GINGRICH, S. F. 1971. Management of young and intermediate stands of upland hardwoods. USDA For. Serv. Res. Pap. NE-195. 26 p.
JOHNSON, P. S. 1977. Predicting oak stump sprouting and sprout development in the Missouri Ozarks. USDA For. Serv. Res. Pap. NC-149. 11 p.
KOMAREK, E. V. 1974. Effects of fire on temperate forests and related ecosystems: Southeastern United States. Pp. 251–277. *in* T. T. Kozlowski and C. E. Ahlgren, eds. Fire and Ecosystems. Academic Press, NY.
LAMSON, N. I. 1976. Appalachian hardwood stump sprouts are potential sawlog crop trees. USDA For. Serv. Res. Note NE-229. 4 p.
LEFFELMAN, L. J., and R. C. HAWLEY. 1925. The treatment of advance growth arising as a result of thinnings and shelterwood cuttings. Yale Univ. Sch. For. Bull. 15. 68 p.
MCINTYRE, A. C. 1936. Sprout groups and their relation to the oak forests of Pennsylvania. J. For. 34:1054–1058.
ROTH, E. R. and G. H. HEPTING. 1943. Origin and development of oak stump sprouts as affecting their likelihood to decay. J. For. 41:27–36.
Roth, E. R. and B. Sleeth. 1939. Butt rot in unburned sprout oak stands. USDA Tech. Bull. 684. 43 p.
SCHWARTZ, G. F. 1907. Sprout forests of the Housatonic Valley of Connecticut. For. Quart. 5:121–153.
SMITH, H. C. 1966. Epicormic branching on eight species of Appalachian hardwoods. USDA For. Serv. Res. Note NE-53. 4 p.
SONDERMAN, D. L. and R. L. BRISBIN. 1978. A quality classification system for young hardwood trees—the first step in predicting future products. USDA For. Serv. Res. Pap. NE-419. 7 p.
TRIMBLE, G. R., JR. and D. W. SEEGRIST. 1973. Epicormic branching on hardwood trees bordering forest openings. USDA For. Serv. Res. Pap. NE-261. 6 p.
WARD, W. W. 1966. Epicormic branching of black and white oaks. For. Sci. 12:290–296.
WENDEL, G. W. 1975. Stump sprout growth and quality of several Appalachian hardwood species after clearcutting. USDA For. Serv. Res. Pap. NE-329. 9 p.
ZAHNER, R., R. K. MYERS, and L. A. CHURCHILL. 1982. Site index curves for young oak stands of sprout origin. Clemson Univ. Dept. For. Bull. 35. 2 p.
ZAHNER, R., and R. K. MYERS. 1984. Productivity of young Piedmont oak stands of sprout origin. South. J. App. For. 8:102–108.
ZON, R. 1907. Management of second-growth in the southern Appalachians. USDA For. Serv. Circ. 118. 22 p.

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Growth of Loblolly Pine Treated With Hexazinone, Sulfometuron Methyl, and Metsulfuron Methyl For Herbaceous Weed Control

J. L. Michael

ABSTRACT. Aerial application of 0.25 pounds active ingredient per acre of sulfometuron methyl [Oust(TM), formerly DPX-5648] or 2.0 pounds of hexazinone [Velpar L (TM)] postemergent in May 1982, resulted in good weed control. Weeds controlled on the silty clay coastal plain soil included pokeweed (Phytolacca americana *L.*), *ragweed* (Ambrosia *sp.*), *goldenrod* (Solidago *sp.*), *and evening primrose* (Oenothera *sp.*). *Growth of 1-year-old loblolly pine* (Pinus taeda *L.*) *seedlings released with sulfometuron methyl or hexazinone was significantly improved in comparison to untreated seedlings. No significant pine mortality was associated with either treatment. On similar sites where blackberry* (Rubus *sp.*), *honeysuckle* (Lonicera japonica *Thunberg*), *and herbaceous weeds are the major problem, application of sulfometuron methyl from pre-emergence to the postemergent stage (when weeds are up to 12 to 18 inches in height) is recommended. Hexazinone is recommended as a postemergent treatment for herbaceous weed control. Treatment with metsulfuron methyl (formerly DPX-T6376-21) did not result in any growth responses significantly greater than untreated seedlings. Impacts of deer browsing on seedlings resulted in a slight height reduction the first and second growing seasons following planting but by the end of the third growing season browsed seedlings had made up the difference. No diameter differences were associated with deer browsing at any time during the study.*

One aspect of intensive southern pine management receiving much attention is herbaceous weed control in very young plantations. While some herbicides are available for this operation, no panaceas exist. Much research must be conducted to determine where and when herbicidal control of herbaceous weeds is most beneficial. Hexazinone, atrazine, and simazine have been reported beneficial in release of loblolly pine from herbaceous competition under some conditions, but results are variable (Fitzgerald 1976, Holt et al. 1975, Nelson et al. 1981). At least some of the variability reported is due to the lack of development of weed cover on untreated check plots in test sites. Lack of development of weed cover on untreated check plots leads to the erroneous conclusion that no growth benefit accrues from herbicide application on the treated plots. Additional variability may be due to the limited range of species affected by the herbicides used and to the use of an application rate too low to effect adequate weed control. Additional testing of herbicides for berbaceous weed control must be conducted to identify herbicides with wide ranges of species activity that can be applied pre- and/or postemergent with no adverse effects on young pine seedlings.

Browsing of planted pine by deer is often observed in very young plantations where deer populations are high. A primary concern in these very young plantations is whether the reduction in forage resulting from herbicide use will result in increased browsing on pine and whether the browsing results in lasting impacts on pine growth.

This paper reports the results of a test of hexazinone, sulfometuron methyl, and metsulfuron methyl at several rates postemergent over the top of l-year-old loblolly pine seedlings. Tests concentrated on determining the optimum rate and chemical effectiveness on sites dominated by pokeweed, ragweed, goldenrod, and evening primrose. In addition, impacts of deer browsing on pine growth were measured.

METHODS

The study site is located in the southern tip of Clarendon County in South Carolina. The silty clay soils of the area belong to the Tawcaw Series and are members of the fine, kaolinitic thermic family of Fluvaquentic Dystrochrepts. They are characterized by slow permeability and slow runoff with high available water capacity and 5 to 7% organic matter. Analysis of the top 6 in. of disked beds revealed an average of 16% sand, 42% silt, and 42% clay, and a pH of 5.0. The average phosphorus content of the top 6 in. of soil on this site is very low (2 ppm), while potassium is low (48 ppm) and magnesium is high (200 ppm).

This Coastal Plain river bottom is typical of many very high site index lands in the South. Located approximately 3 miles below the Lake Marion Dam, the site is flooded with 1 to 5 ft. of water several times a year when the dam flood gates are opened to relieve high water pressure. Flooding normally takes place between the middle of December and the end of March each year, and each inundation may last from one to several weeks.

Following clearcutting in 1979-80, the site was disked and bedded in 1980. In April 1981, it was planted with H-week-old containerized loblolly pine seedlings obtained from the Georgia-Pacific nursery located near Savannah, Georgia. Between planting and study installation approximately 20% seedling mortality occurred.

Herbaceous competition rapidly colonized the area following site preparation, and two dominant vegetation types emerged. One vegetation type was dominated by pokeweed, which grew to heights in excess of 6 ft. The pokeweed was very dense, averaging 7,500 stems / acre. Associated with the pokeweed were blackberry and cane (*Arundinaria* sp.). The second vegetation type found in the area in late 1981 was dominated by a nearly uniform mixture of goldenrod, ragweed, and evening primrose. Species in the goldenrod type grew taller than 6 ft. at an average density of 95,800 stems / acre (Figure 1).

The study, a randomized complete block design with four replications, was blocked on each of the two major herbaceous weed types. Nine treatments (Table I) were applied to the 36 plots 300 × 50 ft. in size used in the study. Effective end-to-end buffer zones among plots were 200 ft. long and side-by-side buffer zones were 60-ft. wide.

In each plot all loblolly pine seedlings (approximately 38) in the two center rows and central 150 ft. were permanently numbered and marked with aluminum tags. Ground-line diameter (g.l.d., diameter 4 in. above the ground) and height (ht.) were recorded in March 1982. At the same time, presence of deer browse damage was recorded for each measurement pine in each plot. Pine ht. and g.l.d. were also recorded in November 1982, and January 1984.

The severity of herbaceous weed competition was estimated in a circular plot with a radius of 3 ft. around each sample pine. The degree of competition was categorized for each pine according to the scale:

Free to grow: Pine well above the competition
Shaded: Pine top easily identified as bring just above or at the same height as the competition
Severely shaded: Pine top below level of surrounding competition
Bare ground: Little or no identifiable competition

Competition was recorded along with the three most abundant weed species in the circle during the week of 12 May 1982 for pretreatment measurements and during the week of 2 August 1982 for post-treatment measurements.

Treatments were applied on I2 May 1982 by a helicopter equipped with raindrop nozzles. All herbicides were mixed in water to make 20 gallons of spray mixture per acre. Surfactant was *not* added to the mixture.

Growth and survival data were averaged for each plot and then analyzed by analysis of variance at the 0.05 probability level. Significant ANOVA results were further analyzed with Duncan's multiple range test.

Figure 1. Very severe competition, principally goldenrod, surrounds loblolly pine seedling 26 months after planting on a disked and bedded site in South Carolina.

Table 1. Summary of loblolly pine diameter growth response to herbicide release treatments applied in South Carolina in May 1982.

Treatment		Ground line diameter[1]		
		When measured (mo/yr)		
		3/82	11/82	1/84[2]
Chemical	Rate	P>F = .2122	= .0636	= .0359
	Lb ai/ac		*Inches*	
Metsulfuron methyl	0.125	0.19	*11.65*	**1.36** abc
Metsulfuron methyl	0.25	0.20	0.70	1.29 bc
Metsulfuron methyl	0.50	0.21	0.81	1.56 ab
Sulfometuron methyl	0.125	0.19	0.74	1.48 abc
Sulfometuron methyl	0.25	0.22	0.86	1.68 a
Sulfometuron methyl	0.50	0.18	0.68	1.48 abc
Hexazinone	1.0	0.18	0.71	1.47 abc
Hexazinone	2.0	0.20	0.82	1.68 a
Untreated check	0.0	0.21	0.53	1.14 c

[1] Diameter .3 ft. above the ground.
[2] Means followed by the same letter are not different at the p = 0.05 level by Duncan's multiple range test.

RESULTS AND DISCUSSION

Herbaceous weeds were controlled to some extent by all treatments (Figure 2). Metsulfuron methyl at 0.125 and 0.25 lb ai/a provided the least weed control. At the time of treatment, 49%; of all pines were free to grow, 3 1% were shaded, and 20% were severely shaded. By August, the May treatments collectively had left 60% of all pines in the free-to-grow category, 22% shaded, and 18% severely shaded. At the same time on the untreated check plots, pines in the free-to-grow category had decreased to 25%, 21% were shaded, and 54% were severely shaded. Thus, in the period May to August 1982 the number of severely shaded pines nearly tripled on the untreated check plots while remaining the same or decreasing on the treated plots. Sulfometuron methyl at 0.25 lb ai/a was the best treatment with a net decrease of 56% of seedlings in the severely shaded category and an increase of 41 % in seedlings in the free-to-grow category. Hexazinone treatment did not result in large net changes in the distribution of pines among the three shading categories but did maintain the status quo. Therefore, during the growing season when hexazinone plots were not changing from pretreatment conditions, untreated check plots were being overgrown. Most of the competition on the site was perennial herbaceous species and a smaller portion was woody vines. The perennial herbaceous species had grown to a height

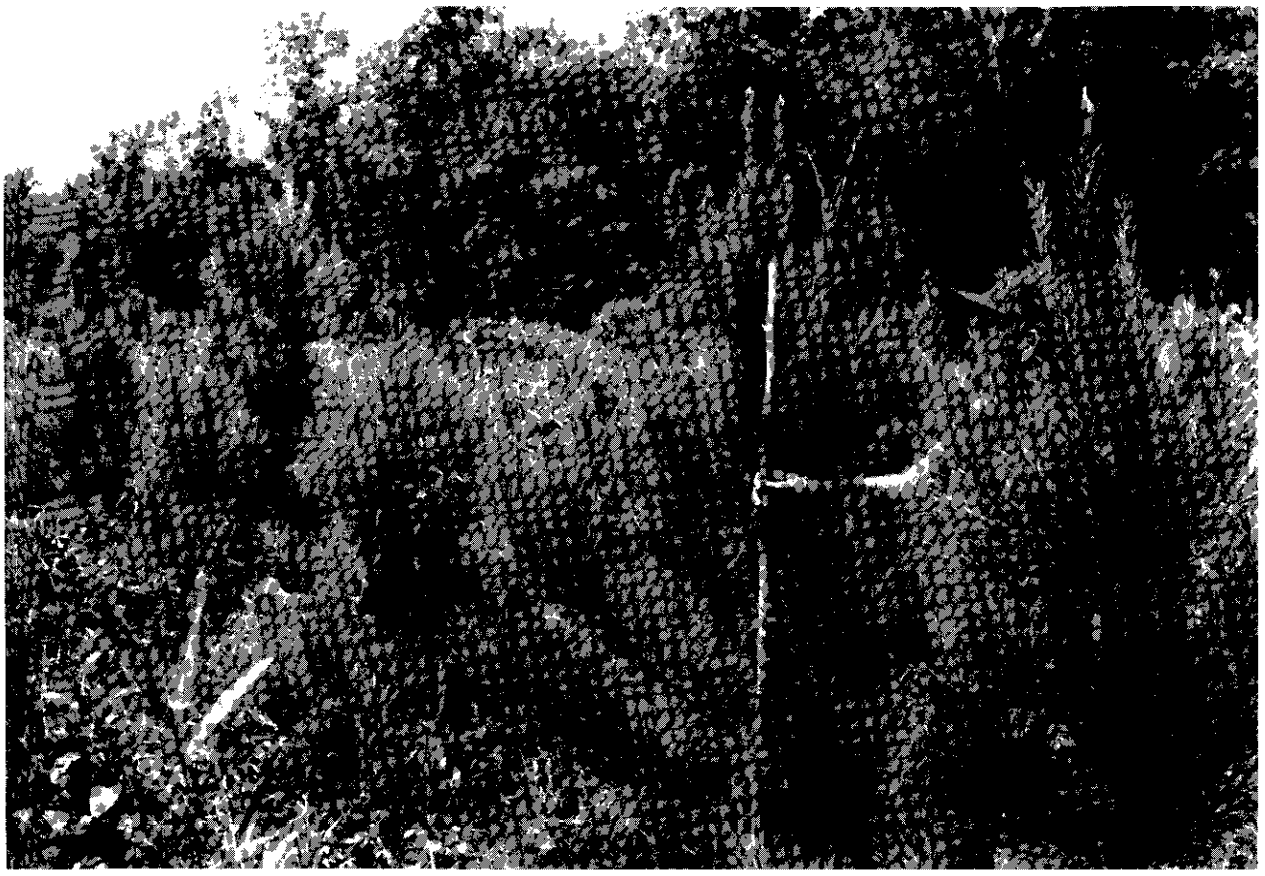

Figure 2. Typical condition of loblolly pine seedlings 13 months after release with 0.25 lb ai/a of sulfometuron methyl or 2 lb ai/a of hexazinone in South Carolina. Seedling age is 26 months, as in Figure 1.

of 12 to 18 in. by 12 May. Allowed to continue growing, these species attain heights of 5 to 8 ft. by June-July. Sulfometuron methyl controlled much of the herbaceous competition as well as some of the woody vines, i.e., honeysuckle and blackberry. Hexazinone also controlled the perennial herbaceous species which would have overgrown the young pine seedlings, but was not as effective as sulfometuron methyl on honeysuckle and blackberry. This difference in activity is why sulfometuron methyl treatment resulted in a net change in the distribution of pines among the three shading categories while hexazinone did not. Metsulfuron methyl treatment appeared to control competition in the same way as hexazinone treatment except at the lowest rate, i.e., herbaceous weeds were controlled but not woody vines. It is now known that addition of a surfactant increases the efficacy of metsulfuron methyl. Because surfactant was not added in this study, different results may be expected in future tests with metsulfuron methyl plus surfactant.

Pine survival was assessed in November 1982. There were no significant differences in survival among the various levels of treatment, which ranged from 97 to 100% during the course of this study. Seedling mortality is slowly increasing on the untreated sites.

Growth of some treated pines was affected by herbicide damage. Terminal buds and needles were damaged by metsulfuron methyl at rates greater than 0.125 lb ai/a. Herbicide effects on pine seedlings similar to those observed on metsulfuron methyl treated plants occurred on sulfometuron methyl treated seedlings at 0.5 lb ai/a. These two related compounds belong to a new group of herbicidally active chemicals and are of considerable interest in forestry, because pines appear tolerant at rates which are active on some weed species. Hexazinone neither killed nor damaged significant numbers of pine seedlings in this study even at 2 lb ai/a. Hexazinone activity is negatively correlated with soil organic matter. The high level of organic matter in this soil (5 to 7%) probably accounts for the low pine toxicity at the high rate.

Pine growth was measured for two growing seasons following application. No statistically sig-

nificant seedling differences in g.l.d. or ht. existed among plots prior to treatment but very significant differences in g.l.d. did develop among the treated seedlings by January 1984 (Table 1). Seedlings treated with sulfometuron methyl at 0.25 lb ai/a and hexazinone at 2 lb ai/a had the largest average g.l.d. Seedlings treated with 0.5 lb ai/a of metsulfuron methyl were also significantly larger in g.l.d. than the control seedlings. By November 1982, seedlings treated with 0.25 lb ai/a of sulfometuron methyl were 6 in. taller than those untreated; and by January 1984, the difference had increased to 1.2 ft., 20% taller than the untreated. These differences were not significant at the 0.05 level; however, the trend in growth rate suggests statistically significant height differences may occur in the future. Table 2 summarizes the change in height and diameter for the first and second growing seasons following treatment. The probability of a greater F statistic (P > F) for the height analysis of variance changed from 0.6906 at the end of the first growing season to 0.1257 at the end of the second growing season following treatment. The largest average height change measured in the 1983 growing season (sulfometuron methyl at 0.25 lb ai/a) was 39% greater than that of the control. The lack of significant height differences following release treatments is not unusual. Observations of other young plantations indicate that released pines typically respond first by cap-

Table 2. Change in loblolly pine height and ground line diameter (g.l.d.) in response to herbicide release treatments applied in South Carolina in May 1982.

Treatment		Change in height in year		Change in g.l.d. in year	
		1982	1983	1982	1983
Chemical	Rate	P>F = .6906	.1257	.0247	.0224
	Lb ai/ac	... Feet ...		Inches	
Metsulfuron methyl	0.125	1.96	3.21	0.47 ab	0.70 ab
Metsulfuro" methyl	0.25	2.07	3.29	0.50 ab	0.58 b
Metsulfuro" methyl	0.50	2.05	3.52	0.60 a	0.74 ab
Sulfometuron methyl	0.125	2.04	3.52	0.54 a	0.75 ab
Sulfometuron methyl	0.25	2.4"	3.84	0.64 a	0.81 a
Sulfometuron methyl	0.50	2.01	3.67	0.50 ab	0.8" a
Hexazinone	1.0	2.23	3.78	0.52 a	0.76 ab
Hexazinone	2.0	2.26	3.68	0.62 a	0.87 a
Untreated check	0.0	1.96	2.76	0.32 b	0.61 b

[1] Means followed by the same letter are not different at the p = 0.05 level by Duncan's multiple range test.

Table 3. Percent of loblolly pine which attained breast height (bh, 4.5 ft.) and average dbh at the end of the second year following release from herbaceous weed competition with herbicides applied in South Carolina in May 1982.

Treatment		Pine with bh 1/84	Average dbh 1/84
Chemical	Rate	P > F = .7524	= .2227
	Lb ai/a	Percent	Inches
Metsulfuro" methyl	0.125	78	0.57
Metsulfuron methyl	0.25	80	0.58
Metsulfuron methyl	0.50	80	0.66
Sulfometuron methyl	0.125	82	0.66
Sulfometuron methyl	0.25	92	0.94
Sulfometuron methyl	0.50	81	0.64
Hexazinone	1.0	80	0.71
Hexazinone	2.0	86	0.76
Untreated check	0.0	74	0.52

Figure 3. Extreme case of deer browse left this loblolly pine seedling and many others without a terminal bud 11 months after planting on a disked and bedded site in South Carolina.

turing the newly available lateral growing space. Increases in height growth follow in later years.

All treatments except 0.125 and 0.25 lb ai/a of metsulfuron methyl and 0.5 lb ai/a sulfometuron methyl resulted in diameter growth rates significantly greater than the untreated for the first growing season following application. By the end of the second growing season only hexazinone at 2 lb ai/a and sulfometuron methyl at 0.25 and 0.5 lb ai/acre had significantly faster diameter growth rates than untreated check seedlings (Table 3).

Treatment with 0.25 lb ai/a of sulfometuron methyl resulted in the most uniform stand. Of the pines in this treatment 92% attained breast height two growing seasons after treatment and the average diameter at breast height (dbh) of these seedlings was 0.94 in., 80% larger than seedlings in the untreated check plots.

Browsing of pine seedlings by deer was extensive in the winter following planting and prior to herbicide application (Figure 3). In March 1982, 42% of all surviving seedlings had been browsed. Seedling growth was affected by deer browsing during the 2 years following planting. By the third year there was no significant difference in seedling height (Table 4) between browsed and not browsed seedlings. All seedlings were observed in June 1983, and no deer browse was evident on the needles, indicating that deer browse did not increase following weed control measures in 1982. It cannot be determined from this study whether herbaceous weed control immediately following planting would affect the frequency or severity of deer browsing. However, it is clear that browsed seedlings recovered in 2 years and that browsing did not affect seedling diameter. During the period of this study, browsing did not affect loblolly pine survival. Prior to study installation there was approximately 20% pine mortality on the site, part of which may have been due to deer browsing activity.

Table 4. Impacts of deer browsing on loblolly pine height (ht.) and ground-line diameter (g.l.d.) in South Carolina

	Date measured (mo/yr)					
	3/82[1]		11/82		1/84	
Treatment	Ht.	g.l.d.	Ht.	g.l.d.	Ht.	g.l.d.
P > F =	.0285[2]	.2632	.0086[2]	.6338	.1836	.8093
Deer browsed	0.94 a	0.20	2.92 a	0.71	6.41	1.45
Not browsed	1.01 b	0.19	3.21 b	0.73	6.69	1.46

[1] Pretreatment measurement, ht. is in feet g.l.d. is in inches.
[2] Means followed by the same letter are not different at the p = 0.05 level by Duncan's multiple range test.

CONCLUSION

Herbaceous weed control can increase growth of young planted loblolly pine on high site index lands following single applications at effective rates. In this study 0.25 lb ai/a of sulfometuron methyl resulted in the greatest height and diameter growth responses and in the most uniform stands of trees. Application rates of 0.25 lb ai/a are recommended as postemergent treatments where pokeweed, goldenrod, evening primrose, and ragweed are severe competitors. Treatment with sulfometuron methyl when these weeds are significantly taller than 12 to 18 in. is not advised. Because earlier applications will result in earlier reduction in levels of competition, they may result in greater pine growth than reported in this paper. Where honeysuckle and blackberry are problems, sulfometuron methyl is also beneficial. This treatment is not recommended where a large number of woody sprouts are anticipated.

A related herbicide, metsulfuron methyl, was applied without surfactant and did not result in growth responses significantly greater than observed on untreated check plots. Future trials with metsulfuron methyl should include surfactant in the mixture. Foliar application rates greater than 0.25 lb ai/a are not advised because of observed pine damage. In this test, pine damage at the 0.5 lb rate may have accounted for the lack of a significant growth response.

Hexazinone treatment at the 2 lb rate resulted in growth rates nearly identical to those of the 0.25 lb sulfometuron methyl treatments and is recommended for similar sires where soil organic matter is high. Hexazinone has the added benefit of reducing the number of woody sterns but was not as effective as sulfometuron methyl on this site in the control of honeysuckle. The foliar application of hexazinone at high rates must be conducted advisedly because of the pine toxicity potential and must be done only on soils with high organic matter content, considerable clay content, and high cation exchange capacities.

Herbicidal control of weeds did not aggravate the deer browsing already observed on the site. Browsing was rampant during the first year following planting but little additional browsing occurred during the following two growing seasons. By the end of the third growing season there was no significant growth impact resulting front deer browsing.

Literature Cited

FITZGERALD, C. H. 1976. Post-emergence effects of Velpar in a piedmont pine plantation. Proc. South. Weed Sci. Soc. 29:299.

HOLT, H. A., J. E. VOELLER, and J. F. YOUNG. 1975. Herbaceous vegetation control as a forest management practice. Proc. South Weed. Sci. Soc. 28:219.
NELSON, LARRY R., RICHARD, C. PEDERSON, LANNY L. AUTRY, STUART DUDLY, and JOHN D. WALSTAD. 1981. Impacts of herbaceous weeds in young loblolly pine plantations. South. J. Appl. For. 5:153–158.

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Decay Following Thinning of Sweetgum Sprout Clumps: *26-Year Results*

F. I. McCracken

ABSTRACT. Butt rot in living sweetgum (Liquidambar styraciflua) *stems was observed 15 and 26 years after the companion living stems were cut in a 55-year-old stand of sprout origin near Tallulah, Louisiana. Living stems had insignificant or no decay 15 years after thinning. Twenty-six years after thinning, an extensive amount of decay had developed in all living stems originating from cut stubs that had split longitudinally down the side during thinning. However, the amount of decay was insignificant or absent when clean cuts had been made which resulted in grown-over stubs that contained water, decay, and anaerobic bacteria. Split stubs did not retain water, and decay had spread into the living stems. Decay risk associated with thinning sprout clumps can apparently be eliminated by undercutting and taking care to prevent splitting during felling.*

Many second-growth stands of sweetgum are of sprout origin and are characterized by the presence of many twin trees or clumps having more than two stems. When these stands are thinned for pulpwood, it is a common practice to thin the sprout clumps to one stern. The open scar creates a risk of decay in the remaining stems.

Roth and Hepting (1943b) reported that thinning of oak sprout clumps initiated decay in about 21% of the trees through wounds associated with thinning. Wounds 4 in. in diameter and larger remained open for at least 5 years, and sprouts of low origin had the least decay hazard. Decay hazard rose rapidly when oak sprouts greater than 3 in. in diameter were removed (Roth 1956). Toole (1960) reported that there was no rot in attached residual sweetgum stems 5 years after the surplus companion sprouts were removed. From the same study, Toole (1965) reported that half of the residual trees had decay from the attached cut stubs of removed stems after 10 years. The volume of decay averaged less than 1%, and he concluded that there is little rot hazard to the remaining stems for a decade after thinning. Observations made in the same study area 15 and 26 years after thinning are included in this paper.

MATERIALS AND METHODS

In April 19.55, a 55-year-old sweetgum stand of sprout origin on the Tensas River in Madison Parish, Louisiana, was thinned for pulpwood. Before thinning, the stand had a basal area of 120 sq. ft. per acre. The average dbh was 10 in. About 10% of the basal area in the stand was composed of other hardwood species. The soil was Sharkey Clay. Site index for sweetgum was estimated at 83 ft. in 50 years (Broadfoot and Krinard 1959). The trees had originated as sprouts at groundline, and two or more stems were fused for 9–70 in. above ground. These appeared as single stems with a low fork. The clumps were thinned to a single stem, which is common practice. The smallest, suppressed, or undesirable stem was felled by chain-sawing outward from between stems. Undercuts were not made. Consequently, some bark and wood split from the side of some stubs when the stems fell. The height of the stub above the crotch varied 1 to 21 in. A total of 189 sprout clumps having one living stem were selected for observation in 1955. However, thinning, destructive sampling, and other causes had reduced that number. Observations on the decay of stubs and presence of fungi were made on 98 sprout clumps in 1970 and on 86 in 1981 when the stand was logged. The live stem and base of 12 sprout clumps were dissected 15 and 26 years after thinning.

Wood chips about 0. I $in.^3$ in size were removed