

PERFORMANCE OF SLASH PINE BARE-ROOT SEEDLINGS AND CONTAINERIZED ROOTED CUTTINGS PLANTED ON FIVE DATES IN LOUISIANA

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Abstract—Landowners are interested in extending the normal planting season, as well as the comparative field performance, of nursery bare-root seedlings and containerized rooted cuttings. The effect of seasonal planting dates on field performance of two stock types of slash pine (*Pinus elliottii* Engelm.) was examined. Slash pine bare-root seedlings (BRS) and containerized rooted cuttings (CRC) were hand planted in September, November, January, March and April in 2000-2001, 2001-2002, and in 2002-2003 on three poorly drained silt loam sites in western Louisiana. Stock types were planted in adjacent row plots and treated identically after planting. Thus far, mean survival of CRC is consistently high at 96 percent, whereas BRS survival is significantly lower at 78 percent and highly variable across planting dates and years. Height growth of trees planted in September, November, and January was significantly higher than that for trees planted in March and April.

INTRODUCTION

Originally restricted to 3 million ha, slash pine's range has been extended by planting to more than 5 million ha at present (Ezell and Moorhead 2000). Bare-root planting stock is primarily used for planting the southern pines (Barnett and Brissette 1986, Brissette and others 1983), and this is normally restricted to the dormant season, late November through early March, to ensure increased survival through reduced planting shock. There is also an escalating interest in using rooted cuttings as planting stock for pines (Stelzer and others 1998). Vegetative propagation can deliver planting stock of higher genetic quality that may increase yield and shorten rotations (Weber and Stelzer 2000). However, research to date on the relative performance of rooted cuttings and bare-root southern pine seedlings have yielded mixed results (Foster and others 1987, Stelzer and others 1998). Rooted cuttings can be grown either as containerized or bare-root. Many studies have shown that planting containerized stock can greatly extend the planting season (Barnett and McGilvray 1993), to year-round in some cases (Malinauskas and Sukhotskas 1996). It can also raise the utilization rate of cuttings because of less falldown in the nursery. The objective of this study was to compare the survival and growth of slash pine bare-root seedlings and containerized rooted cuttings when planted on five different annual planting dates.

MATERIALS AND METHODS

Study Sites

Two locations in Beauregard Parish and one location in Calcasieu Parish in southwestern Louisiana were planted for this study. The soils at all three sites are very deep, poorly drained, silt loam Alfisols on nearly level to very gently sloping terraces. The climate is warm and humid. Average annual temperature is 19.3 °C and annual precipitation is 1,494 mm (date for DeQuincy, LA, 1940-90). The study sites, previously planted with slash pine stands, were clearcut and mechanically bedded with a combination plow in 2000. Prior to planting, sites were sprayed with triclopyr and glyphosate to control competing vegetation. After planting, hexazinone and sulfometuron methyl was applied

to control herbaceous vegetation and to promote uniformity across sites.

Planting Stock and Study Establishment

Planting stock tested in this study were bare-root seedlings (BRS) and containerized rooted cuttings (CRC) of slash pine. The BRS were produced through standard nursery culture at the Beauregard Nursery near Merryville, LA. The CRC were produced by Boise Corporation at their seed orchard near Evans, LA. Cuttings were harvested from less than 3-year-old slash pine hedges. CRC were full-sib and BRS were half-sib in the 2000-2001 planting season. They had one parent in common, whereas both CRC and BRS were full-sib from the same family in the 2001-2002 planting season. Both CRC and BRS were hand planted at 1.8-by 3.4-m spacing. BRS were lifted and planted on the same day. All trees were fertilized at planting with diammonium phosphate at the equivalent of 225 kg per ha.

Study Design and Statistical Analysis

Each location was planted on five different dates (September, November, January, early March, late April) in three successive years (2000-2001, 2001-2002, 2002-2003). Data from the first two planting seasons are discussed in this paper. The design was a split-plot with planting date as the main plot and stock type as the sub-plot. Trees were planted in 20-tree rows with 10 replications per site-year. This layout required planting 18,000 trees. Analysis of variance was performed using the General Linear Model procedure of SAS for a split-plot design (SAS Institute 1997). Percentage survival data were arcsin transformed before analysis, but untransformed means were presented for clarity. Mean separations were tested using the Duncan's new multiple range test ($\alpha = 0.05$) method.

Measurements

Basic measurements included survival, height, groundline stem diameter (GLD), and diameter at breast height (d.b.h.). Survival was determined for all plantings every September. Tree size was measured for all plantings every January.

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RESULTS AND DISCUSSION

Survival

Survival data for the 2000-2001 plantings (fig. 1), measured in September of 2002, showed that CRC had a significantly ($P < 0.0001$) higher survival (95 percent) than did BRS (79 percent). Time since planting ranged from 17 to 24 months at the September 2002 survival assessment. BRS survival varied from 87 percent for the April planting to as low as 64 percent for March. However, CRC survival varied from 98 percent for the November planting to 87 percent for April.

Survival of the 2001-2002 plantings (fig. 2), also assessed in September 2002, showed that CRC (98 percent) significantly ($P < 0.0001$) out-performed BRS (77 percent). Time since planting ranged from 5 to 12 months at the September 2002 survival assessment. BRS survival varied from 95 percent for the November planting to as low as 52 percent for September. Alternatively, CRC survival varied little, from 99 percent for January to 96 percent for April. To summarize, CRC survival was significantly ($P < 0.0001$) higher than that for BRS in both years.

Height, GLD and D.B.H.

Trees planted in the 2000-2001 season were in the field between 9 to 16 months when total height and groundline stem diameter data were collected in January 2002. CRC planted in September 2000 through March 2001 were taller than BRS, but there was no height difference between BRS and CRS planted in April 2001 (fig. 3).

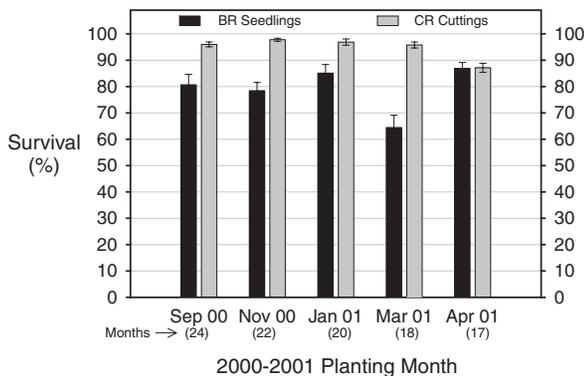


Figure 1—Survival of 2000-2001 plantings. Error bars indicate one standard error. Numbers in parentheses show months since planting.

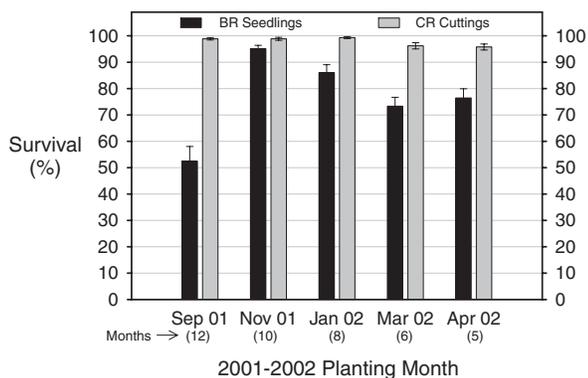


Figure 2—Survival of 2001-2002 plantings. Error bars indicate one standard error. Numbers in parentheses show months since planting.

Height and GLD of trees planted in the 2000-2001 planting season were measured again in January 2003 (figs. 4 and 5). Time since planting varied from 28 months for September 2000 to 21 months for April 2001. Tree height averaged for both stock types varied in the order September > November

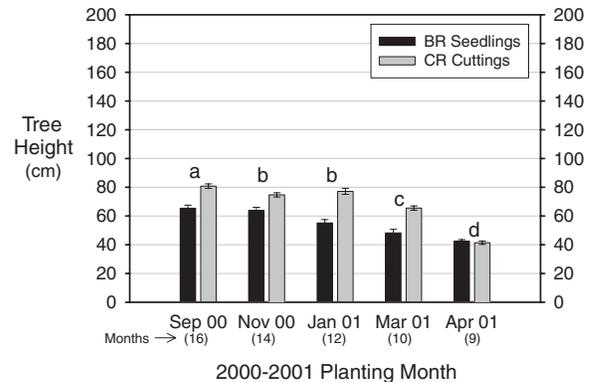


Figure 3—Mean height of 2000-2001 plantings measured in January 2002. Error bars indicate one standard error. Numbers in parentheses show months since planting. Letters are statistical differences ($\alpha = 0.05$) for months as a main effect.

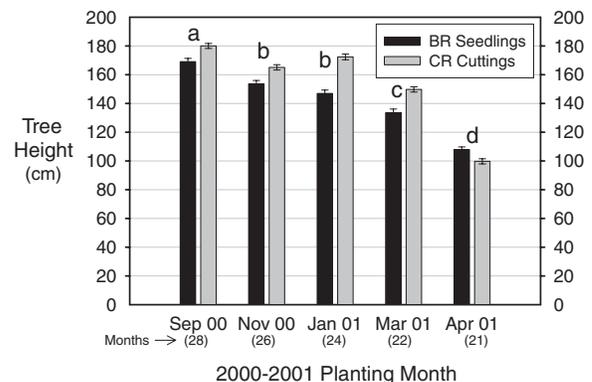


Figure 4—Mean height of 2000-2001 plantings measured in January 2003. Error bars indicate one standard error. Numbers in parentheses show months since planting. Letters are statistical differences ($\alpha = 0.05$) for months as a main effect.

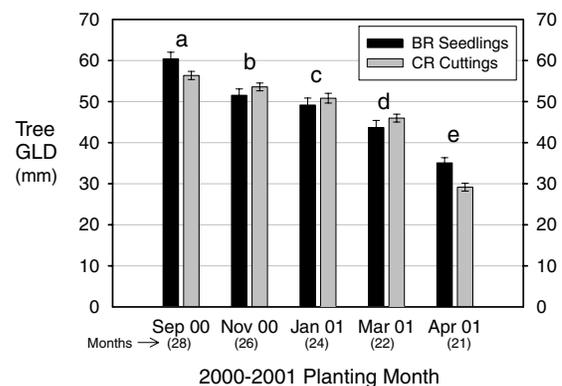


Figure 5—Mean groundline stem diameter of 2000-2001 plantings measured in January 2003. Error bars indicate one standard error. Numbers in parentheses show months since planting. Letters are statistical differences ($\alpha = 0.05$) for months as a main effect.

= January > March > April (fig. 4). CRC were significantly ($\alpha = 0.05$) taller than BRS in every planting month except April, when there was no difference.

Similarly, GLD varied in the order September > November > January > March > April across stock types after 21 to 28 months in the field (fig. 5). However, GLD differed between stock types only in trees planted in September and April when bare-root seedlings had significantly ($\alpha = 0.05$) larger GLD than did CRC, 28 and 21 months after planting, respectively.

Height and GLD of trees planted in 2001-2002 season were measured in January 2003. CRC were significantly ($\alpha = 0.05$) taller than BRS, except for April plantings for which there were no differences. CRC had significantly ($\alpha = 0.05$) higher GLD than did BRS for all months (fig. 6).

Diameter at breast height was also measured for those trees that had a d.b.h. of at least 1.5 cm. There were no d.b.h. differences between stock types or planting months after 21 to 28 months in the field (fig. 7). As expected, early plantings had a larger percentage of trees that had developed a d.b.h. than did the later plantings (fig. 8).

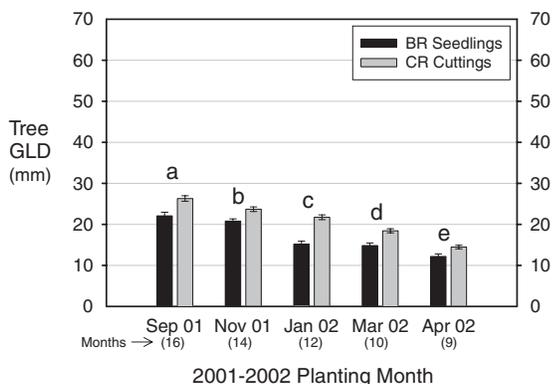


Figure 6—Mean groundline stem diameter of 2001-2002 plantings measured in January 2003. Error bars indicate one standard error. Numbers in parentheses show months since planting. Letters are statistical differences ($\alpha = 0.05$) for months as a main effect.

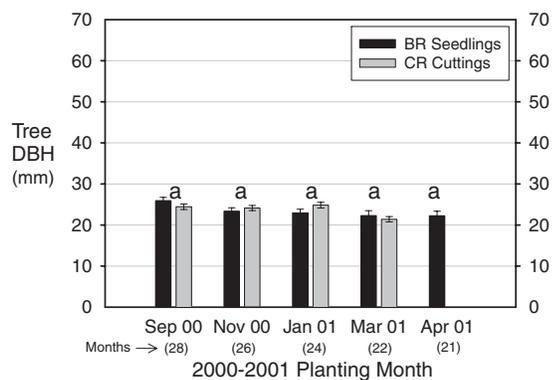


Figure 7—Mean diameter at breast height of 2000-2001 plantings measured in January 2003. Error bars indicate one standard error. Numbers in parentheses show months since planting. Letters are statistical differences ($\alpha = 0.05$) for months as a main effect.

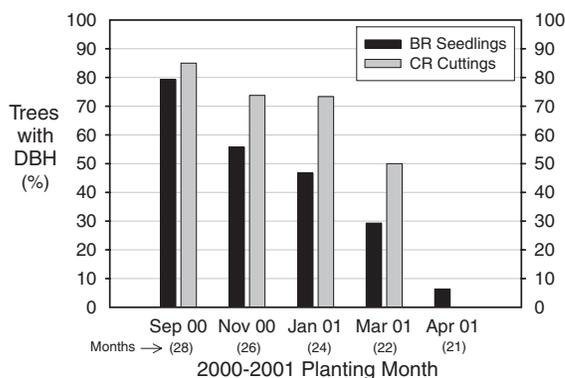


Figure 8—Percentage of trees that had developed DBH. Numbers in parentheses show months since planting.

Total Plot Height

Height data for the 2000-2001 plantings were weighted with survival data by calculating a total plot height through summing the heights of all existing trees on a plot in January 2003 (fig. 9). CRC had higher total tree plot height than did BRS for all planting months except for April. Total plot height varied little among September, November and January plantings for CRC. For BRS, September plantings had the highest total plot height, whereas the spring plantings (March and April) had the lowest.

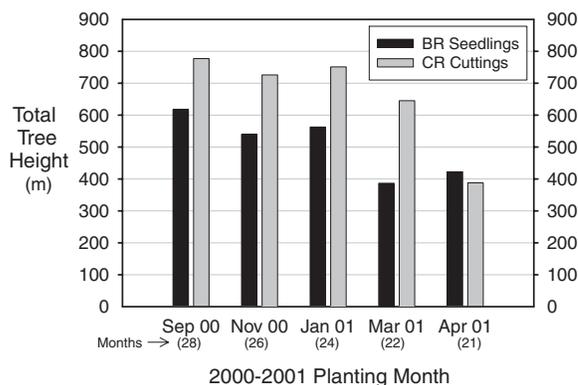


Figure 9—Total plot tree height of 2000-2001 plantings measured in January 2003. Numbers in parentheses show months since planting.

DISCUSSION

CRC planted between September 2000 and March 2001 had greater height and GLD growth compared to BRS at the end of the first full growing season in January 2002. Measurements in January 2003 show that 21 to 28 months after planting, CRC were taller than BRS. However, the GLD difference between stock types was negligible in the second year. BRS planted in September 2000, the oldest in the field, had the highest mean GLD in January 2003. The difference in heights but the lack of difference in GLD between the stock types suggests a difference in tree form in these young trees. Some studies with radiata pine showed that vegetative propagules had straighter boles with less taper (Libby and others 1972, Spencer 1987). However Stelzer and others (1998) did not find any differ-

ence in height, d.b.h., volume or stem taper between the rooted cuttings and seedlings of 10-year-old loblolly pine although they reported early age propagule differences.

Height difference between stock types was also lessening at the end of the second growing season. BRS height increment averaged across all five planting times was greater in the second growing season than that of CRC, but CRC had greater height increment in the first year. Foster and others (1987) found that rooted cuttings were significantly taller at ages one and four although the seedlings had higher relative growth rates. These results may indicate that the differences in early years might virtually disappear as the trees mature.

We suspect that CRC's greater height and GLD increment in the first growing season is an indication of CRC's quick adaptation to its environment after being planted. Whereas second-year growth of BRS was higher than that of CRC, the often much lower survival of BRS makes total area-wide production less than that of CRC. Some research indicated the higher survival of cuttings compared to seedlings (Frampton and others 2002, Stelzer and others 1998). Struve and others (1984) found that trees from rooted cutting origin had greater wood volume per hectare per year relative to trees from seedlings, and they attributed this to the higher survival rates of trees from rooted cuttings.

Survival and growth data indicate thus far that use of CRC can extend the planting season by allowing planting as early as September. Extending the planting season by planting later into the spring thus far has produced more disappointing results than planting early. Our data suggest that CRC, with its superior and steady survival and often better height growth, has thus far out-performed BRS.

ACKNOWLEDGMENTS

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