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The Effects of Fall Planting on the Performance of Containerized Longleaf Pine Seedlings

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Abstract

Two studies were initiated in 2003 (Test 1) and 2005 (Test 2) to examine the effects of fall planting on the survival and growth of container grown longleaf pine seedlings. Treatments evaluated were planting dates of longleaf seedlings lifted and then out-planted every two weeks from early September through December. Survival and height was measured after three years on both tests, after six years on Test 1, and after five years on Test 2. Results showed that percent survival increased significantly (p= 0.05) from the September through the December planting dates while seedling as measured in height decreased significantly (p=0.05). Third year height across all planting dates averaged 3.38 feet and 2.75 feet for Test 1 and Test 2 respectively. Overall survival for Test 1 was very poor, ranging from 21 percent for the Sept 4th and Sept 30th planting dates to 39 percent for the Nov 28th planting date. Test 2 survival was higher ranging from 45 percent for Oct 21st to 85 percent for Nov 3rd. For both test years the best survival and growth is realized for the October and November planting dates. For Test 1 significant height differences (p= 0.05) remained at age six, with values ranging from 10.6 feet to 13.6 feet. For Test 2 no significant height differences were found at age five, with values ranging from 9.02 feet to 10.38 feet. The periodic annual height growth increment was 2.98 feet from age 3 to age 6 for Test 1, and was 3.42 feet from age 3 to age 5 for Test 2. Study results suggest that survival is not greatly improved by early fall planting but better growth is realized. Early growth gains diminish by the 6th growing season.

Introduction

Since the early 1990's, containerized seedlings have become the preferred stock type for regenerating longleaf pine largely because of higher and more consistent survival and may nitiate height growth sooner compared to bare-root longleaf seedlings. This performance advantage is assumed to be because the container plug protects the root system from damage during lifting, storage, and planting. In addition the plug peat medium provides moisture to the seedling until the roots grow and are able to extract water from the soil, a process that might take a week or more.

Container seedlings are typically planted from November through March when the seedlings are dormant and planting site soil moisture is high. Some foresters suggest that survival and early growth increases if longleaf seedlings are planted in early fall. Nursery managers encourage early planting to increase the seedling lifting window and to reduce mortality from winter freezing at the nursery.

The study was initiated to examine the effects of fall planting on the growth and survival of longleaf pine seedlings. Tests were established in 2003 and 2005. The study sought to demonstrate the benefits of early planting on the growth of longleaf containerized seedlings. The hypothesis is that early planting improves establishment success and increases the number of seedlings that initiate height growth at the end of the second growing season.

Methods

Both study sites are located at Bladen Lakes State Forest on a Keenansville soil series. The soil is described as a well-drained, deep sand with a low water holding capacity and a mean annual water table below 80 inches. The first test was installed in September of 2003 (Test #1) and the second in September of 2005 (Test #2).

Genetically improved 1-0 container-grown seedlings from the NC Forest Service Claridge

Figure 1. BLSF forester Hans Rohr measuring height at age three on the Test 2

Nursery were out-planted every two weeks from September through December. Seedlings were extracted from their containers and planted on the same day. In Test 1 a total of 160 trees were planted each planting date in a randomized 20 tree-row design replicated eight times. In Test 2 a total of 120 trees were planted on each planting date in a randomized 20 tree-row plot design replicated 6 times. Test 1 evaluated 9 planting dates and Test 2 evaluated 8 planting dates. Survival was tallied after the first year and survival and height measured after the third year on both tests. Test 2 seedling height was measured 2 growing seasons after out-planting and used to determine percent seedling initiating height growth. Height was measured on the sixth year for Test 1 and the fifth year for Test 2.

For Test 1 a destructive sampling plot of twenty seedlings was established for each planting date. The first week of February after planting, ten seedlings per plot were extracted to measure winter root growth. Roots of the seedlings collected were washed to remove all the potting medium or soil. The root collar diameter was measured. The seedling was cut in half at the root collar and root biomass and foliage biomass was oven-dried, and weighed.

Duncan's multi-range test was used to analysis the data for statistical significance.

Results and Discussion

Root Diameter and Weight

Test #1 (2003)—Fall and early winter root growth was measured for all treatments (Table 1). Root system measurements did not show significant differences among the planting dates for root collar diameter (RCD) or foliage weight. Significant differences for root weight are evident (p=0.05) with the late summer and early fall planting dates showing best growth.

Survival

Test #1 (2003) -- Survival three years after out-planting was very poor across all planting dates ranging from 21 percent to 39 percent. An anomaly in the test is seen for the December 12th treatment which recorded a survival rate of 84 percent. The reason for the poor overall survival and the anomaly are not apparent. Percent survival values for each planting date are depicted in Table 2.

Test #2 (2005) – Significant survival differences are evident three years after planting. Survival after three years ranged from 45 percent to 85 percent. Survival was poorest on the Oct 21st planting date, while the November 3rd planting date had the best survival. Survival difference is not statistically significant (p=0.05) among the October 5th, October 21st, November 17th, or December 13th planting dates. Survival values for each planting date are depicted in Table 3.

Figure 2. These photos show the new root growth exiting from the soil plug for seedling planted 1. September 4th, 2. September 30th, 3. November 28th, and 4. December 19th. Seedlings were dug up for measurement on March 1st.

Table 1. Root growth results for Test 1 seedlings dug up on March 1 to measure dormant season development.

Planting Date	Root Weight (grams)	RCD (inches)	Foliage Weight (grams)
4-Sep	3.49 ab	0.29 a	5.20
18-Sep	5.15 c	0.29 a	5.42
30-Sep	4.43 bc	0.29 a	7.43
16-Oct	3.02 ab	0.29 a	7.24
30-Oct	3.16 ab	0.31 a	8.51
12-Nov	3.29 ab	0.33 a	6.27
28-Nov	2.81 a	0.32 a	5.33
9-Dec	2.83 a	0.29 a	4.02
19-Dec	3.00 a	0.29 a	5.46

Height

Table 2. Height and survival results at age 3 and height age 6 for Test 1.

Planting Date	Third Year Percent Survival	Third Year Height (feet)	Sixth Year Height (feet)	Periodic Annual Growth Increment Year 3 to Year 6
Sept 30	21% c	4.3 e	13.3 a	3.0
Sept. 4	21% c	4.1 e	13.6 a	3.2
Sept. 18	23% c	3.9 de	12.9 ab	3.0
Oct 30	32% b	3.8 de	12.4 ab	2.9
Oct 16	19% c	3.7 de	13.3 a	3.2
Nov. 13	31% b	3.3 cd	12.4 ab	3.0
Dec. 19	34% b	2.9 bc	11.4 bc	2.8
Nov 28	39% b	2.5 ab	10.9 c	2.8
Dec. 9	84% a	2.1 a	10.6 c	2.8

Test #1 (2003) - Height growth shows a significant decreasing trend from the September through December planting dates. Height after three years averaged 3.4 feet. The tallest trees were planted in mid September, October, and early November. The worst height growth occurred on the September 8th planting date and both December planting dates. Height after six years averaged 12.3 feet across all planting dates with a range from 10.6 feet to 13.6 feet. Significant height differences among the planting dates were measured at six years (p=0.05). The tallest trees are found in the September, October, and early November planting dates. The periodic annual height increment averaged 3.0 feet ranging from 2.8 feet to 3.2 feet height growth per year per from year three to year six. Average height values for each planting date are depicted in Table 2.

Test #2 (2005) - Height after three years averaged 2.7 feet. Significant height differences among planting dates were measured (p= 0.05). The best growth occurred on the trees planted from mid September through early November. The worst growth occurred in trees planted early in September or December. The general trend shows slight decrease in overall height from September through December. More seedlings remained in the grass stage for the December planting dates compared to early fall planting dates. The seedlings that got out of the grass stage earliest are generally the tallest after three years. Height after 5 years averaged 9.6 feet ranging from 9.0 feet to 10.4 feet. No significant height differences among planting dates are noted (p= 0.05). Early height differences are no longer evident after five years. The periodic annual height increment averaged 3.4 feet (ranging from 3.2 feet to 3.7 feet per year) for the period from year three to year five. Average height values for each planting date are depicted in Table 3.

Table 3. Test #2 (2005) height and percent survival results measured at three years, height measured five years after planting and percent height growth initiation two years after planting.

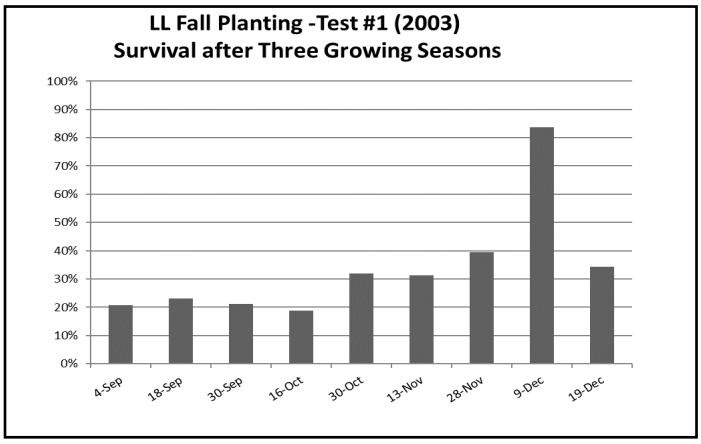
Planting Date	Third Year Height (feet)	Fifth Year Height (feet)	Third Year Survival	Height Growth Initiation after 2 years
Nov. 3	3.3 b	9.2 a	77% c	80%
Oct. 5	2.8 ab	10.0 a	69% bc	82%
Oct 21	2.8 ab	9.3 a	56% ab	83%
Sept. 22	2.8 ab	9.1 a	58% ab	84%
Sept. 8	2.6 a	10.4 a	52% a	78%
Nov. 17	2.6 a	9.6 a	74% bc	77%
Dec. 13	2.5 a	9.0 a	71% c	69%
Dec. 1	2.4 a	10.0 a	71% c	62%

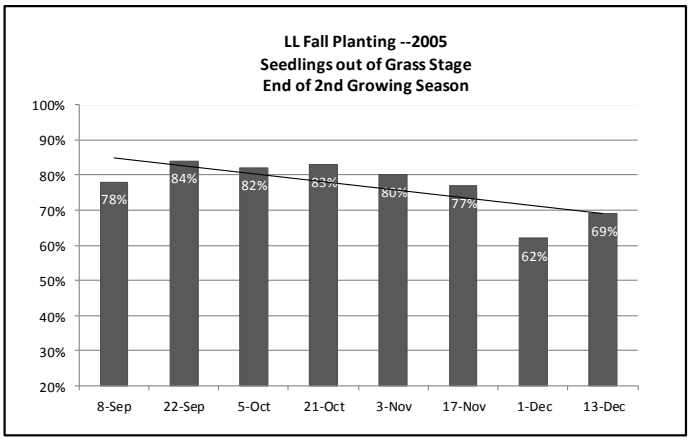
Conclusions

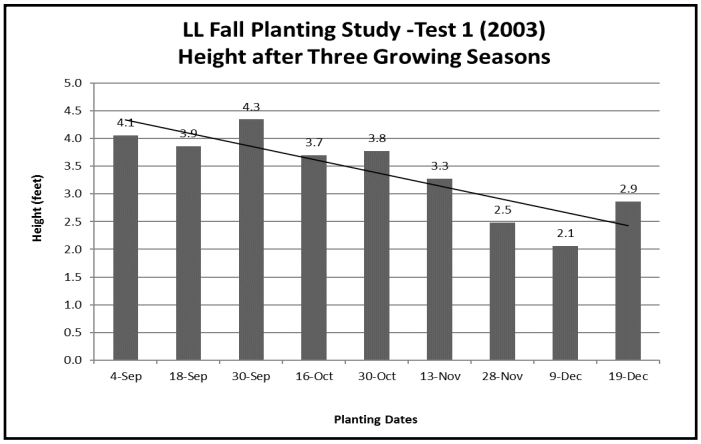
This study supports previous findings that report adequate survival rates and increased early growth. for seedlings planted early. The poor survival rates measured in this study for the September planting dates are likely due to increased moisture stress on the seedlings from the droughty soil type and seasonally higher evaporation and transpiration rates. Although not part of this study, it was observed by the author that survival was aversely impacted planted with lower soil moisture. Survival increased for seedlings that experienced rain within 2-3 days before or after planting. Good survival rates for this soil type are seen for the October, November, or December planting dates when soil moisture is high or increasing and seasonally influenced evapotranspiration is low or declining.

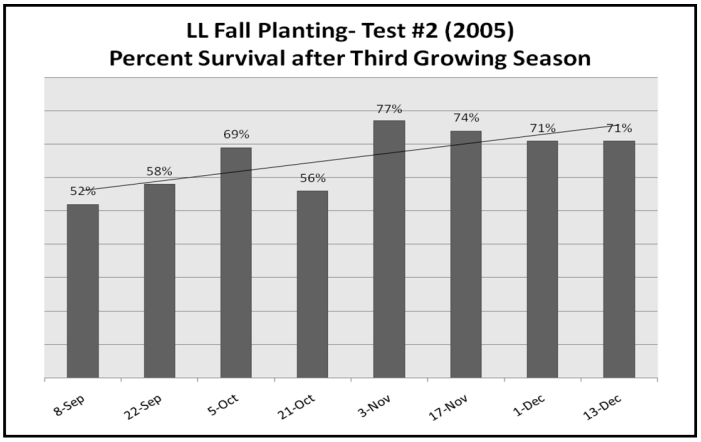
At age 3 seedlings planted in October and early November are taller and have the fewest seedlings remaining in the grass stage . The number of seedlings beginning height growth and their subsequent early growth decreased significantly for planting dates from mid November and both December. We believe this is due to diminished winter root growth in response to lower soil temperatures. The early growth advantage gained in the first three growing seasons disappeared by age 5 for Test 2 and was diminishing in Test 1.

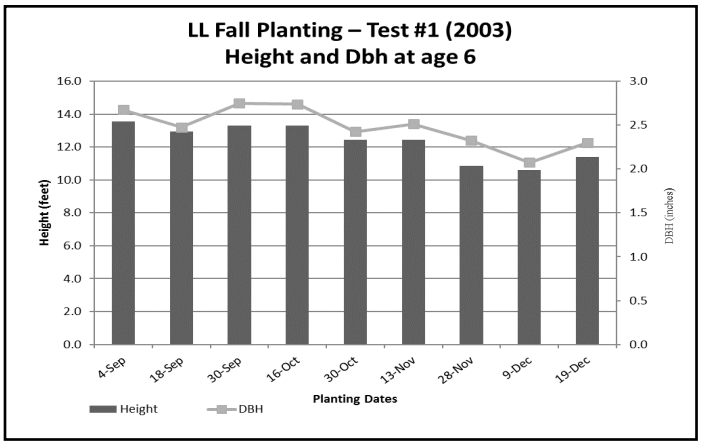
The study results support the recommendation to plant containerized seedlings in the fall months. Good survival can be expected with fall planting especially when planted with adequate soil moisture. Better early height growth and height growth initiation is expected for seedlings planted in October and November. The benefit of the seedlings getting out of the grass stage quicker outweighs the lower survival rate that may result with early planting. Higher survival rates are also likely on better sites and with good site preparation that controls herbaceous competition. Seedlings planted in the winter months remain in the grass stage longer and are more susceptible to vegetative competition. The early growth response to fall planting was not maintained and the average height began to converge by age five.











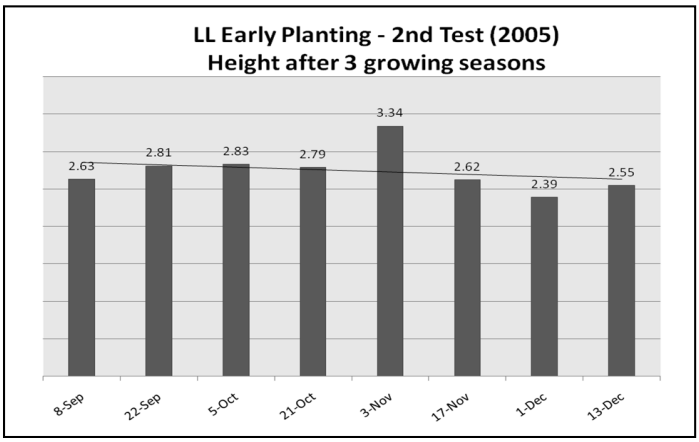


Figure 3. Average percent survival three years after out-planting, height three years after out-planting, and height and DBH six years after out-planting for longleaf seedlings from Test #1 (2003)

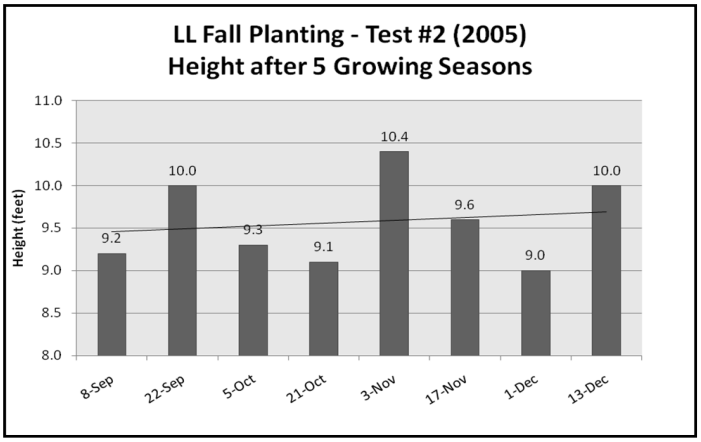


Figure 4. Percent of seedlings out of the grass stage and initiating height growth 2 years after out-planting, average percent survival 3 years after out-planting , and height in feet 5 years after out-planting. from Test #2 (2005)