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SURVIVAL AND GROWTH TWO YEARS AFTER CONTROL OF HERBACEOUS COMPETITORS IN NEWLY PLANTED SEEDLINGS OF LOBLOLLY PINE

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ABSTRACT

Early or late over-the-top applications of herbicides were used to control herbaceous competition in machine planted loblolly pine (*Pinus taeda* L.) seedlings at two locations in a pasture near Alleene and hand planted seedlings on a bedded site near Fouke. Sites were selected for diverse competitors. None of the treatments controlled weeds for the entire growing season. Only glyphosate + sulfometuron methyl produced seedling survival and growth below the check plots. The best over-the-top treatments were sulfometuron methyl alone or sulfometuron methyl + hexazinone.

INTRODUCTION

Forest managers are beginning to realize the importance of controlling herbaceous competitors about newly planted pine seedlings. A recognition of the potential contribution of early weed control to total site productivity has stimulated investigations on the impact of specific herbicides on early pine seedling development.

Studies using potted seedlings and various watering regimes have demonstrated a strong positive correlation between soil moisture and growth of loblolly pine (Wenger, 1952; Zahner, 1962). Likewise, field studies by Stransky (1961) and Koshi and Stephenson (1962), showed a positive relationship between growth and soil moisture when weeds were controlled. In addition, growth of loblolly pine seedlings was inversely related to herbaceous weed cover or biomass following weed control treatments (Nelson *et al.*, 1981). Depending on the site, percentage of herbaceous cover seven weeks after herbicide treatment explained 43 to 81% of the variation in first-year height growth of loblolly pine. In another study of low, medium, or high levels of herbaceous control, first-year pine growth was most likely correlated to soil moisture level in late August, when soil moisture was lowest (Zutter *et al.*, 1986). From a summary of studies in herbaceous competition in 16 plantations largely in Alabama, researchers showed first, competition control had a significant positive effect on height and diameter at all 16 locations, and on survival or density when competition was intense. Second, a second year of herbaceous vegetation control led to significant additional gains in height and diameter at six and seven of 10 locations, respectively. And third, application technique did not significantly influence survival, or growth in height and groundline diameter (Creighton *et al.*, 1987). Increased growth in these studies was presumably due to increased soil moisture, nutrient availability and light availability as a result of removing competing herbs.

Much of the research in the South on herbaceous competitors has focused on traditional Coastal Plain sites and its competitors. Problem competitors often associated with poor soil drainage and non-timbered sites need to be examined and justifies the establishment of this study.

OBJECTIVES

The objectives of this study were to compare (1) the efficacy of selected herbicides on herbaceous competitors found on newly planted pine sites and (2) the growth response of newly planted pine seedlings to release from these competitors.

METHODS

Three sites were included in this study. Locations one and two were in a pasture near Alleene, AR. Location one supported mixed grasses (*Digitaria* spp., *Panicum* spp., *Croton* sp., *Carex* spp., and *Festuca* sp.) while location two had a dense bermudagrass *(Cynodon dactylon)* sod. These sites were machine planted in February 1986. Location three was near Fouke, AR. It was prepared by shearing, windrowing and bedding prior to hand planting in February 1986. The bedding was completed in November 1985.

Seedling buds and bermudagrass were evaluated for dormancy prior to the application of early (March 20) and late (April 22) treatments. On March 20, Fouke seedlings received early treatments of herbicides and were evaluated as 10% flushed, 20% swollen, and 70% dormant. At Alleene, locations one and two were given the same assessment: 10% flushed, 50% swollen, and 40% dormant. On July 2, Fouke seedlings were released with late treatments of herbicides and assessed as 100% flushed. At Alleene, late treatments were applied on April 22 and seedling buds assessed as 90% flushed, 5% swollen and 5% dormant. Bermudagrass was absent at Fouke and 10% green at Alleene.

Herbicides (Tables 1 and 2) were applied over-the-top in 1-meter bands centered over seedlings. No effort was made to protect seedlings from contact with herbicides. Herbaceous biomass was collected from a 1-meter square in each check plot at all sites. Samples were taken 30, 60, 90 and 120 days after treatment (DAT).

Percent reduction of herbaceous competition as compared to check plots was evaluated in 10% intervals for each plot. Evaluations were performed 30, 60, 90 and 120 DAT.

Table 1. Herbicides tested.

Trade Name	Common Name	Registered Trademark
Escort	metsulfuron methyl	E. I. du Pont de Nemours & Company
Fusilade	fluazifop	ICI Americas Inc.
Oust	sulfometuron methyl	E. I. du Pont de Nemours & Company
Poast	sethoxydim	BASF Wyandotte Corporation
Roundup	glyphosate	Monsanto Chemical Company
Velpar L	hexazinone	E. I. du Pont de Nemours & Company

Table 2. Mean percent control of herbaceous competitors.

Time[1]	Treatment (kg/ha a.i.)	Days After Treatment 30	60	90	120
		-----(% herbaceous	control)-----		
		Alleene (Mixed Grasses)			
E	0.15 Sulf[2]	93 B[3]	92AB	70 BCD	55 BC
E	0.28 Sulf	93 B	96A	86AB	77A
E	0.84 Hex+0.15 Sulf	99A	97A	87AB	75A
E	0.56 Hex+0.28 Sulf	99A	99A	95A	85A
E	0.56 Gly+0.15 Sulf	99A	95A	83ABC	68AB
E	0.43 Gly+0.28 Sulf	99A	99A	92A	83A
L	0.43 Flu+0.15 Sulf	93 B	68 C	58 D	50 C
L	0.43 Flu+0.28 Sulf	97A	80 BC	66 CD	50 C
L	0.56 Seth+0.28 Sulf	99A	95A	83ABC	78A
L	0.07 Met	30 C	23 D	15 E	10 D
		Alleene (Bermudagrass)			
E	0.15 Sulf	97 B	85ABC	55 C	45 D
E	0.28 Sulf	99A	92AB	78AB	60 BC
E	0.84 Hex+0.15 Sulf	99A	90AB	82A	68ABC
E	0.56 Hex+0.28 Sulf	99A	90AB	85A	73AB
E	0.56 Gly+0.15 Sulf	99A	85ABC	63 BC	55 CD
E	0.43 Gly+0.28 Sulf	99A	90AB	80AB	68ABC
L	0.43 Flu+0.15 Sulf	90 C	83 BC	63 BC	63 BC
L	0.43 Flu+0.28 Sulf	90 C	95A	80AB	80A
L	0.56 Seth+0.15 Sulf	90 C	78 C	75AB	68ABC
L	0.56 Seth+0.28 Sulf	90 C	93A	75AB	75AB
		Fouke (Wet Site Grasses)			
E	0.15 Sulf[2]	99A[3]	99A	99A	99A
E	0.28 Sulf	99A	99A	99A	99A
E	0.56 Gly+0.15 Sulf	99A	99A	99A	99A
E	0.43 Gly+0.28 Sulf	99A	99A	99A	99A
E	0.56 Hex+0.28 Sulf	99A	100A	99A	99A
E	0.84 Hex+0.15 Sulf	99A	98A	90A	74 B
L	0.84 Hex+0.15 Sulf	99A	99A	90A	90A
L	0.56 Hex+0.15 Sulf	97A	92A	99A	99A
L	1.00 Hex+0.15 Sulf	97A	99A	99A	90A
L	1.00 Hex+0.07 Met	50 B	50 B	50 B	30 C

[1] E=early; L=late;

[2] Sulf=sulfometuron methyl; Met=metsulfuron methyl; Gly=glyphosate; Hex=hexazinone;

[3] Treatment means having the same letter within the column are not significantly different at the 0.05 level (Duncan's Multiple Range test).

Heights and groundline diameters were recorded immediately after planting and in late October 1986 and December 1987. Seedling survival was expressed in percent, height in centimeters, and groundline diameter in millimeters.

The study layout was a randomized complete block design with four blocks. Each block contained 11 one-row plots with 10 seedlings per row.

Data were evaluated using analyses of covariance with initial seedling size as the covariate. Duncan's Multiple Range test was used to separate means. All statistical tests were conducted at the 0.05 level of confidence.

RESULTS AND DISCUSSION

Efficacy

Overall control of herbaceous competitors was good at all sites (Table 2). Treatments with 0.15 kg/ha of sulfometuron methyl alone or in mixture generally exhibited less control than the 0.28 kg/ha rate approximately 90 DAT. This suggests that the low rate of sulfometuron methyl was possibly too light and that an intermediate rate may provide grass control similar to the high rate at a lower cost. Mixtures containing sulfometuron methyl showed little additional control above that observed for sulfometuron methyl alone. On mixed grasses, metsulfuron methyl gave narrow spectrum weed control. At Fouke, hexazinone + metsulfuron methyl proved the least effective.

At 60 to 90 DAT, bermudagrass had invaded plots from the sides regardless of timing, rate, or herbicide. Future tests on bermudagrass should include fall applications prior to spring planting, over-the-top applications with a wider band (1.7 meters), or multiple applications of herbicide. At 120 DAT herbs were re-established in all plots at all sites.

Early applications were more effective than late ones (Table 3). This may be related to differences in competitor biomass levels at application (Zutter *et al.*, 1986) in which case lower rates may be used if herbicides are applied early (Table 4).

Table 3. Mean percent control of herbaceous competitors.

Time	Days After Treatment 30	60	90	120
	-----(% herbaceous	control)-----		
	Alleene (Mixed Grasses)			
Early	97A[1]	96A	86A	74A
Late[2]	80 B	67 B	56 B	47 B
	Alleene (Bermudagrass)			
Early	99A	89A	74A	62 B
Late	90 B	87A	73A	72A
	Fouke (Wet Site Grasses)			
Early	99A	99A	99A	95A
Late	86 B	85 B	85 B	77 B

[1] Treatment means having the same letter within the column are not significantly different at the 0.05 level (Duncan's Multiple Range test).

[2] Without metsulfuron methyl 30, 60, 90, and 120 day means are: 96%, 81%, 69%, and 59%, respectively.

Table 4. Trends in herbaceous biomass (kg/ha) on untreated plots.

Location	May	June	July	August	September
Mixed Grasses	209	901	1181	1721	1841
Bermuda-grass	177	708	1214	2345	2856
Wet Site Grasses	71	131	289	791	741

Seedling Response

First- and second-year survival and growth were greater at Alleene than Fouke (Table 5). This probably occurred for two reasons. First, levels of herbaceous biomass were higher at Alleene than Fouke, and thus the release was greater (Table 4). Land managers should consider site conditions, the density of herbaceous competitors and the type and timing of site preparation before recommending additional competitor control. Avoid blanket recommendations. Second, Fouke was poorly drained with water standing between beds through June. During this same period, Alleene was well drained. Excessive moisture is known to inhibit seedling development (Patrick, 1977; Stone, 1977).

Based on survival, height and groundline diameter, treatment of mixed grasses with sulfometuron methyl, hexazinone + sulfometuron methyl and sethoxydim + sulfometuron methyl were the most effective treatments (Table 5). These treatments provided first-year responses averaging 17% more survival, 59% more height, and 235% more groundline diameter. Glyphosate treatments resulted in 17% less survival, 49% less height and 6% more groundline diameter than check seedlings.

For bermudagrass control, similar and best survival and growth in height and groundline diameter were recorded on sulfometuron methyl and sethoxydim + sulfometuron methyl treated plots (Table 5). These treatments provided first-year responses averaging 6% more survival, 61% more height growth, and 210% more groundline diameter than check seedlings . During this same period, glyphosate + sulfometuron

Table 5. Mean survival (SUR), total height (HT) and groundline diameter (GLD) after one (86) and two (87) growing season.

Time[1]	Herbicide (kg/ha)	SUR (%) 86	SUR (%) 87	HT (CM) 86	HT (CM) 87	GLD (MM) 86	GLD (MM) 87
	-Alleene (Mixed Grasses)-						
L	0.43 Flu+0.15 Sulf[2]	98A[3]	93A	36AB	83 BC	7 B	17 C
L	0.43 Flu+0.28 Sulf	95A	93A	39AB	105A	7AB	21ABC
L	0.56 Seth+0.28 Sulf	95A	88A	42A	109A	8A	22AB
L	0.07 Met	93AB	85AB	32 BC	95AB	5 C	19 BC
E	0.15 Sulf	98A	98A	41A	116A	7AB	24AB
E	0.28 Sulf	97A	95A	42A	116A	8A	25A
E	0.84 Hex+0.15 Sulf	95A	88A	40A	113A	8AB	22ABC
E	0.56 Hex+0.28 Sulf	90AB	90A	36AB	95AB	7AB	22ABC
	Check	78 BC	70 BC	26 C	67 C	4 D	12 D
E	0.56 Gly+0.15 Sulf	68 C	57 C	12 D	45 D	3 D	9 D
E	0.43 Gly+0.28 Sulf	63 D	57 C	12 D	42 D	4 D	8 D
	-Alleene (Bermudagrass)-						
L	0.56 Seth+0.28 Sulf	100A	100A	47ABC	139A	9A	28AB
L	0.56 Seth+0.15 Sulf	97A	95A	42 CD	121 BC	8 BC	25 C
L	0.43 Flu+0.15 Sulf	100A	100A	43 BCD	131AB	9 BC	28AB
L	0.43 Flu+0.28 Sulf	100A	100A	44 BCD	121 BC	8 BC	25 BC
E	0.15 Sulf	98A	97A	49AB	137AB	9AB	28AB
E	0.28 Sulf	97A	97A	51A	144A	10A	30A
E	0.56 Hex+0.28 Sulf	98A	98A	37 D	111 C	8 C	22 C
E	0.84 Hex+0.15 Sulf	95A	98A	41 CD	133AB	8 BC	28AB
	Check	92A	89A	30 E	94 D	5 D	17 D
E	0.43 Gly+0.28 Sulf	53 B	50 B	11 G	42 E	4 D	7 E
E	0.56 Gly+0.15 Sulf	49 B	21 C	19 F	22 F	3 E	4 E
	-Fouke (Wet Site Grasses)-						
E	0.15 Sulf	98A	97A	37AB	82AB	10ABC	22AB
E	0.28 Sulf	87A	90A	30 BC	57 C	8 BCDE	14 D
E	0.56 Gly+0.15 Sulf	98A	97A	36AB	84AB	9ABCD	19 BCD
E	0.43 Gly+0.28 Sulf	97A	97A	37AB	84AB	10AB	21ABC
E	0.56 Hex+0.28 Sulf	93A	90A	34ABC	71ABC	10ABC	20 BCD
E	0.84 Hex+0.15 Sulf	90A	90A	39A	68ABC	10ABC	20ABC
L	0.84 Hex+0.15 Sulf	93A	93A	39A	88A	11A	25A
L	1.00 Hex+0.07 Met	90A	88A	35ABC	74ABC	8 CDE	17 BCD
L	0.56 Hex+0.15 Sulf	88A	85AB	35ABC	85A	9 BCDE	21ABC
	Check	87A	87AB	32ABC	71ABC	7 DE	13 D
L	1.00 Hex+0.15 Sulf	70 B	70 B	27 C	62 BC	7 E	16 CD

[1] E=early; L=late;
[2] Sulf=sulfometuron methyl; Met=metsulfuron methyl; Gly=glyphosate; Hex=hexazinone;
[3] Treatment means within a column sharing the same letter are not significantly different at the 0.05 level (Duncan's Multiple Range test).

methyl treatments exhibited 41% less survial, 22% less height, and 34% less groundline diameter than untreated checks.

At Fouke, similar and best survival and growth occurred with sulfometuron methyl, hexazinone + sulfometuron methyl, and glyphosate + sulfometuron methyl (Table 5). These treatments provided first-year responses over that of check seedlings by 5% for survival, 29% for height, and 68% for groundline diameter.

Second-year mortality was less than 2% for check and non-glyphosate plots at all locations. In glyphosate treated plots, second-year mortality averaged 9%, 16% and 0% in the studies of mixed, bermuda-grass and wet site grasses, respectively. Data showed a two-year growth response to herbaceous control. The magnitude of the first-year response was greater than for the second year. Reduced growth was apparent on glyphosate treated plots after two growing seasons.

Treatment time was contrasted for effect on survival and growth (Table 6). Differences were detected but when mixtures of glyphosate + sulfometuron methyl were not considered, early and late applications provided similar responses with differences among treated and untreated plots. Similar seedling survival and growth on plots receiving early (March 20) and late (April 20) treatments indicates that (1) practitioners can integrate herbaceous control with tree planting and controlled burning as weather and other duties permit, and (2) applicators can locate and release seedlings prior to and during emergence of herbs while seedlings are easy to see. Thus, land managers can capitalized on the pre-emergence and postemergence attributes of herbicides for safe and reliable control.

These results show that complete weed control does not always correlate with seedling performance. The low rate of sulfometuron methyl provided intermediate competitor control but was among treatments with the best seedling survival and growth. Metsulfuron methyl provided the worst control of mixed grasses and above average seedling survival and growth. This suggests that total control may not be needed for optimal seedling growth. Additional work is needed to determine the level of control needed for optimal seedling performance and cost effective treatments. Second, physiologically active seedlings should not be treated with mixtures of glyphosate. That is, pine tolerance can not be sacrificed to gain additional control for subsequent growth. Third, several mixtures and rates of herbicides are available for control of selected herbaceous competitors. Therefore, land managers can select herbicides based on availability, cost and the specific competitors to be controlled. Fourth, sulfometuron methyl alone or mixed with hexazinone provided best seedling response at all three sites. Fifth, a two-year increase in survival and growth can be used to justify treatment cost. Sixth, March through April applications provided similar seedling responses giving land managers an opportunity to integrate herbaceous vegetation control with other land management practices.

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LITERATURE CITED

CREIGHTON, J. L., G. R. GLOVER, and B. R. ZUTTER. 1986. Loblolly pine growth response to herbaceous weed control — a summary of 15 studies. Proc. South. Weed Sci. Soc. 39:193.

KOSHI, P. T. and G. K. STEPHENSON. 1962. Shade and mulch as influences on loblolly pine seedlings and their immediate environment. For. Sci. 8:191-204.

NELSON, L. R., R. C. PEDERSEN, L. L. AUTRY, S. DUDLEY and J. D. WALSTAD. 1981. Impacts of herbaceous weeds in loblolly pine plantations. South. J. Appl. For. 5(3):153-158.

PATRICK, W. H. 1977. Chemistry of flooded soil and effects on mineral nutrition. Pp. 40-48, *in:* W. E. Balmer, ed. Proc. Soil Moisture...Site Productivity Symposium. 400 pp.

STONE, E. L. 1977. A critique of soil moisture-site productivity relationships. Pp. 377-387, *in:* W. E. Balmer, ed. Proc. Soil Moisture...Site Productivity Symposium. 400 pp.

STRANSKY, J. J. 1961. Weed control, soil moisture, and loblolly pine seedling behavior. J. For. 59:282-284, 289-290.

WENGER, K. F. 1952. Effect of moisture supply and soil texture on the growth of sweetgum and pine seedlings. J. For. 50:862-864.

ZAHNER, R. 1962. Terminal growth and wood formation by juvenile loblolly pine under two soil moisture regimes. For. Sci. 8:345-352.

ZUTTER, B. R., G. R. GLOVER and D. H. GJERSTAD. 1986. Effects of herbaceous weed control using herbicides on a young loblolly pine plantation. For. Sci. 32:(4)882-899.