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Chainsaw and Shear Cutting of Upland Hardwoods

Impact on Regeneration

By
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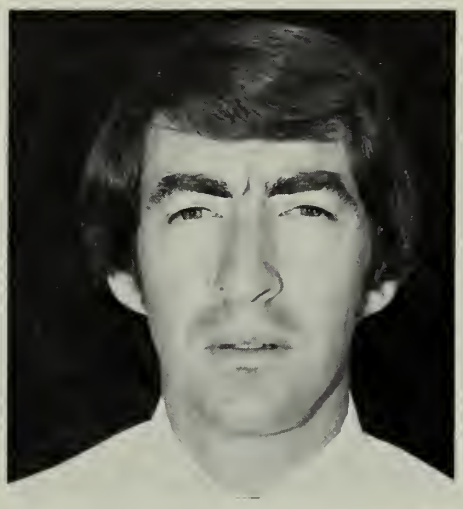

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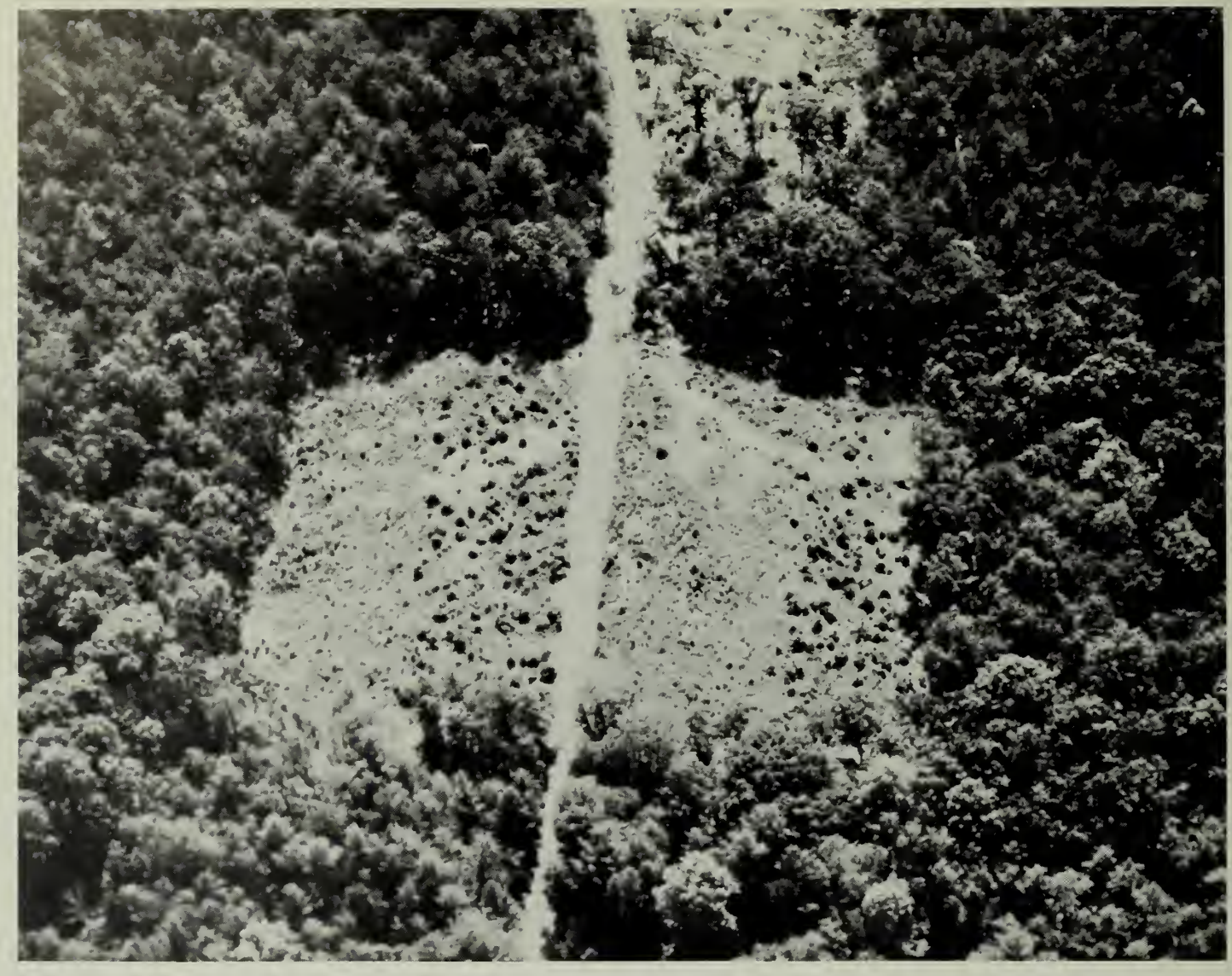

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INTRODUCTION

The Piedmont uplands of the Southeast contain many low quality hardwood stands that resulted from high-grade cutting and a lack of planned regeneration. Until recently, there was little hope for upgrading these stands because of poor markets for small, mixed-species hardwoods and potentially poor returns on investments in stands. The situation improved in the 1970's when the demand for wood as fuel increased dramatically. A new harvesting system that includes shearing, grapple skidding, and total-tree chipping made it practical to clear these stands and replace them with more valuable stems.

In a recent study in the upper Piedmont of Georgia, McMinn (1983) cleared all the trees in this manner and increased the pine component of the new stand. Would the pine component have been just as great if the trees had been cut with chainsaws? What effect does shearing have on hardwood stump sprout growth and development? Furthermore, does a sheared stump receive chemical treatment more or less readily than a chainsaw cut stump? Will planted pines survive better in sheared areas? In order to answer these questions, research plots were established on two sites in the upper Piedmont of Georgia. Results reported here are for the first two growing seasons following treatment.

PROCEDURES

The two areas selected for study were in Dawson and Walker counties in north Georgia. The Dawson County area had been farmed prior to 1940, then abandoned and allowed to revert to forest. The resulting timber stands were high-graded until merchantable volume was too low for traditional logging (Table 1). Basal area averaged about 16 square feet per acre, of which approximately 70 percent was hard hardwood, 20 percent soft hardwood, and 10 percent pine. Hard hardwood diameters ranged from 1 to 18 inches, soft hardwoods from 1 to 8 inches, and pine from 1 to 12 inches. Large diameter trees were few in number, had poor form, and were low in quality. The soil is a Fannin fine sandy loam with inclusions of Tallapoosa fine sandy loam. Site index for loblolly pine (Pinus taeda L.) is approximately 80 feet at 50 years (Table 1).

The Walker County site has moderate sloping topography. It was farmed until the turn of the century, then abandoned and allowed to revert to forest. In 1942, all merchantable material was removed. Residual stems, some of which were large and unmerchantable, remained on the site until the present harvest. Basal area averaged about 61 square feet per acre, of which approximately 40 percent was hard hardwoods, 40 percent was soft hardwoods, and 20 percent was pine. Hard hardwood diameters ranged from 1 to 31 inches, soft hardwood from 1 to 25 inches, and pine from 1 to 14 inches. The soil is in the Fullerton series, which is characterized by a gravelly topsoil with a red clay base. Site index for loblolly pine is about 95 feet at 50 years (Table 1).

Table 1.--Stand description of Dawson and Walker county sites prior to harvesting by whole-tree chipping.

	Stand features							
					Average tree			Stumps with multiple stems
Location	Age	Site index[1/]	Stems[2/]	Stumps	D.b.h.	Total ht.	Stump d.o.b.[3/]	
	Years		--Number/acre---		Inches	Feet	Inches	Percent
Dawson Co.	24	80	340	323	3.0	23	4.3	5
Walker Co.	40	95	1,142	1,000	3.1	31	4.8	12

1/ Estimates for loblolly pine at age 50.

2/ Trees > 4.5 feet tall.

3/ Measured at groundline.

Figure 1.--Bobcat feller-buncher used on shear plots. Notice the tracked rear wheels which were thought to be very damaging to small stumps.

Plot Layout

In Dawson County, three typical poor quality hardwood stands were selected. Two one-acre plots were established in each stand, and species, d.b.h., ground-line diameter, and total height were recorded for all stems greater than 4.5 feet tall on each plot. Following inventory, the two plots in each stand were randomly assigned a felling treatment: chainsawing or mechanical shearing. Georgia Forestry Commission personnel harvested the plots during the winter of 1979-80. A typical whole-tree harvest system consisting of a Bobcat[1/] feller-buncher (Figure 1), a grapple skidder, and a chipper was used on plots designated for mechanical shearing. The feller-buncher was replaced

1/ Use of tradenames is solely to identify materials and equipment used and does not constitute endorsement by Clemson University, USDA Forest Service, or the Georgia Forestry Commission.

Table 2. Sprout regrowth from stumps up to 10 inches d.b.h. at Dawson and Walker county sites felled by chainsawing and shearing.

Location and herbicide treatment	Sprouting stumps per acre		Stump sprouts per acre		Sprouts per stump		Sprout height	
	Chainsaw	Shear	Chainsaw	Shear	Chainsaw	Shear	Chainaaw	Shear
	Number						Feet	
First Year								
Dawson County								
No sprout control	892*†[1]	456†	11,454*†	5,796 †	12.8	12.7	2.4†	2.0
Sprout control[2]	254*	162	3,104	1,922	12.2	11.9	1.5	1.5
Walker County								
No sprout control	583†	538†	7,568†	7,635†	13.0	14.2	2.2	2.1
Sprout control[2]	325*	240	2,858	2,340	8.8	9.8	2.1	2.0
Second Year								
Dawson County								
No sprout control	903*†	352†	6,817*†	3,180†	7.5	9.0	3.7	3.3
Sprout control[2]	276*	152	1,583*	887	5.7	5.8	3.2	2.9
Walker County								
No sprout control	783*†	513†	5,227†	5,460†	6.8	10.6†	4.3	3.8
Sprout control[2]	230	300	990	1,160	4.3	3.9	3.7	4.5

[1] An asterisk (*) indicates a statistically significant difference at the 0.05 level between chainsawing and shearing. The dagger (†) indicates a significant difference between no sprout control and Tordon 101 sprout control at the 0.05 level.

[2] Tordon 101 applied to stumps to inhibit sprout growth.

by chainsaw felling on other plots.

In Walker County, six 0.5 acre plots were established on a portion of a 140-acre area that was to be harvested by total-tree chipping. The growing stock on each plot was inventoried as at Dawson County, and the plots were randomly assigned a felling treatment. Three plots were designated for mechanical shearing with the feller-buncher, while the remaining three were cut with chainsaws. The area was harvested during the winter of 1979-80 by a local commercial operator with a whole-tree system similar to that used at the Dawsonville location.

At both locations, the feller-buncher could not cut trees over 12 inches in diameter, so on plots that were sheared, only trees with stump diameters of 10 inches outside bark (OB) or less were sheared. Stumps larger than 10 inches in diameter were cut with a chainsaw. Since the majority of trees on all plots (in excess of 90%) had stumps less than 10 inches OB, this procedure was not a serious drawback.

Shearing and chainsawing created stumps with very different appearances (Figure 2). Chainsaw-cut stumps had smooth-cut surfaces with little damage to the cambial surface between wood and bark. They were approximately 1/3-to 1/2-foot in height. Sheared stumps were irregularly shaped with noticeable separation of wood and bark and a rough crushed surface. Sheared stumps were cut just above groundline (Figure 2).

Post-harvest Sprout Control and Planting of Pines

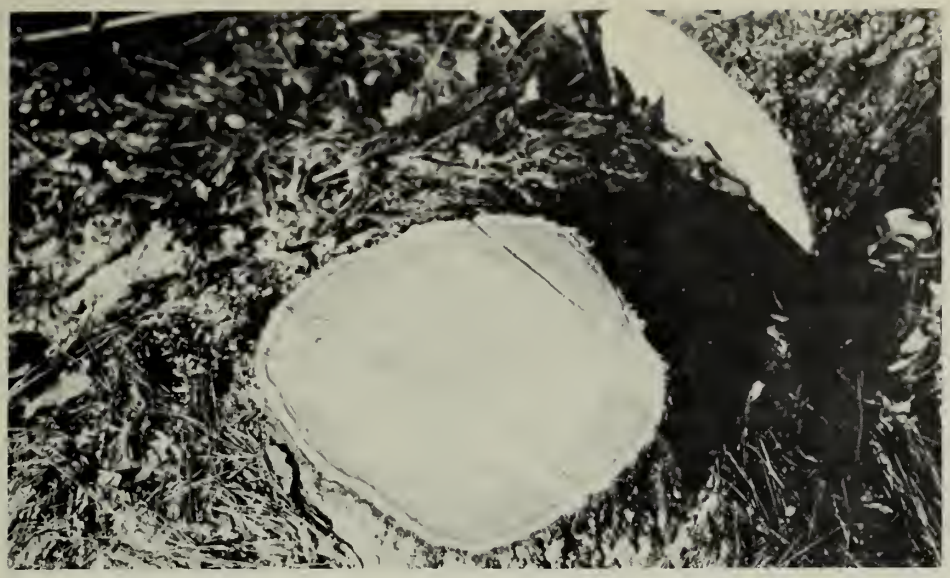
After the harvests at both locations, each plot was divided in half, and one half was randomly assigned a herbicide sprout control treatment. Plot size was 0.5 acre at Dawson County and 0.25 acre at Walker County. Tordon 101 solution (Dow Chemical[1]) was diluted in an equal volume of water and sprayed directly onto stumps in mid-April using a portable backpack sprayer; 1.5 gallons of diluted solution were applied per acre. Three weeks after spraying and during early May, all plots (treated and untreated) were hand planted with nursery grown 1-0 loblolly pine seedlings at a 10- by 10-foot spacing. All subsequent samplings were confined to the interior 1/10 acre of all plots.

Sprout Growth Inventory

Woody stems were measured in October at the end of the first and second growing seasons after harvest. All regrowth greater than 1/2-foot in height was tallied by species, origin, and height. Stems were recorded as sprouts, seedlings, and root suckers. Stump heights and diameters were recorded for sprouts that originated from stumps. Root suckers were distinguished from seedlings by examining them for attachment to a visibly exposed root, by tracing them to an occasionally exposed root, by observing their size (suckers are typically larger than seedlings), and by knowledge of species silvical characteristics (Fowells 1965, Schopmeyer 1974). Stems of doubtful origin were tugged or pulled slightly and the ground movement observed to help identify the nature of underlying roots.

Analysis of Data

Differences in regrowth by treatment were tested for significant differences at the 0.05 level by analysis of variance. Dawson County data were examined using a randomized complete block design with two replications in each block. The Walker County data were examined using a completely random design with six replications.



a. Chainsaw-cut stump. Notice the clean-cut surface and approximate 1/3-foot stump height.

b. Shear-cut stump. Notice the uneven crushed surface and the approximate groundline height.

Figure 2.--Comparison of (a) chainsaw-cut stumps and (b) shear-cut stumps.

RESULTS

The number of stumps that sprouted and thus the total number of sprouts per acre were significantly reduced by shearing (Table 2). Reductions in numbers of sprouts were recorded following shearing at both sample locations, for both the first and second year of growth, and in the presence and absence of herbicide treatment. Shearing prevented sprouting of many stumps that were less than 3 inches d.b.h. (Figure 3) Stumps larger than 5 inches d.b.h. had about the same number of sprouts per stump regardless of cutting method. Through observation we judged that reduced sprouting was caused more by damage to small stumps by the tracks of the Bobcat tractor than by the shearing action on the stump itself. Many stumps were damaged and some were even uprooted by the tractor.

Evidence that the reduction in number of sprouts per acre was due primarily to a reduction in the number of sprouting stumps is reinforced by data on the number of sprouts per stump. Although the total number of sprouts per acre was dramatically lower on sheared than on sawed plots, the number of sprouts per stump stayed about the same (Table 2). There was a reduction in the number of sprouts per stump from the first year to the second year, but the reduction was about equal for chainsawed and sheared plots.

In all cases, Tordon 101 applied to stumps significantly reduced both the number of stumps that sprouted and the number of sprouts per surviving stump. By the end of the second growing season, areas that had been chemically treated had only 900-1600 sprouts per acre, whereas untreated areas still had 3000-7000 sprouts per acre. (Table 2).

The average height of stump sprouts was about 2 feet after one year of growth and 3 1/2 feet after two years. No significant differences were detected in sprout height between chainsawed and sheared plots, and only minor differences in height were found between chemical sprout control and no sprout control plots (Table 2).

There was a significant difference in stump heights between the two felling methods. Sheared stumps averaged just over 2 inches high, whereas chainsawed stumps were about 4 inches high. Differences can be explained by the way each cutting method is conducted. The feller-buncher shearing knives are bolted to the bottom of mounts that rest on the ground as shearing occurs. A chainsaw operator must allow room to notch the tree for directional felling and cut far enough above groundline to keep the chain out of dirt.

Comparisons of the Dawson and Walker County locations showed sprouting variations that can be attributed to site differences and features of the preharvested stand. The Walker County stand was 16 years older, had better site quality, and had four times as many stems per acre at harvest as the Dawson County stand (Table 1). The Walker County stand also had more mesic species present. The number of stumps per acre with sprout growth was the same at Walker County for each felling method after the first growing season, but was significantly lower for sheared stumps after the second year (Table 2). Total

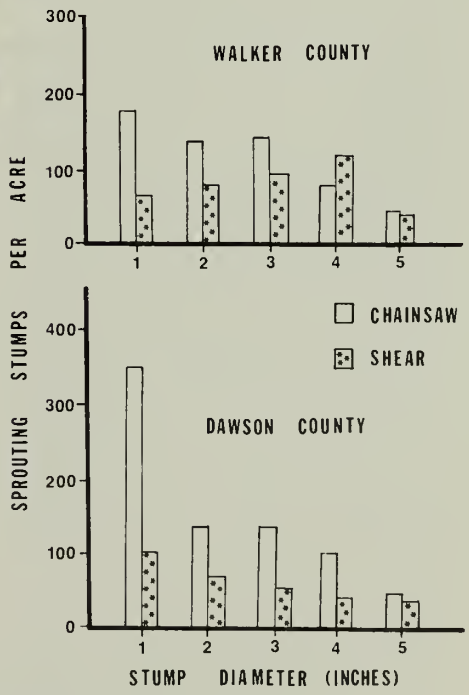


Figure 3. Number of sprouting stumps per acre by diameter class for chainsaw and shear-cut stumps at Dawson and Walker County locations. Values shown are average for the first and second year

stump sprout stems per acre, nowever, remained the same through 2 years for both felling methods. Herbicide reduced the number of sprout stems in proportions similar to those observed at Dawsonville.

Sucker and Seedling Growth

Although the primary objective of this study was to examine the response to felling method, it is important to know the total regrowth response of a stand. One might expect that as the number of stump sprouts are reduced, the number of seedlings and suckers increase. Just the opposite occurred in this study. On sheared plots, where the number of stump sprouts was significantly lower, numbers of seedlings and suckers were also lower, except where Tordon 101 was applied (Table 3).

Large numbers of suckers per acre and small numbers of seedlings (greater than 1/2-foot tall) per acre were found the first year after harvesting. Some suckers may have been called seedlings and vice versa because of the difficulty of knowing the exact origin of a plant short of digging it up. However, the data are based on the best judgement of supervised field crews. By the second year, the number of suckers had decreased slightly and the number of natural seedlings greater than 1/2-foot tall had increased dramatically from 50-400 per acre to 2000-7000 per acre. Second-year measurements show shortleaf (Pinus echinata Mill.) and loblolly pine accounted for 70 percent of the seedling population at Dawson County, but these seedling stems were 50 percent of the total regrowth composition. At Walker County, these pine species made up nearly 80 percent of the seedling inventory and also accounted for 50 percent of total regrowth composition at the end of the second year. An abundance of wind-desseminated light-seeded hardwoods species of flowering age are present near both locations. These species--sycamore, ash, sweetgum, yellow-poplar and maple--accounted for the remaining seedling regeneration. Pine seeds apparantly originated from the seedcrop of the pine component in the pre-cut stand. The seeds remained in the duff after winter harvest, and germinated during spring of the first year. There was no evidence that herbicide damaged these seeds.

Table 3. Sucker and seedling growth on Dawson and Walker county sites harvested by whole-tree chipping.

Location	Suckers per acre		Seedlings[1] per acre	
	Chainsaw	Shear	Chainsaw	Shear
	----------Number----------			
	First Year			
Dawson County				
No sprout control	3,736*†[2]	1,893	240†	402†
Sprout control[3]	2,367	2,089	183	238
Walker County				
No sprout control	2,301*†	1,294	151†	44
Sprout control[3]	918	1,113	92	58
	Second Year			
Dawson County				
No sprout control	1,663*	1,257	4,233†	3,750
Sprout control[3]	1,667	1,745	2,350	3,266
Walker County				
No sprout control	2,483*†	1,743†	6,833*†	3,733
Sprout control[3]	693	817	3,766	4,267

[1] Naturally occurring hardwood and pine seedlings.

[2] An asterisk (*) indicates a statistically significant difference at the 0.05 level between chainsawing and shearing. The dagger (†) indicates a significant difference between no sprout control and Tordon 101 sprout control at the 0.05 level.

[3] Tordon 101 applied to stumps to inhibit sprout growth.

Survival and Growth of Planted Pines

Approximately 350 planted pines per acre, or 80 percent, survived the first year after planting at both sites. By the end of the second growing season, survival ranged from 60 to 75 percent, with slightly higher losses in Dawson County (Table 4). The higher losses in Dawson County may have resulted from the drier summer weather there.

Planted pine survival was significantly lower on plots treated with Tordon 101 at Dawson and Walker counties (Table 4). Losses ranged from 15 to 25 percent greater on treated plots as compared to untreated plots. These lower survivals were likely related to the time between herbicide treatment and planting of seedlings. Tordon 101 is a water soluble herbicide, and delay of 4 weeks is recommended before planting seedlings on treated areas. Seedlings were planted 2-1/2 and 3 weeks after treatment at the Dawson and Walker county locations, respectively. Rainfall was plentiful shortly after planting, which probably caused some spreading of Tordon 101 and consequently some pine mortality.

Height growth of planted pines was minimal the first year and lagged well below that of stump sprouts. Height of seedlings expressed as a percentage of stump sprout height averaged about 45 to 60 percent on unsprayed plots and 50 to 70 percent sprayed plots (Table 4). By the end of the second year, height growth had improved dramatically at the Dawson County site, where seedling heights were almost equal to those of stump sprouts. At the Walker County location where site quality was higher, second-year stump sprouts were strong height growth competitors. Consequently, planted pine seedling heights remained at approximately 50 to 70 percent of that for stump sprouts. Even though planted pines are generally not as tall as competing stump sprouts, they are taller, on the average, than suckers and natural seedlings, and are sure to make up a significant part of the new stand.

Species Composition

Initial species composition differed at each study site and was changed to some extent by harvesting. Precut species composition at Dawson County was largely oak (Quercus spp.) with fairly large components of hickory (Carya spp.), dogwood (Cornus florida L.) and sourwood (Oxydendrum arboreum L.). First- and second-year regrowth inventory showed that the oak component decreased by almost 15 percent, while sourwood and blackgum in-

Table 4. Survival and growth of planted loblolly pine on Dawson and Walker county sites harvested by whole-tree chipping.

Location	Field[1] survival		Pine height as percent of stump sprout height	
	Chainsaw	Shear	Chainsaw	Shear
	Seedlings/ac (percent)		-----Percent------	
	First year			
Dawson County				
No sprout control	348 (79)†[2]	357 (81)†	44†	54†
Sprout control[3]	269 (61)	295 (67)	67	69
Walker County				
No sprout control	344 (78)†	379 (86)†	54	62†
Sprout control[3]	220 (50)	251 (57)	49	50
	Second year			
Dawson County				
No sprout control	264 (60)†	309 (70)†	68*†	82†
Sprout control[3]	212 (48)	225 (51)	90*	106
Walker County				
No sprout control	331 (75)†	331 (75)†	54†	58
Sprout control[3]	251 (57)	198 (45)	71	60

[1] Loblolly pine seedlings were planted at a spacing of 10 x 10 feet, which established a density of 441 seedlings per acre on each plot.

[2] An asterisk (*) indicates a statistically significant difference at the 0.05 level between chainsawing and shearing. The dagger (†) indicates a significant difference between no sprout control and Tordon 101 sprout control at the 0.05 level.

[3] Tordon 101 applied to stumps to inhibit sprout growth.

creased by 100 or more percent. Other species were about equally represented before and after cutting.

Precut inventory at Walker County showed that the stands contained primarily sweetgum (Liquidambar styraciflua L.) , oak, beech (Fagus grandifolia Ehrh.), dogwood, and yellow-poplar (Liriodendron tulipifera L.). First- and second-year regrowth showed that the oak and yellow-poplar components decreased by 25 to 30 percent, beech decreased by more than 100 percent, and sweetgum increased by more than 100 percent. Although harvesting changed species composition as just described, there was no difference due to harvest method. Species composition changes occurred with the same pattern whether the stems were sheared or cut with a chainsaw.

DISCUSSION

Hardwood regrowth quickly occupied the sites following cutting at both Dawson and Walker counties. Sprout height growth was rapid and quickly exceeded that of natural seedlings, suckers, and planted pines. For successful conversion of these sites to pine, any factor that reduces the amount of hardwood regrowth will favor planted and natural pine regeneration and improve the chances of the area becoming a predominantly pine or pine-hardwood stand. Because sheared plots had significantly less regrowth than chainsawed plots, shearing with the Bobcat feller-buncher had a desirable site preparation effect for conversion to pine.

One would have expected significantly fewer sprouts per stump following shearing because shorter, more highly damaged stumps may have fewer dormant buds to develop into sprouts (Kozlowski 1971, Brown and Kormanik 1967). In this study, there was not a reduction in the number of sprouts per stump on sheared plots. The sheared stumps that did sprout had just as many stems as chainsawed stumps, but reductions occurred because many small diameter sheared stumps did not sprout at all. It appeared that these stumps did not sprout because of damage from the tracks of the Bobcat feller-buncher as it worked its way back and forth over the site.

Although it was not measured, there was visible evidence that hardwood sprouts from sheared stumps will be higher in quality than those from chainsawed stumps. A high proportion of sprouts from sheared stumps originated at or below groundline and further away from cut surfaces where exposed wood can rot. On higher chainsawed stumps, many dominant sprouts originated from the upper part of the stump, close to the cut surface. Here there is greater risk of decay and development of poor anchorage. Where a hardwood regrowth component is desired, sheared stumps appear to provide better quality hardwood stems.

Tordon 101 herbicide applied as a direct spray to stumps was highly effective in reducing stump sprout growth. Sheared stumps which had considerable bark damage did not show greater or less herbicide response than chainsawed stumps, which had relatively undisturbed stump bark. Small diameter stumps were difficult to find following harvesting so some were missed during herbicide treatment. On sheared plots, there were more untreated stumps in this category, probably because they were lower and harder to see. The herbicide treatment appeared to act during a 4-week period. There was little evidence of reduced growth of sprouts during the second year following herbicide treatment.

CONCLUSIONS

The principal findings of this study are:

1. Plots that were sheared with the Bobcat feller-buncher had significantly lower numbers of sprouts per acre than chainsawed plots, primarily because fewer stumps 3 inches in diameter and less sprouted on sheared plots.
2. Tordon 101 herbicide was equally effective in reducing sprouting of both sheared and chainsawed stumps. Herbicide-treated plots had significantly fewer sprouting stumps and sprout stems per acre than untreated control plots.
3. Planted pines grew best on sheared and herbicide-treated plots where competition and regrowth density per acre was least. On these plots, the new stand will likely have a significant pine component.
4. Sheared stumps are significantly lower than chainsawed stumps. Sprouts from these stumps will likely be of better quality than those from chainsawed stumps because the sprouts are more firmly anchored at or below groundline.

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