Growth of Containerized *Taxodium distichum* in a Cedar-Amended Substrate

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Significance to Industry: This study evaluated the growth of *Taxodium distichum* (L.)Rich. (Baldcypress) in pine bark and sand substrates amended with 0, 5, 10, 20, or 80% eastern redcedar (*Juniperus virginiana* L.*)* chips (JVC). The results show that JVC is suitable as a potential pine bark replacement or amendment for *T. distichum* in a container-grown production system.

Nature of Work: Pine bark (PB) continues to be the industry standard for container production of woody ornamentals throughout the Southeast (8). However, for many reasons, PB is experiencing reduced availability for the nursery industry and a corresponding increase in price (4,5). This has lead to a demand for alternative substrates to supplement or replace PB particularly in regions that lack indigenous pine species, which further increases shipping costs. Eastern redcedar grows in most of the Great Plains. Once held back by grazing and wild fires from fully entering the grasslands of the Great Plains, community development and farming have reduced these natural control measures. Additionally, the use of the species as windbreaks, erosion control, and wildlife cover since the 1960's has increased the seed population (2,6). Utilization of eastern redcedar as a component of nursery potting substrates could alleviate PB demand with a sustainable, local resource. Previous work has demonstrated that JVC may be an acceptable substrate for some woody species (3). The purpose of this investigation was to determine if JVC could act as a substrate or PB extender for containerized nursery crop production of other species.

Eastern redcedar chips were obtained from Queal Enterprises (Pratt, KS). Whole trees were harvested from Barber County, KS and aged for six months. Trees were then processed into chips using a horizontal woodgrinder (Rotochoper, St. Martin, MN). Further processing occurred through a hammermill (Model 5-2 0-4 WW Grinder Inc. Wichita KS.) to pass a 3/4 in screen. The JVC were then used to create six substrates containing 0, 5, 10, 20, 40, or 80% JVC (by vol). Sand (20% by vol) was incorporated into each substrate and the remaining volume contained PB. Each substrate treatment was pre-plant incorporated with 1.5 $lbs{\cdot}yd^{3}$ of Micromax (The Scotts Company, Marysville, OH) and either a low (7.5 $lbs{\cdot}yd^{-3}$) or high (15 $lbs{\cdot}yd^{-3}$) rate of controlled release fertilizer (Osmocote 19-6-12; 12 to 14 month release; The Scotts Company, Marysville, OH) resulting in 12 treatments. On May 20, 2009 one year old baldcypress seedlings were graded and transplanted into #3 containers containing the treatment substrates. Containers were then placed on a gravel production pad where they received 1.0 in of irrigation daily via overhead sprinklers. The experiment was terminated on September 9, 2009, 113 days after planting (DAP). The experimental design was a randomized complete block design with a factorial arrangement of treatments. There were six substrate blends and two fertilizer rates. The experiment was replicated eight times.

The North Carolina State University Substrates Laboratory determined substrate air space (AS), water holding capacity (WHC), substrate bulk density, and total porosity (TP) (1). Substrate pH and electrical conductivity (EC) were determined at 15, 29, 43, 57, 71, 85, 99, and 113 DAP using the PourThru technique (7). Shoot dry weight (SDW) and root dry weight (RDW) were recorded at the conclusion of the study (113 DAP) by drying in a forced air oven at 160^{o}F for 7 days.

Results: The pH of 0% JVC at 15 DAP was 5.7 which increased to 7.2 at 113 DAP while pH of 10% JVC at 15 DAP was 5.5 and also increased to 7.0. Substrates at 80% JVC had a starting pH of 7.7 and decreased to 7.5 at 113DAP (data not shown). Electrical conductivity for 0% JVC was 1.6 µS/cm at 15 DAP and decreased to 0.7 µS/cm by 113 DAP while EC of 10% JVC at 15 DAP was 1.4 µS/cm, and decreased to 0.7 µS/cm by 113, DAP as well. Substrates at 80% JVC started with an EC of 1.4 µS/cm at 15 DAP and decreased to 0.9 µS/cm by 113 DAP (data not shown). Plants exhibited no significant difference in shoot height based on JVC substrate content at 113 DAP (Table 1). However, fertilizer had a significant effect with the high rate resulting in taller plants than the low rate (119 cm and 112 cm, respectively). Shoot dry weight and RDW showed differences within both treatments but no interaction occurred between percent JVC and fertilizer treatment. Shoot dry weight in the high rate was greater than the low rate (119 g and 80 g, respectively). Similarly, RDW in the high rate was greater than the low rate (136 g and 92 g, respectively). Shoot weight was similar in PB and PB:JVC substrates containing up to 40% (low) 80% (high) JVC. Root dry weight was greatest in the 0% JVC which was similar to substrates incorporating up to 80% (low) or 40% (high) JVC.

While there were statistical differences in plant dry weight especially at the highest JVC content, plant height was not significantly affected. These results suggest that JVC as a substrate component could be a promising replacement for PB in the Plains States. We speculate that the substrate physical properties were the primary factors for decreased weight in 80% JVC substrates. Substrates containing 80% JVC had significantly higher porosity, lower container capacity, and higher air space resulting in less plant available water during production (Table 2). Future studies will focus on evaluation of diverse ornamental crops and manipulation of the physical properties of JVC to maximize plant growth. This data is encouraging for nursery growers in the Plains States, as they will have more options for container-grown plant production substrates in the future.

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Table 1. Height, shoot weight, and root weight of containerized *T. distichum* grown in a substrate amended with *J. virginiana* chips (JVC) at two fertility rates (High and Low)

	Plant height (cm)[z]	**Shoot dry weight (g)**[y]		**Root dry weight (g)**[x]	
Substrate[w]		Low	High	Low	High
80% PB: 0% JVC	114.8[ns]	87.7 a[u]	126.4 ab	109.8 ab	161.4 a
75% PB: 5% JVC	116.1	94.8 a	125.0 ab	131.9 a	121.6 ab
70% PB: 10% JVC	117.4	90.1 a	135.3 a	97.2 bc	154.8 a
60% PB: 20% JVC	117.6	86.6 a	128.3 ab	95.9 bc	160.1 a
40% PB: 40% JVC	118.3	72.7 b	116.4 b	69.1 cd	136.8 ab
0% PB: 80% JVC	109.7	48.5 c	79.7 c	50.2 d	84.0 b

[z]Plants were measured from the top of the substrate to the apical meristem (1 cm = 0.397 in.).

[y]Shoots were harvested at the container surface and oven dried at 160˚F for 7 days (1 g = 0.0035 oz.).

[x]Roots were washed of substrate and oven dried at 160˚F for 7 days (1 g = 0.0035 oz.).

[w]PB = pine bark, JVC = *Juniperus virginiana* chips. Substrates mixed on v:v:v basis with each treatment containing 20% sand.

[v]Means within column followed by the same letter are not significantly different based on Waller-Duncan k ratio t tests ($\alpha = 0.05$, $n = 8$).

[u]Substrates were pre-plant incorporated with either a low or high rate of controlled release fertilizer.

ns indicates that means are not significantly different.

Table 2. Physical properties of pine bark- and *J. virginiana*-based substrates.

Substrates[z]	Air space (% Vol)	Container capacity (% Vol)	Total porosity (% Vol)	Bulk density ($g*cm^{-3}$)
80% PB: 0% JVC	12.6 c	63.0 b	75.5 a	0.51 bc
75% PB: 5% JVC	9.1 cd	66.5 a	75.6 a	0.50 c
70% PB: 10% JVC	8.2 d	62.0 b	70.2 b	0.52 b
60% PB: 20% JVC	10.4 cd	63.9 ab	74.3 a	0.51 bc
40% PB: 40% JVC	20.8 b	55.2 c	75.9 a	0.51 bc
0% PB: 80% JVC	29.9 a	39.3 d	69.1 b	0.58 a

[z]Treatments were: PB = pine bark, JVC = *J. virginiana* chips. Substrates mixed on v:v:v basis with each treatment containing 20% sand.

[y]Means within column followed by the same letter are not significantly different based on Waller-Duncan k ratio t tests (α = 0.05, n = 3).