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EFFECTS OF SUBSOILING AND COMPETITION CONTROL ON FIRST YEAR SURVIVAL AND GROWTH OF FOUR HARDWOOD SPECIES

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Abstract—Afforestation of abandoned agricultural land with hardwood seedlings is being conducted on thousands of acres in the South annually. More than 300,000 acres have been planted under the auspices of the Wetland Reserve Program, and other cost-share programs also promote the planting of hardwood species. Unfortunately, survival in many of these planting efforts has been extremely low. To evaluate the importance of cultural treatments on first-year survival, one-half of previously cultivated area was subsoiled in October 2001. The remainder of the test area was not treated mechanically. In February 2002, 1-0, bareroot seedlings of Shumard oak (*Quercus shumardii*), water oak (*Q. nigra*), willow oak (*Q. phellos*) and green ash (*Fraxinus pennsylvanica*) were planted by hand (half of each species in subsoil trenches; half in adjacent untreated areas). Oxyflurofen and sulfometuron were applied over-the-top of the planted seedlings for control of herbaceous vegetation with three replications of each species/treatment combination. Initial total height and groundline diameter (GLD) were measured for sample trees in each species/treatment plot including trees in untreated check plots. In November 2002, survival was evaluated, and height and GLD were remeasured. Subsoiling significantly increased both height and groundline diameter. Survival was not affected by any of the treatments, but differences are expected in year 2 or 3.

INTRODUCTION

Thousands of acres are planted with hardwood species each year in the South. While this regeneration practice is applied to cutover areas, a significant proportion of these acres is on "retired" agricultural land. To date, more than 300,000 acres of such land has been planted in the Lower Mississippi Alluvial Valley (Gardiner and Oliver 2002). Unfortunately, many of these acres have experienced very low survival (James 2001), and in effect, the hardwood planting effort has been of little or no value on many thousands of acres. The potential for afforestation with hardwoods is very significant. By 2040, it is estimated that more than 30 million acres of retired agricultural production land will be planted in trees (Wear and Greis 2002). Of this total, a notable portion will be planted with pines, but due to landowner disposition, site variables, and the current market for some pine products, millions of these acres are forecast to be planted with hardwoods. It is therefore extremely important that future hardwood regeneration efforts result in greater seedling survival.

The variables which must be addressed in hardwood seedling survival are seedling quality, planting quality, soil-site conditions, and competition control (Ezell and Hodges 2002). Landowners must learn to match the proper hardwood species to regeneration sites, use only high-quality seedlings, and ensure a high quality planting effort is utilized. What lies beyond the control of the land manager is the weather and resulting site conditions during the growing season. On most sites, it is virtually impossible to plan for extreme drought or flood conditions. However, the competing vegetation is known to be well-established on these former agricultural lands, and decades of cultivation or grazing are known to have created potentially negative soil conditions. Thus, this study was undertaken to evaluate the influence of both subsoiling and herbaceous competition control on the first-year survival and growth of four hardwood species.

MATERIALS AND METHODS

Study Site

The study was installed on the Mississippi Agricultural and Forestry Experiment Station near Pontotoc, MS. The site had been retired from production after decades of cultivation and/or use for pasture. At the time of study initiation, the site was occupied by a mixture of fescue, *Andropogon*, and broadleaf forbs. Such a site is truly representative of millions of acres across the South which will be planted with hardwoods.

Treatments

One-half of the study site was subsoiled in November, 2001. The subsoil trenches were installed on 10-foot centers, and the depth of the subsoiling was approximately 18 inches. The site was dry at the time of mechanical treatment, and the subsoiling would have been very successful at breaking any restrictive/compacted layers within the treatment depth.

In January, 2002, seedlings of Shumard oak, water oak, willow oak, and green ash were planted on the site. One-half of each species was planted in the subsoiled trenches, and one-half was planted in the adjacent untreated area. The plantings were arranged into three "planting blocks" with each species represented in each block. These blocks served to provide three replications of all species/competition control combinations.

In February, three competition control treatments were applied (table 1). All treatments were applied prior to any of the seedlings breaking dormancy. An untreated portion was retained for each species in each planting block. Thus,

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Table 1—List of treatments used in 2002 hardwood planting study

Treatment	Herbicide
no.	*rate per acre*
1	Goal 2XL (64 oz.)
2	Oust XP (2 oz.)
3	Goal (32 oz.) + Oust XP (1 oz.)
4	Untreated

the experimental design was four species x two soil treatments x four competition control treatments x three replications. All preemergent (February) herbicide treatments were applied in a six-foot swath over-the-top of the planted seedling using a CO_2-powered backpack sprayer with a 4-nozzle hand-held boom. Total spray volume was 20 gallons per acre. A grass herbicide (Select®) was applied in June to all herbicide treatment plots.

Data Collection and Analysis

After planting but prior to herbicide application, the aboveground height and groundline diameter (GLD) were measured on each seedling. Plots were evaluated at 60, 90, 120, and 150 days after initial herbicide treatments with an ocular estimate of percent ground cover by grass, broadleaves, or vines. At the same timings, seedlings were evaluated for any phytotoxic symptomology. In December, 2002, seedlings were evaluated for survival, height, and GLD. Data was subjected to analysis of variance (ANOVA) and means separation tests.

RESULTS

Survival

Survival ranged from 91.7 percent to 100 percent in all treatment plots. No significant differences resulted from any treatment or combination of soil/herbicide treatments. Precipitation on the study site was more than adequate during the growing season of 2002. Based on measured seedling parameters and earlier studies (Hodges and Ezell 2001), it will not be surprising to see appreciable mortality in untreated plots in the next few years.

Height Growth

Average total height for all species and treatment combinations is found in table 2. For Shumard oak, there was no significant difference among any competition control treatments within a soil treatment. However, trees in the subsoiled area were all significantly taller than those in the unsubsoiled area. Thus, the subsoiling provided adequate resources to the seedlings for growth in the first growing season.

For water oak, trees in Treatment 2 (Goal 2XL) were significantly taller than those in Treatments 1 and 3 on the subsoiled area. Otherwise, average heights in the subsoiled area were not significantly different. In the unsubsoiled area, trees in the Treatment 1 plots were significantly shorter than other treatment plots. Again, all average heights in the subsoiled area were significantly taller than those from the unsubsoiled area.

The results for willow oak were very similar to those for Shumard and water oaks. The exception to this generality was the lack of significant difference between trees in the subsoiled and unsubsoiled plots which received Treatment 1. Otherwise, trees in subsoiled areas were all significantly taller than those in unsubsoiled areas when comparing plots with the same herbicide treatment. Green ash exhibited the same trend as the oaks. Trees in the subsoiled area were significantly taller than those in the unsubsoiled area when comparing plots with the same herbicide treatments.

Table 2—Average total height and average total groundline diameter for all species by treatment (average all reps)

		Average total height				Average total groundline diameter			
Treatment	Soil trt.	SHO	WAO	WIO	GRA	SHO	WAO	WIO	GRA
no.		*feet*				*inches*			
1	Sub	2.38a	1.99b	2.14c	3.08a	0.31b	0.24a	0.33b	0.51a
	Un	1.77b	1.38d	2.07c	2.50b	0.27c	0.18b	0.27c	0.48a
2	Sub	2.26a	2.28a	2.23b	2.42b	0.30b	0.28a	0.35a	0.36b
	Un	1.78b	1.60c	2.11c	2.31c	0.27c	0.26a	0.28c	0.27c
3	Sub	2.29a	1.98b	2.34a	2.78a	0.33b	0.27a	0.39a	0.41b
	Un	1.62b	1.70c	2.14c	2.17c	0.24c	0.21b	0.32b	0.30c
4	Sub	2.30a	2.08ab	2.34a	2.89a	0.49a	0.26a	0.31b	0.41b
	Un	1.81b	1.73c	2.27b	2.18c	0.27c	0.19b	0.29bc	0.31c

SHO = Shumard oak; WAO = water oak; WIO = willow oak; GRA = green ash; Sub = subsoiled; Un = untreated.
Values in a column followed by the same letter do not differ at $\alpha = 0.05$.

Groundline Diameter

Average GLD values are found in table 2. In Shumard oak, the average GLD values were very consistent in the unsubsoiled area irrespective of herbicide treatment, and all averages were significantly less than those from the subsoiled area. The trees in the "untreated" (Treatment 4) plots had the largest average GLD in the subsoiled area, but this was the only species to exhibit this result.

For water oak, there was no significant difference between trees in subsoiled or unsubsoiled areas with Treatment 2 applications. Otherwise, all average GLDs were greater in subsoiled areas when compared to those in unsubsoiled areas.

Willow oak results differed slightly. Average GLD was always greater for trees in the subsoiled area than the unsubsoiled area when making comparisons within a treatment. The differences were all statistically significant except in the untreated (Treatment 4) plots.

Green ash trees in Treatment 1 plots (irrespective of soil treatment) all had larger GLD values than in other treatments. Once again, the trees in the subsoiled area were significantly larger than those from the subsoiled area when comparisons were made within a treatment.

SUMMARY

Subsoiling significantly increased height and GLD for the species on the study site. The adequate rainfall of the 2002 growing season is considered to be a significant factor in the lack of first-year survival differences, but that may change in years 2 or 3. All species in the study responded well to the treatments, and while competition control was known to be an important factor in hardwood establishment, it appears that subsoiling may also be very important and may be of additive value.

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Description: Ninety-two papers and thirty-six poster summaries address a range of issues affecting southern forests. Papers are grouped in 15 sessions that include wildlife ecology; fire ecology; natural pine management; forest health; growth and yield; upland hardwoods - natural regeneration; hardwood intermediate treatments; longleaf pine; pine plantation silviculture; site amelioration and productivity; pine nutrition; pine planting, stocking, spacing; ecophysiology; bottomland hardwoods - natural regeneration; and bottomland hardwoods—artificial regeneration.