. Effects of various substrates on growth of *Buddleia davidii* 'Black Knight'.

Substrate[z]	Growth indices[y]				Leaf chlorophyll content[x]				Number of inflorescences		% Rootball coverage	Shoot dry weight (gm)
	55 DAP[w]	92 DAP	141 DAP	373 DAP	63 DAP	92 DAP	141 DAP	373 DAP	62 DAP	92 DAP	373 DAP	377 DAP
1¼ inch CCR	43.8 a[v]	68.9 b	83.6 a	101.8 a	53.6 a	49.1 a	53.1 a	54.8 a	6.3 a	10.8 a	72.5 c	145.4 a
¾ inch CCR	44.3 a	68.3 b	79.8 a	96.5 a	54.4 a	47.9 a	53.8 a	55.4 a	5.1 a	9.8 a	75.0 bc	136.6 a
½ inch CCR	43.5 a	74.5 ab	78.7 a	85.9 a	53.2 a	48.3 a	50.5 a	56.2 a	8.0 a	8.3 a	85.0 ab	128.2 a
⅜ inch CCR	42.9 a	77.6 ab	88.0 a	97.6 a	52.2 a	50.4 a	52.1 a	54.9 a	7.5 a	12.4 a	90.0 a	152.4 a
PB	45.1 a	80.8 a	87.2 a	98.4 a	52.2 a	49.6 a	52.8 a	54.8 a	8.3 a	14.5 a	93.1 a	162.4 a

[z]Treatments were: PB = pine bark, CCR = clean chip residual.

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

[x]Leaf chlorophyll content quantified using a SPAD-502 chlorophyll meter (average of 5 leaves per plant).

[w]DAP = days after planting (potted 6 June).

[v]Means within column followed by the same letter are not signicantly different based on Waller-Duncan k ratio t tests (α =0.05).

Table 3. Effects of various substrates on growth of *Lagerstroemia indica* 'Hopi'.

Substrate[z]	Growth indices [y]				Leaf chlorophyll content[x]				% Rootball coverage	Shoot dry weight (gm)
	55 DAP[w]	92 DAP	141 DAP	373 DAP	63 DAP	93 DAP	141 DAP	373 DAP	373 DAP	377 DAP
1¼ inch CCR	49.8 a[v]	46.3 a	54.5 a	64.0 a	60.0 a	66.2 a	63.6 a	49.4 a	86.9 a	81.2 a
¾ inch CCR	46.9 a	45.5 a	51.5 a	64.5 a	56.5 a	60.4 a	60.6 a	49.4 a	76.3 a	83.0 a
½ inch CCR	44.9 a	45.9 a	51.7 a	68.6 a	57.6 a	62.6 a	61.6 a	48.9 a	90.0 a	94.3 a
⅜ inch CCR	41.0 a	40.6 a	45.8 a	65.4 a	58.2 a	61.6 a	62.2 a	48.1 a	81.9 a	87.7 a
PB	42.6 a	42.9 a	48.2 a	67.1 a	58.3 a	61.9 a	64.1 a	49.4 a	88.1 a	89.3 a

[z]Treatments were: PB = pine bark, CCR = clean chip residual.

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

[x]Leaf chlorophyll content quantified using a SPAD-502 chlorophyll meter (average of 5 leaves per plant).

[w]DAP = days after planting (potted 6 June).

[v]Means within column followed by the same letter are not signicantly different based on Waller-Duncan k ratio t tests ($\alpha = 0.05$).

Table 4. Effects of various substrates on growth of *Azalea* 'Fashion'.

Substrate[z]	Growth indices [y]				Leaf chlorophyll content[x]			% Rootball coverage	Shoot dry weight (gm)
	63 DAP[w]	89 DAP	144 DAP	373 DAP	89 DAP	144 DAP	373 DAP	373 DAP	377 DAP
1¼ inch CCR	15.1 a[v]	15.1 a	16.8 a	33.9 a	49.1 a	54.4 a	51.9 a	66.3 b	26.3 a
¾ inch CCR	15.6 a	16.0 a	16.5 a	33.2 a	46.2 a	55.8 a	53.5 a	69.4 b	21.1 a
½ inch CCR	13.8 a	14.4 a	14.8 a	33.8 a	52.5 a	56.8 a	53.3 a	70.6 b	24.8 a
⅜ inch CCR	15.1 a	15.2 a	16.3 a	34.4 a	48.7 a	50.1 a	56.1 a	71.3 b	22.4 a
PB	15.2 a	15.1 a	16.5 a	38.2 a	53.7 a	59.1 a	53.1 a	93.8 a	30.5 a

[z]Treatments were: PB = pine bark, CCR = clean chip residual.

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

[x]Leaf chlorophyll content quantified using a SPAD-502 chlorophyll meter (average of 5 leaves per plant).

[w]DAP = days after planting (potted 6 June).

[v]Means within column followed by the same letter are not signicantly different based on Waller-Duncan k ratio t tests ($\alpha = 0.05$).