Genetic And Silvicultural Factors Affecting Productivity Of Planted Cypress In Florida

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ABSTRACT
The potential of baldcypress (*Taxodium distichum* var. *distichum*) and pondcypress (*T. distichum* var. *nutans*) for plantation culture in Florida is being evaluated through a series of genetic and silvicultural studies. Five baldcypress provenances planted on muck in southern Florida differed in tree size (up to 13m in height and 20cm in DBH) but not survival and wood density after 13 years. Across six studies established in 1996-97, nine baldcypress provenances and five baldcypress checklots were, on average, similar in survival and height to 16 pondcypress progenies after as many as four years. Within taxa, individual provenance/progeny differences were significant, but no provenances or progenies were consistently better across sites that ranged from bottomland in northwest Florida to wet and dry flatwoods in northeast Florida to a fertile but poorly drained clay settling area in central Florida. Inconsistent topsoil redistribution hindered the growth of 21 baldcypress progenies and two pondcypress progenies planted on a reclaimed phosphate mine in northeast Florida in 1998. Bedding+compost on a good flatwoods site significantly increased the growth of 30 baldcypress and four pondcypress progenies compared to bedding alone in studies established in 1999 and 2000. In another flatwoods study planted in 2000, bedding+compost also resulted in better growth and survival than just bedding, which in turn was superior to no bedding. Performance of 13 seedlots in two progeny tests and two commercial plantings in 2000-01 on central Florida clay settling areas highlighted the advantages of good site preparation and bedding. An intensively managed seed orchard with 12 pondcypress progenies, nine baldcypress provenances, and three baldcypress clones produced cones on trees five years from seed and up to 5.2m tall. Results to date suggest potential for commercial cypress plantations on non-wetland sites for the production of mulchwood and sawtimber in rotations of 10 to 25 years.

Keywords: *Taxodium distichum* var. *distichum, T. distichum* var. *nutans*, baldcypress, pondcypress

Baldcypress (**BC**) and pondcypress (**PC**) are common to forested wetlands in the Southeast. **BC** is typically found along the Atlantic and Gulf coastal plains and on the floodplains of the Mississippi River to southern Illinois (Wilhite and Toliver 1990). **PC** is not as far west or north ranging. Both varieties can occupy the same site and are adaptable to varying regimes of flood, fire, nutrients, and soils, although **PC** is more common to Spodosols and Ultisols with a pH lower than 6.8 and sites with ponded water (Wilhite and Toliver 1990).

Florida and Louisiana have the greatest cypress volumes (Williston et al. 1980). Within Florida, cypress is the most common wetland tree species (Ewel 1990). Net annual harvest of cypress in Florida of 41.7 million cubic feet exceeded net annual growth of 40.2 million cubic feet, due largely to 128,000 tons of cypress mulch produced annually (Brown 1995). The sustainability of the natural cypress resource in Florida, and the industries that depend on it, is thus in jeopardy. Swamps that once held a preponderance of cypress now are second growth tupelo, ash, oak, and gum trees. Stands of pure second growth cypress, on the other hand, may be overstocked and stagnating (Dicke and Toliver 1988).

Gains in the productivity of pine plantations due to genetic improvement and silviculture suggest a similar potential for intensively managed cypress on poorly drained flatwoods and other sites in Florida. While superior provenances for cypress have not been found, family variation in height and diameter growth suggests the potential for genetic gain (Faulkner and Toliver 1983). Liu *et al*. (1990) noted that **BC** exhibited 95% of its genetic variability within populations with a high number of alleles per locus. At 1x1m spacing on south Florida muck, a local **BC** source quickly suppressed competing vegetation, was 7.9m tall after seven years, and coppiced consistently from 3 to 7 years of age (Rockwood and Geary 1991). Cypress is tolerant of the alternately saturated/droughty conditions that frequently occur on over 150,000 acres of clay settling area reclaimed from phosphate mining in peninsular Florida. Gaviria (1998) reported encouraging early results from studies of up to 30 seedlots and various cultures on a wide range of sites. This paper updates Gaviria's findings and extends the assessment of genetic, silvicultural, and site factors that are critical to cypress plantation establishment in Florida.

MATERIALS AND METHODS

Fourteen cypress studies in Florida (Table 1) involving over 80 seedlots primarily from Florida (Table 2) contribute to this paper. The studies were located throughout the state and varied in age, soil type, silvicultural treatment, and seedlot composition. Study EREC at the Everglades Research and Education Center at Belle Glade on muck approximately 61 cm (2') deep over limestone included five **BC** provenances (Table 3) that were planted in a randomized complete block (RCB) design with five replications of 40-tree row plots at 1.5 x 1.5m spacing. At age 13, 12mm bark-to-bark cores were taken at 1.4m from 15 trees randomly selected from small, medium, and large DBH classes to represent the DBH range in each provenance. The smaller pith-to-bark segment of each of the five large cores for each provenance was divided into three ring groups (11-13 years, ~6-10 years, and ~≤5 years), which were then processed for basic density and moisture content.

Six studies planted in 1996-97 typically had a RCB design with cultural treatments assigned to main plots and seedlots in subplots. SRWC-63 trees were grown in 3-gallon pots that received three slow release fertilizers in February and twice more during 1997. SRWC-64, SRWC-65, and SRWC-66 had the same planting design of five replications with main plots of two varieties and the checks and six-tree row subplots of seedlots. Each tree was fertilized with 8-oz of 3-2-3 slow release fertilizer split equally between the planting hole and the closing hole. Additional unfertilized plots were included with each replication with a border row separating the two. Spacing was 10' between rows and 3' within rows. SRWC-67 assessed four silvicultural treatments (control, straw mulch (M), bedding (B), and B + M + 3-2-3 slow release fertilizer) on a clay-settling area on phosphate-mined lands. SRWC-68 evaluated two spacings (2 x 3', 2 x 1') and 28 seedlots planted on the shore of two ponds previously mined for peat. The two extra genetic checklots (GC) in SRWC-63 were the tallest **BC** and **PC** nursery seedlings in the standard GCs.

Table 1. Location, planting date, number of **BC**, **PC**, and genetic check (GC) seedlots, site type, and silvicultural treatments for 14 studies.

Study SRWC-	Location in Florida	Plant. Date	No. of Seedlots			Site Type	Silvicultural Treatments
			BC	**PC**	GC		
EREC	Belle Glade	2/88	5			Muck	Disking, mowing
63	Day	12/96	9	16	5	Media	Potted, 3 fertilizers
64	Day	12/96	9	16	3	Sandhills	Fertilizer, no fertilizer
65	Caryville	12/96	9	16	3	Bottom	Fertilizer, no fertilizer
66	Tennile	12/96	9	16	3	Flatwoods	Fertilizer, no fertilizer
67	Ft. Meade	1-2/97	9	16	3	Clay	Bedding, herbicide, fertilizer
68	Davenport	2/97	9	16	3	Sandhills	2 spacings
72	Winter Garden	3/98	6			Sandhills	4 cultures including effluent
73	White Springs	2/98	21	2	1	Clay	Topsoil over mine fill
79	Cross City	1/99	16	2	2	Flatwoods	Bedding w/ and w/o compost
85	Cross City	2/00	11	1	2	Flatwoods	Bedding w/ and w/o compost
86	Gainesville	2-3/00	11	1	2	Flatwoods	3 cultures, 2 spacings
88	Lakeland	7/00	11	1	2	Clay	Bedding
89	Ft. Meade	5/01	10		2	Clay	w/ and w/o Bedding

Table 2. Type, origin, and number of **BC** and **PC** seedlots in studies.

Type	Origin	Number of Seedlots by Study
	BC	
Provenance Bulk	Arkansas	1 in SRWC-63, -64, -65, -66, -67, -68
Provenance Bulk	Illinois	1 in SRWC-63, -64, -65, -66, -67, -68
Provenance Bulk	Louisiana	2 in SRWC-63, -64, -65, -66, -67, -68
Provenance Bulk	Northwest FL	4 in EREC; 2 in SRWC-63, -64, -65, -66, -67, -68
Provenance Bulk	Northeast FL	1 in EREC; 2 in SRWC-63, -64, -65, -66, -67, -68
Provenance Bulk	South FL	1 in SRWC-63, -64, -65, -66, -67, -68
Individual Tree	Texas	15 in SRWC-79
Individual Tree	Arkansas	3 in SRWC-72; 10 in SRWC-73
Individual Tree	Northwest FL	3 in SRWC-72; 11 in SRWC-73
Individual Tree	Northeast FL	1 in SRWC-73; 3 in SRWC-79; 11 in SRWC-85, -86, -88; 9 in SRWC-89
	PC	
Individual Tree	Northwest FL	3 in SRWC-63, -64, -65, -66, -68; 1 in SRWC-67
Individual Tree	Northeast FL	9 in SRWC-63, -64, -65, -66, -68; 3 in SRWC-67; 2 in SRWC-73; 2 in SRWC-79; 1 in SRWC-85, -86, -88
Individual Tree	Central FL	4 in SRWC-63, -64, -65, -66, -67, -68

The 25 seedlots in the six 1996-97 studies were also included in a seedling seed orchard (CO97) established near Day, Florida, in December 1997. The best seedlings of the nine **BC** and 12 top **PC** seedlots in SRWC-63 based on averaged standardized height evaluations from Studies SRWC-63, -64, -65, -66, -67, and -68 (Gaviria 1998), plus ramets of three **BC** clones, were systematically assigned to single tree plots in 24 replications of an RCB design. Each replication was four rows of six trees at a spacing of 10 x 5'. The best seedlings of the four other **PC** seedlots in SRWC-63 were systematically allocated to four positions at the end of each row, resulting in an orchard of 320 trees (eight rows of 40 trees). Ten additional seedlots were interplanted in CO97 through 2000. Paclobutrazol was applied to 37 trees in June 1999.

SRWC-72 and SRWC-73 each evaluated seedlots in 6-tree row plots at 10 x 3' spacing. In SRWC-72, the row plots were randomized within four culture main plots that were replicated three times in a RCB design. The cultures were sewage effluent (E), E + M, E + compost (C), and E+M+C. SRWC-73 was a RCB design with five replications and only one culture - topsoil redistribution on top of a reclaimed phosphate mine.

SRWC-79 and SRWC-85 each used a RCB design with two replications to assess bedding with and without compost in main plots and 6-tree row subplots for seedlots. Spacing was 10' between beds and 3' within beds.

SRWC-86 compared three cultures, two spacings, and 14 seedlots in a RCB design with two replications. Unbedded, B, and B + C + weed control cultures were main plots, 10 x 3' and 10 x 6' spacings were subplots, and seedlots were six-tree row subsubplots.

SRWC-88 and SRWC-89 extended the assessment of the seedlots in SRWC-85 and SRWC-86 from flatwoods in north Florida to clay settling areas in central Florida. B and no B with and without fertilizer blocks in SRWC-89 included three replications of seedlot row plots. Spacing in SRWC-88 was 12 x 3', 12 x 5' in SRWC-89.

The seedlots evaluated in these studies (Table 2) included 64 **BC** accessions, of which 14 were provenance bulklots ranging from Illinois into Florida and 50 were individual tree collections from Arkansas, Texas, and Florida. The 18 **PC** accessions were all from individual trees in Florida. Except for the EREC trees, all planting stock was commercially grown 1-year-old bareroot seedlings. The EREC trees were wild seedlings transplanted from the vicinity of superior phenotypes.

Tree height and survival were measured periodically in all studies. In Study EREC and CO97, Diameter at Breast Height (DBH) was taken for use in calculating stand volume index (SVI = 0.00002618*DBH^2*Height*(Trees per ha: 4,444 for EREC, 2,152 for CO97)*(1 for a live tree, 0 for a dead/missing tree)), and tree quality on a 0 (straight stem, short horizontal branches) to 5 (crooked stem, long angular branches or forking) scale. Analyses of variance were conducted on these variables to identify significant genetic, silvicultural, and site factors. As appropriate, means were tested with Duncan's multiple range test.

RESULTS AND DISCUSSION

The five **BC** provenances in Study EREC differed in tree size but not survival, SVI, tree quality, basic density, and moisture content after 13 years (Table 3). The Oklawaha provenance had the tallest and largest DBH trees, but because it had less than 17% survival, its SVI was not significantly larger. Because of its greater survival, the Choctawhatchee provenance ranked second in SVI. The Blountstown provenance not only tended toward the smallest trees but the lowest survival and SVI. The Oklawaha provenance also had favorable tree quality and the highest percentage (6.7%) of top quality trees. Individual trees were up to 13m in height and

20cm in DBH in 13 years, but tree growth rate slowed considerably after 10 years, very likely because of the shallow muck soil and dry climate.

Significant differences among provenances were not detected in wood basic density or moisture content of pith-to-bark cores, although three provenances had denser wood in the 6-10 ring group (Figure 1) and the Ochlocknee and Oklawaha provenances tended to be denser. Basic densities of individual trees ranged considerably from .299 to .370. No consistent age effect was noted for basic density. At an average basic density of .330, the wood of the EREC **BC** is much less dense than previously reported for cypress (.47, Panshin et al. 1964).

While the Oklawaha provenance thus appears to be the best suited **BC** origin for planting on southern Florida muck, uncertainties about the representation and uniformity of these five provenances and the Study's low survival argue for continued and expanded genetic testing in south Florida.

Table 3. BC provenance means for survival, DBH, height, SVI, tree quality, basic density (g/cc), and moisture content (%) at 13 years in Study EREC.

Provenance	Survival (%)	DBH (cm)	Height (m)	SVI (m^3/ha)	Quality	Basic Density	Moisture Content
Blountstown	14.1a	14.0b	8.3b	43.4a	2.9a	.331a	203a
Choctawhatchee	44.4a	15.1b	9.4b	139.4a	2.9a	.320a	214a
Kennedy Creek	28.5a	15.4b	9.5b	90.4a	2.6a	.320a	213a
Ochlocknee	43.7a	14.1b	9.7b	111.6a	3.0a	.342a	193a
Oklawaha	16.7a	24.3a	11.8a	144.4a	2.5a	.338a	196a

*Provenance means not sharing the same letter for the same trait differ at the 5% level

Across the six studies established in 1996-97, nine **BC** provenances, three to five **BC** checklots, and 16 **PC** progenies were generally similar in early height and survival (Table 4). Growth in these studies also reflected site nutrition and moisture availability as Studies SRWC-64 and SRWC-68 on infertile, frequently dry sandhills grew poorly and Study SRWC-66 growth through four years on flatwoods was slight due to several droughty years. **PC** survival was the lowest of the three groups in Study SRWC-66, but survival of the taxa in all studies generally exceeded 90%. The best growth was in Study SRWC-63, which included fertilization and irrigation. Within taxa, individual provenance/progeny differences were significant, but no provenances or progenies were consistently better across sites that also included bottomland in northwest Florida (SRWC-65) and a fertile but poorly drained clay settling area in central Florida (SRWC-67).

While overall differences among the four cultures in SRWC-67 were not significant for 9-month tree height, the cultures differed significantly for survival. Both B alone and M alone increased survival and height over the unbedded, unmulched, and unfertilized control (90.8 and 94.6 vs. 77.9% for survival, 0.75 and 0.87 vs. 0.64m for height), and B+M+fertilizer culture increased height over the control (0.88 vs 0.64m) but decreased survival (65.4 vs. 77.9%), possibly due to root burn resulting from putting the slow release fertilizer pellets in the planting holes. On clay settling areas, M effectively controls cogon grass and B improves soil moisture.

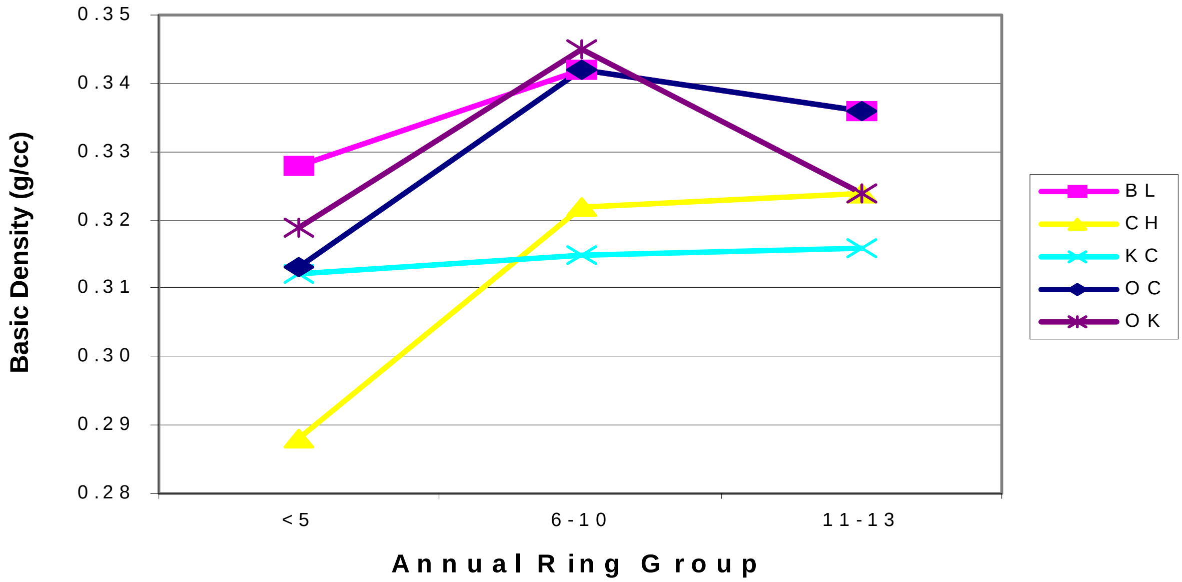

Figure 1. Variation in wood basic density with annual ring age in **BC** provenances Blountstown (BL), Choctawhatchee (CH), Kennedy Creek (KC), Ochlocknee (OC), and Oklawaha (OK) in Study EREC.

Table 4. BC, **PC**, and checklot minima, maxima, and means for survival and height in Studies SRWC-63 (9 months), -64 (9 months), -65 (9 months), -66 (4 years), -67 (9 months), and -68 (1 year).

Taxon	Study SRWC-					
	63	64	65	66	67	68
	Survival (%)					
BC	, 90.9b*	, 95.8a	, 95.5a	73.3,93.3 83.7ab	, 85.2a	, 96.7a
PC	, 96.0a	, 96.7a	, 95.8a	46.7,80.0 65.0b	, 77.6a	, 89.6b
Checklots	, 97.3a	, 99.0a	, 98.6a	80.0,90.0 86.7a	, 85.4a	, 94.4a
	Height (m)					
BC	1.15,1.27 1.19b	0.45,0.68 0.60a	0.69,0.92 0.77a	1.21,1.76 1.45a	0.68,1.01 0.82a	0.34,0.54 0.41b
PC	1.07,1.21 1.16b	0.52,0.73 0.64a	0.68,0.92 0.81a	1.34,1.78 1.51a	0.57,0.80 0.70b	0.40,0.62 0.50a
Checklots	1.15,1.34 1.23a	0.56,0.66 0.62a	0.80,0.84 0.82a	1.20,1.60 1.44a	0.84,0.96 0.90a	0.36,0.64 0.47a

*Taxa means not sharing the same letter for the same Study-Trait differ at the 5% level

In Study SRWC-72, in spite of intensive culture involving abundant water and nutrition, six **BC** progenies had low survival because of heavy weed competition at the 10 x 3' spacing. After nine months, trees without compost had higher survival but were shorter (E culture - 39% survival, 0.73m tall; E+M culture - 45% survival, 0.76m tall) than with compost (E+C - 30% survival, 1.61m tall; E+C+M - 18% survival, 0.87m tall) because of greater weed growth with compost. After 16 months, surviving trees in the E+C culture averaged 2.7m in height, suggesting the growth that could occur if good nutrition were combined with vegetation control on effluent irrigated sandhills sites.

Inconsistent topsoil redistribution hindered the growth of 21 **BC** progenies and two Florida **PC** progenies planted on a reclaimed phosphate mine in Study SRWC-73 (Table 5). After three years, overall survival was 96.4% but total height was only 0.84m. The 10 **BC** progenies from Arkansas were similar to the 10 from Florida in survival and height.

Table 5. Minimum, maximum, and average 3rd-year survival (%) and height (m) for 20 **BC** progenies, two **PC** progenies, and one checklot in Study SRWC-73.

Trait	Arkansas **BC**	Florida **BC**	**PC**	GC
No. of Seedlots	10	10	2	1
Survival	86.7,100 96.9a	93.3,100 96.8a	90.0,96.7 87.5a	-,- 93.3a
Height	0.72,1.00 0.84a	0.77,1.00 0.83a	0.92,0.92 0.92a	-,- 0.66b

*Taxa means not sharing the same letter for the same Trait differ at the 5% level

B+C on a good flatwoods site significantly increased the growth of 30 **BC** progenies and four Florida **PC** progenies compared to B alone in studies established in 1999 and 2000 (Tables 6 and 7). In SRWC-79 after two years, B+C increased height by more than 1 m and survival by more than 10%. The 15 **BC** progenies of Texas origin, 14 from Florida, and one from Arkansas were similar in performance. After one year of much below normal rainfall in SRWC-85, B+C only increased height slightly but still improved survival about 10% across taxa.

In SRWC-86 after nine months, the same **BC** and **PC** in SRWC-85 also responded significantly to silvicultural treatments. B+C, involving much less compost than in SRWC-79 and -85, was slightly superior to B alone for growth but not in survival (Table 7). B alone was in turn superior for height but not survival to no B (0.66, 0.69, and 0.75m, and 95.4, 100, and 95.8%, respectively, for **BC**, **PC**, and GC) on this average flatwoods site after one growing season with much below normal rainfall.

In SRWC-88, B on another fertile but poorly drained clay settling area resulted in good initial growth (Table 7). All seedlots had 100% survival in spite of below normal rainfall and considerable weed competition after the high beds became vegetated. All seedlots were at least 0.90m tall in just seven months after an early summer planting.

The most recent progeny test, SRWC-89, on a third clay settling area, and some 45,000 trees of the same seedlots in two adjacent large block plantings highlighted the advantages of good site preparation and bedding. As in SRWC-88, good bedding provided excellent initial

Table 6. Minimum, maximum, and average 2nd-year survival (%), height (m), and tree quality for 16 **BC** progenies, two **PC** progenies, and two checklots in response to bedding (B) and/or B+compost (C) cultures in Study SRWC-79.

Trait	B			B+C		
	BC	**PC**	GC	**BC**	**PC**	GC
Height	0.63,1.35 1.18a	0.94,1.29 1.09b	1.07,1.30 1.20a	1.57,2.53 2.13a	1.96,2.50 2.24a	1.90,2.30 2.09a
Survival	66.7,100 81.9a	66.7,83.3 75.0a	75.0,100 87.5a	75.0,100 91.1a	83.3,91.7 87.5a	91.7,100 95.8a
Tree Quality	3.5,4.5 4.0b	4.0,4.7 4.4a	3.5,3.6 3.5c	2.4,3.8 3.2a	2.4,3.4 2.9a	2.8,3.7 3.3a

*Taxa means not sharing the same letter for the same Culture-Trait differ at the 5% level

Table 7. Minimum, maximum, and average survival (%) and height (m) for 12 **BC** progenies, one **PC** progeny, and two checklots in response to bedding (B) and/or B+compost (C) cultures in Studies SRWC-85, -86, and -88.

Study -Age - Trait	B			B+C		
	BC	**PC**	GC	**BC**	**PC**	GC
SRWC-85 - 10 months - Height	0.79,1.54 1.07b	-,- 1.19ab	1.24,1.30 1.27a	0.80,1.32 1.15b	-,- 1.36a	1.20,1.26 1.23ab
- Survival	58.3,100 84.1a	-,- 83.3a	66.7,75.0 70.8b	58.3,100 90.1a	-,- 100a	91.7,100 95.8a
SRWC-86 - 9 months - Height	0.56,0.92 0.79b	-,- 0.97a	0.84,1.04 0.95a	0.85,1.04 0.93b	-,- 1.11a	0.97,1.04 1.00ab
- Survival	91.7,100 98.1a	-,- 95.8a	91.7,100 95.8a	95.8,100 99.6a	-,- 95.8a	95.8,100 97.9a
SRWC-88 - 7-months - Height	0.90,1.10 1.00a	-,- 0.90b	1.04,1.06 1.05a	-,- -	-,- -	-,- -
- Survival	100,100 100a	-,- 100a	100,100 100a	-,- -	-,- -	-,- -

*Taxa means not sharing the same letter for the same Study-Culture-Trait differ at the 5% level

control of cogon grass, willows, and other vigorous competition common on unbedded clay settling areas in central Florida.

In the seed orchard CO97, many of the 12 **PC** progenies, nine **BC** provenances, and three **BC** clones grew well in response to irrigation and weed control (Table 8). Overall, the **BC** provenances had the best survival and largest tree size and SVI, while the **PC** progenies had the best tree quality. The **BC** clones had low survival and the worst tree quality. The ranges among **PC** progeny means was always greater than among **BC** provenance means, suggesting the potential for making more genetic gain by selecting among progenies instead of among provenances. Several **PC** progenies combined good survival with large tree size and desirable quality characteristics. Individual **BC** and **PC** trees were up to 5.2m tall in four years.

Production of improved seed for operational planting began with cones produced in Fall 2000 on trees five years from seed. While the paclobutrazol treatment was applied in time to influence the 2000 cone crop, its significance for enhancing cypress seed production is unquantified.

Table 8. Minimum, maximum, and average 4th-year survival, height, DBH, SVI, and tree quality of nine **BC** provenances, three **BC** clones, and 12 **PC** progenies in seedling seed orchard CO97.

Taxon	Survival (%)	Height (m)	DBH (cm)	SVI (m^3/ha)	Tree Quality
BC Provenances	75.0-91.6 88.9a	2.9-3.7 3.3a	4.0-5.2 4.6a	3.63-6.74 4.91a	2.3-3.5 3.1b
BC Clones	41.7-93.3 63.9b	2.9-3.0 3.0a	3.2-4.0 3.7b	2.37-3.86 2.91b	3.5-5.1 3.9a
PC Progenies.	33.3-75.0 56.3b	2.4-3.8 2.9a	1.6-5.5 3.2b	1.30-3.58 2.44b	1.6-3.5 2.6b

*Taxa means not sharing the same letter for the same trait differ at the 5% level

The **BC** and **PC** comparisons in the current studies are inconclusive. No single study includes a wide enough representation of **BC** or **PC** provenances or progenies to make extensive taxa level comparisons. Different **BC** and **PC** seedlots, and genetic checklots, across the series of studies, i.e., SRWC-63 to -68 and CO97, SRWC-72 and -73, SRWC-85 to -89, limit comparisons across the three series. With the exception of EREC, all studies can now only provide preliminary conclusions. Still, large differences were noted among **BC** and/or **PC** progenies in the individual studies.

Results to date suggest potential for commercial cypress plantations on non-wetland sites in Florida for the production of mulchwood and sawtimber in rotations of 10 to 25 years. Genetic improvement through limited provenance selection and particularly progeny selection can contribute to productivity enhancements. Silvicultural enhancements, notably good site preparation, vegetation control, and nutrition amendments, following selection of good quality sites, are essential. Assessment of genetic variation and cultural requirements of **BC** and **PC** is ongoing through the studies presented here and through planned studies and new accessions which will expand the cypress genetic base population beyond the current 82 seedlots (Table 2).

ACKNOWLEDGMENTS

We gratefully acknowledge Lehman Hardy, George Snyder of the Everglades Research and Education Center, Marvin Buchanan of Central Florida Lands & Timber, Bill Lowe of the Western Gulf Tree Improvement Program, Cargill Fertilizer, Knights Sawmill, the Common

Purpose Institute, PCS Phosphates, the City of Orlando/Orange County, the Northwest Florida Water Management District, Foley Lands and Timber, Greenleaf Products, and the Florida Institute of Phosphate Research for invaluable assistance in designing, installing, maintaining, measuring, and/or funding these studies.

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