THIRTEEN YEARS LOBLOLLY PINE GROWTH FOLLOWING MACHINE APPLICATION OF CUT-STUMP TREATMENT HERBICIDES FOR HARDWOOD STUMP-SPROUT CONTROL

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Abstract—Thirteen year growth results of 1-0 out-planted loblolly pine seedlings on non-intensively prepared up-land mixed pine-hardwood sites receiving machine applied cut-stump treatment (CST) herbicides onto hardwood stumps at the time of harvesting is presented. Plantation pine growth shows significantly higher growth for pine in the CST treated plots compared to non-CST plots. Planted pine survival, diameter, height, stem-volume, and total volume per plot was higher in CST treated plots when compared to non-treated plots. Total pine volume in CST treated plots is as high as 125 percent higher than in non-treated plots. Pine growth advantage in CST treated plots has existed since time of planting. CST herbicides were selectively applied to the cut surface of hardwood stumps for stump-sprout control. The selective application of CST herbicides was combined with operation of a drive-to-tree type feller-buncher tree-harvester.

INTRODUCTION

Forest regeneration to pure pine stands after clearcut harvesting mixed pine-hardwood stands is a common forest management objective in the Southern United States. Competition from undesirable woody and herbaceous vegetation reduces pine survival and growth however. Pine volume after five years with competition control for both herbaceous vegetation and woody plants averaged about fourfold more than pine stands with no competition control for thirteen plantation study sites (Miller and others 1991). With only woody plant control pine volume increased by an average of 67 percent and with herbaceous control only pine volume increased by 171 percent. A significant portion of the woody competition may be hardwood occurrence from stump sprouting. Two conditions favorable for hardwood stump sprouting are low stump height and harvest of immature trees (Smith 1962). Those two conditions commonly result with mechanized harvesting using feller-buncher tree harvesters, especially when harvesting trees for pulp. Sprouts of hardwood stump origin are more vigorous than from seedling-origin (Smith 1979). Furthermore, the growth advantage of hardwoods of stump-sprout origin is maintained into later years (Smith 1962). After 12 yrs, diameter and height growth of stems of stump origin were almost twice that of stems from seedling origin for some hardwoods of seedling origin (Smith 1979). Vidrine and Adams (1993) reported hardwood stump sprouting had occurred on 67 percent of hardwood stumps two years after harvesting a mixed pine-hardwood stand. Vidrine also reported six year loblolly pine survival and growth results resulting from machine applied CST herbicides and the description of the sprayer system. Pine survival and growth in the CST plots were significantly higher than in control plots receiving no CST herbicides.

The sprayer system was adapted for use on a drive-to-tree type feller-buncher tree harvester to apply the CST herbicide immediately after cutting each hardwood tree. CST herbicides must be applied shortly after cutting to be effective (Wenger 1984). The sprayer system used in Vidrine's study consisted of an operator-controlled 12-volt direct current powered pump and full cone type spray nozzle with the nozzle mounted onto the feller-buncher harvester shear head. Immediately after shearing a hardwood tree the feller-buncher operator sprayed the cut stump surface using the sprayer system with a CST herbicide. This paper, using remeasured data from the same study as Vidrine, reports follow-up pine growth results after thirteen growing seasons as the stand nears the time for a first thinning harvest.

METHODS

The site is located in north central Louisiana in southern Lincoln Parish. Soils are Sacul (Aquic Hapludults) and Bowie (Plinthic Paleudults) silt loams with an estimated site index of 85 feet for loblolly pine at age 50 year (Kilpatrick and others 1996). The mixed pine-hardwood stand consisted of loblolly pine (*Pinus taeda L.*) and the hardwoods consisted principally of oak (*Quercu* spp), hickory (*Carya* spp), maple (*Acer* spp), and sweetgum (*Liquidambar styraciflua*). The site was clearcut harvested in July and August, 1985, with whole trees processed for fuel and pulp chips using an in-woods chipper, and replanted to pine the following winter. Trees were mechanically felled using a drive-to-tree type feller-buncher equipped with a double-acting shear head and whole tree skidding was performed using four-wheel-drive rubber-tired grapple skidders. Other than applying CST herbicide to hardwood stumps to control

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stump sprouting with the feller-buncher harvester, no mechanical, chemical, control burn, or other site preparation treatment was applied. The CST herbicides were machine applied at the time of felling while performing the clearcut harvest. Fifteen 0.2 ac CST test plots established consisted of three replicates of five treatments for the randomized block experimental design. The five CST treatments for the study consisted of a control (no CST herbicide applied), picloram (Tordon 101R), triclopyr-ester (Garlon 4), triclopyr-amine (Garlon 3A), and dicamba (Banvel CST)—all labeled for cut-stump-treatment. The freshly cut hardwood stump surfaces were machine-sprayed with one of the undiluted CST herbicides to include a thorough wetting of the cambial area in accordance with CST-label instructions. Bareroot 1-0 loblolly pine seedlings were outplanted in the 0.2-acre feller-buncher-sprayer treatment plots in February, 1986, on a 8 by 8-ft spacing using a 7 by 7 array for a total of 49 planted pines in each measurement plot of area 0.072 acre. Each planted pine was marked by a flagpin at the time of planting and at year ten aluminum tags were nailed to the remaining trees of the 49 originally planted. Tag labeling consisted of plot number, tree number, and the CST treatment. Performance evaluation of the process was based on 13-year growth measurements of pine total height, DBH, associated calculations of stem volume of individual trees, the resulting total planted pine volume in each plot determined by summing individual stem volumes, and hardwood stem count. Total tree volumes were calculated according to equations by Clark and Saucier (1990) from DBH and total tree height measurements. Duncan's New Multiple Range Procedure was used for mean separation for planted pine survival, height, diameter, stem volume, total volume in each plot, and number hardwoods present in each plot for the five-treatment three-replicate randomized block experimental design.

RESULTS AND DISCUSSION

Pine survival and growth on all machine-applied herbicide CST plots was significantly higher than pine growth on the control plots after thirteen growing seasons although there were differences within herbicide treatments (table 1).

Table 1—Planted pine survival, growth, and hardwood/volunteer pine competition of machine-planted DST herbicide treated plots after thirteen growing seasons[1]

	Plot Means						
Treatment	Survival (pct)	Ht. (ft)	DBH (in)	Stem Volume (ft^3)	Pine Volume (ft^3/ac)	Hardwoods (#/ac)	Volun. Pines (#/ac)
Picloram	77a	42a	6.3bc	3.9a	2030a	1240bc	429
Tri-a[2]	64abc	40bc	6.5ab	4.0a	1733ab	833d	371
Tri-e[3]	61bc	41b	6.7a	4.2a	1725ab	1181bcd	389
Dicamba	68ab	38c	6.2c	3.3b	1538b	2157ab	399
Control	46d	39c	5.6d	2.9b	904c	2343a	403

[1]Columnar means followed by the same letters are not significantly different at the 95-percent probability level, according to the Duncan's New Multiple Range Test.
[2]Tri-a is triclopyr amine
[3]Tri-e is triclopyr ester.

Mean number hardwoods and number of volunteer pines are also reported in table 1. Pine survival, height, and total pine volume were significantly higher in the picloram CST plots than other treatment plots. Pine diameter and stem volume were highest for the triclopyr-ester treated plots. Planted pine survival, height, diameter, stem volume and total plot volume were lowest in the control plots receiving no herbicide treatment to control hardwood stump sprouting. Mean total pine volume ranged from a low of 904 ft^3/acre in the control plots receiving no CST herbicide to a high of 2030 ft^3/acre for the picloram CST herbicide treatment. Plot volume, which accounts for the individual stem volumes and survival, was consistent with those factors. The inverse relationship between hardwood competition and pine growth reported by Langdon and Trousdell (1974) is supported by the results. Number of hardwood stems was the highest in the control plots at 2343 stems/acre with associated pine volume at 904 ft^3/acre while the picloram and triclopyr amine CST plot had the lowest hardwood stem count of 1240 and 833 stems/acre and the highest pine volume at 2030 and 1733 ft^3/acre, respectively. The dicamba plots had the highest hardwood stem count of the CST plots at 2157 stems/acre and lowest associated planted pine volume of the CST plots at 1538 ft^3/acre. There were almost as many volunteer pines on the plots as there were planted pine at thirteen years but the volunteer pine were generally smaller in diameter and height than the planted trees. Seed source of the volunteer pine was probably from the pines harvested at the time this study was established and from neighboring pine trees in the area. Statistical analysis was not applied to the mean number volunteer pines per plot since their occurrence was independent of the CST procedures applied. The occurrence of hardwood in the CST plots was generally not of stump sprout origin with the exception of the dicamba treatment. After two growing seasons, hardwood stump sprouting on picloram and triclopyr CST plots was only about 6 percent, while on the control plots stump sprouting was 67 percent, as reported by Vidrine and Adams (1993). Stump sprouting on the dicamba treated plots after two years was about 20 percent and may have contributed to the high number of hardwoods and low pine volume at age thirteen.

CONCLUSIONS

Results of this study indicate that machine application of CST herbicides during harvest to control hardwood stump sprouting is effective at suppressing hardwood competition thus allowing increased production of planted loblolly pine plantations. Pine volume on picloram treated plots was highest of all treatments at 2.25 times that of pine volume on non-CST treated plots after thirteen years growth. Pine volume was not significantly different for the picloram and the triclopyr treatments. Pine volume on the dicamba treated plots was lowest of the CST treatments but still 1.70 times that of the control plots. The 13-year results agree with the results from six-year growth, pine survival, diameter, and height in the picloram and triclopyr treated plots were significantly higher than for the other treatments (Vidrine and Adams 1993) indicating the benefits of the two CST treatments are maintained. Follow up studies of using machine applied CST herbicides for stump sprout control should be performed using sawhead equipped feller-bunchers as commonly used today rather than the shear type used in

this study. Also, machine application techniques should be developed where the herbicide is applied only to the cambial area of the cut rather than wetting the entire cut surface to reduce the amount of herbicide required. For trees 3-inches dbh and larger, the recommended treatment area is the cambial area (USDA Forest Service 1994).

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