# Eastern Red Cedar as an Amendment to Pine Bark in the Production of Ornamental Species©

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## INTRODUCTION

Increasing energy cost has resulted in the use of pine bark (PB) as an alternative resource of clean fuels (Lu et al., 2006). Increasing demand for bark coincides with the slowly declining timber industry (Haynes, 2003). Without a decrease of energy cost in sight and PB remaining as the horticulture industry's standard media for container grown production shortages could occur (Yeager et al., 2007).

Many areas are looking for locally available plant material as alternate substrate components. Eastern red cedar (*Juniperus virginiana*) had become a "weed species" throughout many parts of the Great Plains and Midwest. Thus far, eastern red cedar has been identified as a viable amendment incorporated, at different percentages, into a PB:sand substrate mixture evaluating seedling growth of Chinese pistache (*Pistacia chinensis*) and Indian-cherry (*Frangula caroliniana*) (Griffin, 2009). Results from evaluation of *Acer saccharinum* seed propagation in varying eastern red cedar:sand:PB percentages concluded cedar could be a potential replacement for pine bark with further development of substrate physical properties (Starr et al., 2010). When *Taxodium distichum* was evaluated in PB : sand substrates amended with percentages of eastern red cedar, data concluded that there was little significant difference in plant height between the treatments (Starr et al., 2011). So far, limited research has been done with ornamental nursery crop production. The objective of this study was to evaluate Eastern red cedar (C) as an alternative substrate to pine bark in the nursery production of ornamental species.

## MATERIALS AND METHODS

Seven substrate treatments were evaluated: 100% PB, 5:95 C:PB, 10:90 C:PB, 20:80 C:PB, 40:60 C:PB, 80:20 C:PB, and 100% C. Cedar was harvested on 7 April 2011 at the Auburn Piedmont Research Station, Camp Hill, Alabama. Cedar was chipped through a Vermeer BC1400XL (Vermeer Co., Pella, IA) on 12 April 2011, then stored until processing through a hammer-mill on 10 May 2011. All substrates were pre-incorporated with a 6:1 (v/v) ratio of sand, and amended with 9.5 $kg{\cdot}m^{-3}$ (15.9 $lbs{\cdot}yd^{-3}$) 15N-2.6P-9.9K (15-6-12) Polyon (Harrell's Fertilizer, Inc., Lakeland, FL) control release fertilizer (8-9 months), 3.0 $kg{\cdot}m^{-3}$ (5 $lbs{\cdot}yd^{-3}$) dolomitic limestone, and 0.9 $kg{\cdot}m^{-3}$ (1.5 $lb{\cdot}yd^{-3}$) Micromax (The Scotts Company, Marysville, Ohio).

Five species were used in the experiment, initiated on May 16, 2011 at the Paterson Greenhouse Complex, Auburn University, Auburn, Alabama. Species include Knock Out rose (*Rosa* 'Radrazz', Knock Out® rose) (32 cell pack), Reeves spirea (*Spiraea cantoniensis*) (72-cell pack), Wintergreen boxwood (*Buxus sinica* var. *insularis* 'Wintergreen') (32-cell pack), Sergeants juniper (*Juniperus chinensis* var. *sargentii*) (32-cell pack), and Formosa azalea (*Rhododendron formosum*) (72-cell pack). Liners were transplanted into #1 containers, except for Wintergreen boxwood which were potted into trade gallons. All plants were watered with overhead irrigation (1.27 cm.day) (0.5 in·day). Formosa azalea was placed under a 30% shade structure; all other species were in full sun.

The experimental design was a randomized complete block design with 8 single pot replications per treatment. Each species was treated as its own separate experiment. Data collected from the study includes physical properties (air space, water holding capacity, and total porosity), bulk density and particle-size distribution (Fonteno et al., 1995). Leachates were collected from the Formosa azalea using the Virginia Tech Pour-through Method (Wright et al., 1986). pH and EC ($mS{\cdot}cm^{-1}$) was measured at 7, 15, 30, 60, 90, and 180 days after potting (DAP). Leaf chlorophyll content was quantified using a SPAD-502 chlorophyll meter (Minolta Camera Co., Ramsey, New Jersey) at 90 and 180 DAP. Growth indices were measured at 90 and 180 DAP. Root growth ratings were taken at 180 DAP on a scale from 1-5, where 1 – less than 20% root ball coverage, and 5 – between 80-100% root ball coverage. Substrate shrinkage was recorded at 180 DAP. Marketability was also determined at 180 DAP on a scale from 1-5, where 1 – dead and 5 – highly marketable. All data was subject to analysis of variance using the general linear models procedure and multiple comparison of means, conducted using Tukey's honest significant test at $\alpha$= 0.05 (Version 9.1.3; SAS Institute, Inc., Cary, North Carolina).

## RESULTS

Substrate treatments containing 80% (25.0) and 100% (29.5) cedar had higher air space than PB (15.3), while all other treatments were statistically similar (Table 1). Substrate water holding capacity was similar among all treatments, except for 10% (42.0) cedar and 100% (48.5) cedar. Total porosity varied throughout the treatments, but was greatest for treatments containing 80 and 100% cedar. The recommend range of physical properties (Yeager et al., 2007) for a standard growing media is between 10-30% air space, 45-65% water holding capacity, and 50-85% total porosity percent per volume. Bulk density varied between the recommended ranges of 0.19-0.70 $g \cdot cm^{-3}$ for all treatments; 100% PB was greatest (0.45) and 100% C was the least (0.35).

Table 1. Physical properties of seven substrates containing pine bark and cedar[z].

| Substrate[y] | Air space[x] (% vol) | Substrate water holding capacity[w] (% vol) | Total porosity[v] (% vol) | Bulk density[u] ($g \cdot cm^{-3}$) |
|---|---|---|---|---|
| 100% PB | 15.3 b[t] | 46.3 ab | 62.7 c | 0.45 a |
| 5:95 Cedar:PB | 22.3 ab | 45.0 ab | 67.3 bc | 0.36 de |
| 10:90 Cedar:PB | 21.3 ab | 42.0 b | 63.3 c | 0.39 bcd |
| 20:80 Cedar:PB | 20.3 ab | 44.0 ab | 64.3 bc | 0.40 bc |
| 40:60 Cedar:PB | 22.7 ab | 46.3 ab | 69.0 bc | 0.37 cde |
| 80:20 Cedar:PB | 25.0 a | 46.0 ab | 71.3 ab | 0.41 b |
| 100% Cedar | 29.5 a | 48.5 a | 78.0 a | 0.35 e |
| Recommended range[s] | 10-30% | 45-65% | 50-85% | 0.19-0.70 |

[s]Recommended ranges as reported by Yeager et al. (2007). Best Management Practices Guide for Producing Container-Grown Plants.
[t]Means within column followed by the same letter are not significantly different based on Tukey's studentized range test at $\alpha$=0.05 ($n$=3).
[u]Bulk density after forced-air drying at 105C (221.0F) for 48 hrs; 1 $g \cdot cm^{-3}$ = 62.4274 $lb \cdot ft^{-3}$.
[v]Total porosity is substrate water holding capacity + air space.
[w]Substrate water holding capacity is (wet weight - oven dry weight)/volume of the sample.
[x]Air space is volume of water drained from the sample/volume of the sample.
[y]PB = pine bark.
[z]Analysis performed using the North Carolina State University porometer (http://www.ncsu.edu/project/hortsublab/diagnostic/porometer/).

Substrate pH levels ranged from 6.2-7.0 throughout the study (Table 2). A trend of increase in pH with an increase in C percentage became apparent at 30 DAP and continued until termination, with 100% C (6.8) having the highest pH level at 180 DAP. EC levels were generally similar throughout the study except at 30 DAP, when 5:95 C:PB had the highest EC level (0.72 $mS \cdot cm^{-3}$). EC levels generally declined over the study.

In general, growth was similar among all treatments across all species (Table 3). There were no statistical differences among juniper or spirea at 90 and 180 DAP. At 180 DAP, azaleas were statistically smaller when cedar levels were 40% or greater. Formosa azalea growth generally declined with increasing cedar levels. Boxwood grown in 100% cedar was slightly smaller compared to all other treatments. All cedar treatments with Knock Out rose were statistically similar to the standard.

Table 2. Solution pH and substrate electrical conductivity (EC) for seven substrates containing pine bark and cedar[z].

| Substrate[x] | 7 DAP[y] | | 30 DAP | | 60 DAP | | 180 DAP | |
|---|---|---|---|---|---|---|---|---|
| | pH | EC ($mS \cdot cm^{-1}$)[w] | pH | EC ($mS \cdot cm^{-1}$) | pH | EC ($mS \cdot cm^{-1}$) | pH | EC ($mS \cdot cm^{-1}$) |
| 100% PB | 6.3ab[v] | 0.35[ns] | 6.7ab | 0.55ab | 6.3ab | 0.40[ns] | 6.4abc | 0.24[ns] |
| 5:95 Cedar:PB | 6.2b | 0.42 | 6.2b | 0.72a | 5.7b | 0.57 | 6.2c | 0.27 |
| 10:90 Cedar:PB | 6.3ab | 0.40 | 6.2b | 0.50ab | 6.2ab | 0.35 | 6.2c | 0.25 |
| 20:80 Cedar:PB | 6.6ab | 0.38 | 6.6ab | 0.55ab | 6.3a | 0.36 | 6.5abc | 0.24 |
| 40:60 Cedar:PB | 6.6ab | 0.37 | 6.7ab | 0.46b | 6.5a | 0.37 | 6.5abc | 0.26 |
| 80:20 Cedar:PB | 6.5ab | 0.37 | 7.0a | 0.66ab | 6.7a | 0.42 | 6.7ab | 0.27 |
| 100% Cedar | 6.7a | 0.34 | 6.9a | 0.47ab | 6.7a | 0.37 | 6.8a | 0.27 |

[v]Means within column followed by the same letter are not significantly different based on Tukey's studentized range (HSD) test at $\alpha = 0.05$ ($n$=4).
[w]$1\ mS \cdot cm^{-1} = 1\ mmho \cdot cm^{-1}$.
[x]PB = pine bark.
[y]DAP = days after potting.
[z]pH and EC of solution determined using pour-through method on 'Formosa' Azalea.
[ns]Means not significantly different.

Table 3. Effect of seven substrates containing pine bark and cedar on growth indices[z] of five woody plant species.

| Substrate[y] | *Juniperus chinensis* var. *sargentii* | | *Spiraea cantoniensis* | | *Rhododendron formosum* | |
|---|---|---|---|---|---|---|
| | 90 DAP[x] | 180 DAP | 90 DAP | 180 DAP | 90 DAP | 180 DAP |
| 100% PB | 28.4[w, ns] | 37.4[ns] | 64.5[ns] | 61.6[ns] | 31.3 a | 42.2 a |
| 5:95 Cedar:PB | 29.4 | 34.6 | 48.8 | 64.9 | 33.2 a | 44.3 a |
| 10:90 Cedar:PB | 30.3 | 36.4 | 58.8 | 58.7 | 29.0 abc | 40.6 a |
| 20:80 Cedar:PB | 32.7 | 40.4 | 63.9 | 65.2 | 30.3 ab | 41.1 a |
| 40:60 Cedar:PB | 29.8 | 36.8 | 51.3 | 59.2 | 29.4 ab | 32.7 b |
| 80:20 Cedar:PB | 27.8 | 32.4 | 50.5 | 59.4 | 22.9 c | 27.4 b |
| 100% Cedar | 26.9 | 33.3 | 49.2 | 56.5 | 24.7 bc | 26.9 b |

| Substrate | *Buxus sinica* var. *insularis* 'Wintergreen' | | *Rosa* 'Radrazz', Knock Out® rose | |
|---|---|---|---|---|
| | 90 DAP | 180 DAP | 90 DAP | 180 DAP |
| 100% PB | 18.3 ab | 18.5 ab | 43.7[ns] | 59.0 ab |
| 5:95 Cedar:PB | 16.5 ab | 17.2 ab | 41.7 | 53.2 ab |
| 10:90 Cedar:PB | 18.5 ab | 18.4 ab | 41.8 | 55.4 ab |
| 20:80 Cedar:PB | 18.6 ab | 19.0 ab | 43.3 | 60.3 a |
| 40:60 Cedar:PB | 18.9 a | 19.7 a | 39.7 | 54.6 ab |
| 80:20 Cedar:PB | 17.0 ab | 17.7 ab | 39.7 | 50.3 b |
| 100% Cedar | 15.0 b | 15.6 b | 42.7 | 50.9 ab |

Table 3. Continued.

| Substrate | *Ligustrum* | | *Lantana* | | *Loropetalum* | |
|---|---|---|---|---|---|---|
| | 90 DAP | 180 DAP | 90 DAP | 180 DAP | 90 DAP | 180 DAP |
| 100% PB | 23.29 ab | 30.25 cd | 51.64 ab | 55.05 ns | 38.63 ab | 46.83 ns |
| 5:95 Cedar:PB | 24.48 ab | 34.29 bcd | 55.17 a | 56.92 | 40.01 a | 47.67 |
| 10:90 Cedar:PB | 27.13 ab | 40.92 ab | 52.46 ab | 55.12 | 32.62 b | 50.00 |
| 20:80 Cedar:PB | 25.96 ab | 42.42 a | 51.29 ab | 56.04 | 35.90 ab | 47.62 |
| 40:60 Cedar:PB | 23.62 ab | 34.96 abcd | 53.40 a | 57.33 | 35.58 ab | 46.79 |
| 80:20 Cedar:PB | 28.04 a | 37.67 abc | 53.85 a | 56.92 | 32.79 ab | 43.79 |
| 100% Cedar | 22.19 b | 29.29 d | 42.70 b | 47.63 | 35.38 ab | 43.38 |

| Substrate | *Blueberry* | | *Gardenia* |
|---|---|---|---|
| | 90 DAP | 180 DAP | 180 DAP |
| 100% PB | 53.33 ns | 36.87 a | 49.42 a |
| 5:95 Cedar:PB | 52.55 | 32.25 abc | 49.83 a |
| 10: 90 Cedar:PB | 52.51 | 36.08 ab | 50.17 a |
| 20:80 Cedar:PB | 50.65 | 33.42 abc | 47.46 a |
| 40:60 Cedar:PB | 52.39 | 27.13 cd | 47.9 a |
| 80:20 Cedar:PB | 52.78 | 28.00 bcd | 44.22 a |
| 100% Cedar | 49.25 | 20.83 d | 36.92 b |

[z]Growth index=[(height+width1+width2)/3].
[y]PB= pine bark.
[x]DAP= days after potting.
[w]Means within column followed by the same letter are not significantly different based on Tukey's Studentized Range Test at α=0.05 (n=8).
[ns]Means not significanly different.

## DISCUSSION

In general, four of the five species grew equally well in substrates amended with up to 80% cedar when compared to PB. Premier azalea did not grow as well in cedar above 40%. This data shows that PB amended with cedar provides a suitable substrate for nursery crops, except with acid loving species. In conclusion, Eastern red cedar has potential for production of ornamental species.

## Literature Cited

Fonteno, W.C., Hardin, C.T. and Brewster, J.P. 1995. Procedures for determining physical properties of horticultural substrates using the NCSU Porometer. Horticultural Substrates Laboratory, North Carolina State University, Raleigh, North Carolina.
Griffin, J. 2009. Eastern red-cedar (*Juniperus virginiana*) as a substrate component for container production of woody plants. HortScience 44:1131 (Abstr.)
Haynes, R.W. 2003. An analysis of the timber situation in the United States: 1952-2050. Gen. Tech. Rept. PNW-GTR-560. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon.
Lu, W., Sibley, J.L., Gilliam, C.H., Bannon, J.S. and Zhang, Y. 2006. Estimation of U.S. bark generation and implications for horticultural industries J. Environ. Hort. 24:29-34.
Starr, Z., Boyer, C.R. and Griffin, J.J. 2011. Growth of containerized *Taxodium distichum* in a cedar-amended substrate. Proc. Southern Nurs. Assoc. Res. Conf. 55:344-346.
Starr, Z.W., Boyer, C.R. and Griffin, J.J. 2010. Growth of containerized *Acer saccharinum* from seed in a cedar-amended substrate. HortScience 45:S234. (Abstr.)
Wright, R.D. and Browder, J.F. 1986. The pour-through nutrient extraction procedure. HortScience 21:227-229.
Yeager, T., Bilderback, T., Fare, D., Gilliam, C.H., Lea-Cox, J., Niemiera, A., Ruter, J., Tilt, K., Warren, S., Whitwell, T. and Wright, R. 2007. Best Management Practices: Guide for Producing Nursery Crops. 2nd ed. Southern Nursery Assn., Atlanta, Georgia.