LOBLOLLY PINE GROWTH 13 YEARS AFTER FOUR SITE PREPARATION TREATMENTS

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Abstract-Thirteen-year growth results of 1-O planted loblolly pine seedlings (*Pinus taeda* L.) on differently prepared upland mixed pine-hardwood sites located in north western Louisiana are presented. The study was designed as a randomized complete block consisting of three blocks of four site preparation treatments, which included: chop and burn, windrow, fuelwood harvest, and fuelwood harvest followed by an application of herbicide. Thirteen-year-growth results of the planted pine show no significant height differences but highly significant diameter differences ($P < 0.01$). Mean height varied from 40 feet for the fuelwood treatment to maximum of 43 feet for the windrow treatment. Mean diameter varied from 5.3 for the fuelwood and the fuelwood/herbicide treatments to a maximum of 6.9 inches for the chop and burn site preparation treatments which was significantly different. The initial performance of the stands change over time and the potential gains by using herbicides to control hardwoods and by using genetically improved seedlings was lost because of high plantation density and pine on pine competition.

INTRODUCTION

In 1984 a study was initiated to evaluate the effects of four site preparation treatments on the soil chemical and physical properties and on the influence of competing vegetation on initial loblolly pine growth. The treatments were chop and burn (CB), windrow (WR), fuelwood harvest (FW), and fuelwood harvest followed by an application of two gallons per acre of Garlon herbicide (FW/H). The early results of the treatments on soil variables and pine growth were reported by Slay and others (1987), Slay and others (1987b) and Lockaby and others (1988), and generally reinforced conventional wisdom about these site preparation methods. The treatments with the most traffic such as the pile and windrow had the most compaction followed by the chop and burn. The fuelwood had the most competing vegetation whereas fuelwood/herbicide had the least competing vegetation. The concentrations of potassium, calcium, magnesium, and organic matter generally followed the pattern of the vegetation (fuelwood > chop and burn = windrow > fuelwood/herbicide).

During the last 15 years there has been an evolution of site preparation techniques. The use of the pile and windrow and chop and burn are out of favor and are rarely used today in this region. Fuelwood harvests, as was done in this study, are also rarely done. However, intensive utilization of the material in our forest sites resembles this technique. The use of herbicide to control woody vegetation was in its infancy, and in the time since the application of this treatment in this study, new herbicides and application techniques have been developed and employed. Since several of these site preparation techniques used 15 years ago are no longer considered the technique of choice, why then should we look at this older study? The purpose of this study is to revisit a 15-year-old study site to see if the early growth results had been sustained to the first thinning and determine effectiveness of various site treatments in producing wood. Also, if there were differences in production patterns at age 14 from the one and the three-year growth results, an attempt to explain the deviation from the expected and actual measured juvenile growth performance was made.

METHODS

The study area, located in northwest Louisiana, is characterized by a warm and humid climate. The themic temperature regime features a mean annual range from 59-72°F, and average precipitation is 56 inches per year (Newton 1972). Two soil series occur throughout the area. The Gore series, a Vertic Paleudalf, composes O-75 percent of the site; the remaining 25-35 percent consists of the Kolin series, a Haplic Glossudalf. These soils are associated with secondary terraces of the Red River. The site is homogeneous with respect to soil texture, slope and aspect. Slope ranges from 1-5 percent.

During the summer of 1983 a stand of loblolly pine approximately 40 years old was removed from the site. In the summer of 1984 four site-preparation treatments were arranged in a randomized complete block design consisting of three blocks. The treatments were chop and burn (CB), windrow (WR), fuelwood harvest (FW), and fuelwood harvest followed by an application of two gallons per acre of Garlon 4 herbicide (FW/H). The fuelwood harvest is equivalent to a whole-tree chipping operation and was sometimes used in lieu of site preparation during this period. The CB treatment consisted of a single pass with a drum chopper (pulled by a bulldozer) followed by a broadcast burn. The WR treatment was composed of a shearing

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Table l-Third year ground line diameter and height of loblolly pine saplings planted on four different site preparation treatments

Treatment	Ground line Diameter	Total Height
	in	ft
Fuelwood/ Herbicide	2.4a	9.6a
Chop&burn	2.1b	8.6b
Windrow	1.8c	8.4b
Fuelwood	1.7c	8.1b

Means followed by the same letter are not significantly different at the P < 0.05 probability level.

operation combined with piling of sheared material into windrows. The windrow piles were outside the treatment areas, thus the treatment plots where not affected by the debris pile nor increased nutrient levels that may result from concentrations of displaced soil and pile and burned biomass. All site preparation treatments were done during the first week of July 1984. All plots were planted (6x8 foot spacing) the following winter (January 1985) with 1-O loblolly pine seedlings genetically selected for this site. Treatment plots were one acre in size and the measurement plots were 1/10 acre and located in the center of each treatment plot.

In 1989 the site was revisited to see if the initial growth results were still as they were after the first year, and to evaluate the competing vegetation on the different site preparations. Trees within the 1/1 O-acre measurement plots were measured for diameter (ground line) and height, and within each measurement plot, samples of herbaceous and woody competing vegetation were taken from three randomly placed l/1000-acre sample plots. Plant samples were oven-dried and weighed.

In September 1999 the 1/10 acre measurement plots were measured for height and diameter (DBH). Volume was calculated using the formula $0.002678D^2H$ (Baldwin and Feduccia 1991). Analysis of variance (SAS 1985) was conducted to determine significance and Duncan's multiple range test was used to separate the means.

RESULTS AND DISCUSSION

The measurements in 1989 showed the same general pattern as the first year results reported by (Lockaby 1988). The first year results for diameter (GLD) were ranked FW/H = CB = WR > FW with the FW significantly ($P < 0.05$) smaller. The height was not significantly different. The three year results were ranked FW/H > CB > WR = FW with the fuelwood with herbicide treatment significantly ($P < 0.05$) larger in GLD and in height (table 1).

The measurements at year 14 (1999) showed a marked change in the ranking for diameter (DBH). The ranking was CB = WR > FW = FW/H or a complete change from what was the best initial performing treatment/seedling combination (FW/H) to being the worst. The CB and WR treatments were significantly ($P < 0.05$) different from the fuelwood and fuelwood with herbicide. There was no difference in total height (table 2).

When the 1999 measurements were being planned and the earlier work reviewed, the assumption was made that the fuelwood with herbicide would be the most effective treatment because of the initial control of competing hardwood vegetation and the past early seedling performance on these sites. However, this was not the case and in the interim the other site preparation treatments were, over the last IO years, more effective from a diameter standpoint, and the fuelwood with herbicide was ranked last and significantly smaller in diameter than the other treatments.

When measurements at age three were taken, the herbaceous and woody biomasses were also sampled. At that time there was no difference in herbaceous material between the treatment plots. Woody biomass (hardwood sprouts) was significantly less ($P < 0.05$) in the WR treatment plots but the other site preparation treatments had the same woody competition. This was a change from the first year results (Lockaby and others 1988) where the fuelwood with herbicide plots had considerably less competing woody material with the other treatments statistically the same. Although this change in competing woody material had occurred by the end of the third growing season, it was not reflected in the total growth measured in each treatment. However, between year three and fourteen the effect of the herbicide was gone and the growth pattern of other treatments including the FW with no additional site work (essentially a check) were as good or better than the FW/H site preparation. The two older, more traditional site

Table 2-Fourteen-year diameter (DBH) and height of loblolly pine trees planted on four different site preparation treatments

Treatment	DBH	Total Height	Volume Per Tree
	in	ft	cuft
Chop&Burn	5.8	41.5	4.0a
Windrow	5.6a	41 .Oa	3.7a
Fuelwood	5.3b	41 .0a	3.4bc
Fuelwood/ Herbicide	5.3b	40.5a	3.2c

Means followed by the same letter are not significantly different at the $P < 0.05$ probability level.

preparation treatments (WR and CB) had produced the largest diameters. The total height was the same across the treatments.

Historically, looking at the development of this stand there are two reasons that may explain why the seedlings given the early advantage of freedom from competition did not maintain this advantage. They are planted pine seedling numbers and planted pine domination of the site.

The stand was planted on a 6X8 spacing (Slay 1986), which is 908 seedlings per acre. These seedlings were genetically improved, and family mixes tested to perform well on the soil types at the planting site were used. The survival was 94 percent at the end of the first year or 850 trees per acre. At age three the survival was essentially unchanged. After age three the crowns began to close and competition became more and more intense with each additional years growth. The close spacing, high survival and fast growth of the planted pine completely dominated the stands with little but planted pine remaining when year 14 measurements were made. Wild pine seedlings and hardwood observed in the early years of the stand were in the overtopped position and essentially were not a factor in the stand.

The planted pine spacing is another matter. The planted pine on planted pine competition has been very intense in the treatment stands. Early fast growth and crown closure negated any advantage of one site treatment over the other. When the 14 year measurements where taken, there were still 762 trees per acre and any advantages given early by cultural treatments or by the use of genetically superior planting stock were lost in the competition among high populations of planted trees. The trees in the treatments having the best early results quickly closed canopy and slowed growth allowing the other treatments to catch up and in some cases exceed the total growth after 14 years. At age 14 the trees in all treatments plots were in less than desirable physical condition based on observations of crown percent and general fullness of the crown indicating severe competition for several years.

The lesson to be learned from this study is that the advantages of using cultural practices and improved genetic planting stock can be quickly diminished by the presence of large seedling/sapling/tree numbers. Trends that appear to be positive initially may not be maintained with high numbers of trees. Adjustment of tree numbers at planting or early in the rotation of the stand is important to keep the stand growing at its potentional. Ignoring this can, as is the case in this study, reduce severely the potential of an adequate or any return on a cultural or genetic investment. This study may be unusual in that the survival was very high but it indicates the importance of control of competition not only from hardwoods or wild pine but control of competition of the trees that we plant. Without being relatively "free to grow", investments early in the stand life may be ineffective.

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