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CONTROL OF HERBACEOUS COMPETITORS IN PROGENY TESTS USING CONTAINER-GROWN SEEDLINGS

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ABSTRACT

Container-grown and May-planted seedlings of loblolly and shortleaf pines were treated with herbicides for control of herbaceous competitors. Weed control and seedling growth were evaluated. Competitor control was good for all treatments. Survival and growth of pines differed by species and herbicide treatment. The best treatment for both species included covering seedlings and spraying competitors with glyphosate. Both species showed decreased survival and growth when treated with medium and high rates of hexazinone + sulfometuron methyl.

INTRODUCTION

Studies have reported herbicide tolerance and performance of loblolly pine (*Pinus taeda* L.) seedlings released from herbaceous competition with various herbicides including sulfometuron methyl, glyphosate, hexazinone, atrazine and imazapyr. Zutter (1984) showed that weed control resulted in greater height and diameter growth of loblolly pine, with trees receiving weed control for two years showing the most improvement. Barber *et al.* (1984) reported that imazapyr and sulfometuron methyl may cause stunting of loblolly pine. Sulfometuron methyl was found to be the most consistently effective herbicide in another study (Nelson and Metcalfe, 1983). Hexazinone caused greater pine mortality on sites with coarser soil texture when used for pine release (Minogue *et al.*, 1984). Increases in early height growth were attributed to herbaceous weed control. Similar information on the performance of seedlings of shortleaf pine (*P. echinata* Mill.) is lacking. All of the above herbicides are labeled for use in herbaceous weed control in forestry in the South (Anonymous 1988).

Most studies of herbaceous competition control have addressed operational plantings of bare-root seedlings. Many of the companies expected to apply this information also participate in tree breeding programs and need similar information for container-grown seedlings used in progeny tests. Progeny tests are used to determine the efficacy of selected matings in a tree breeding program, and are maintained in a relatively artificial environment compared to operational plantings (van Buijtenen and Lowe, 1982). Such plots usually receive broadcast weed control. Progeny tests represent a substantial investment of time and money to the company, and are usually maintained at all costs.

Container-grown seedlings differ from bare-root seedlings in that they may be less than six months old, and no dormant period is experienced prior to outplanting. Seedlings are vigorous, often with little woody tissue, and are actively growing when planted in late spring after danger of frost is past. Bare-root seedlings are nearly one year old and are dormant when lifted from the nursery bed prior to planting during the winter months.

Planting methods also differ between bare-root and container-grown stock. Ordinarily, bare-root seedlings are planted by hand using a dibble with a 10 inch long spade, which often places the root collar of these seedlings several inches below ground. Container-grown seedlings have more uniform root development, and are planted using tools designed for such seedlings. While this places the tree at the appropriate position in the substrate, it also places its roots in a more vulnerable location when soil-active herbicides are applied.

The limited information on the response of shortleaf pine and container-grown seedlings to herbicide treatments and control of herbaceous competitors justifies the establishment of this study. The study objectives are: 1) to contrast the efficacy of herbicides, and 2) to compare the survival and growth of container-grown seedlings of loblolly and shortleaf pines when released from herbaceous competitors using herbicides.

MATERIALS AND METHODS

The study is near Batesville in Independence County, which is physiographically in the Ozark Highlands of northern Arkansas. The soil is a sandy loam with 62 percent sand, 34.5 percent silt, 2 percent clay and 1.5 percent organic matter.

Christmas trees were removed from the site in 1985 leaving a dense sod supporting major proportions of broomsedge (*Andropogon* spp.), sedges (*Carex* spp.), and panicgrass (*Panicum* spp.), with lesser proportions of crabgrass (*Digitaria* spp.), bermudagrass (*Cynodon* spp.), blackberry (*Rubus* spp.), greenbriar (*Smilax* spp.), and sumac (*Rhus* spp.).

In mid-September, 1986, 3.2 kg/ha glyphosate was broadcast over the entire study. In November, seeds from loblolly and shortleaf pines were sown in styroblocks® (No. 8) and the seedlings were grown in a greenhouse. Two weeks before outplanting, seedlings moved outside to become acclimated. Actively growing seedlings were outplanted on May 6, 1987 on a 1.2 x 2.4 M spacing. The fall application of glyphosate plus droughty conditions over the previous year contributed to minimal early May herbaceous competition. Approximately 1.9 cm of precipitation fell shortly before and on the day of planting.

Treatments were applied in 0.9 m bands centered on seedlings. Each herbicidal treatment was mixed with water until the total volume was 93.5 1/ha. Treatments were applied in late May following 2.54 cm of postplanting precipitation. Seedlings were visible and herbaceous competitors abundant at treatment. The glyphosate treatment was scheduled as a preplant application, but lack of herbaceous vegetation resulted in delaying application until late May with the other treatments. Treatments tested are presented in Table 1.

Reduction of herbaceous competition was expressed to the nearest 5% class by visual estimation at 30 and 60 days after treatment. Following the 60-day evaluation, seedlings were covered and glyphosate (3.2 kg/ha) applied to all non-check plots in a 0.9 m band to control the regrowth of *Rhus* and *Cynodon* spp.

Seedling heights (cm) and groundline diameters (mm) were recorded on planting day and again in November 1987. Seedlings were also assessed in July for mortality.

The study was a randomized block design with three blocks. Each block contained 20 one-row plots with 20 seedlings per plot. Data were evaluated using analyses of covariance ($P = 0.05$) with initial height or initial groundline diameter as covariates. Duncan's Multiple Range test was used to contrast means ($P = 0.05$).

RESULTS AND DISCUSSION

The fall application of glyphosate was effective. The composition of September 1986 and May 1987 herbaceous competitors was similar, although many May competitors were new germinants. This probably contributed to the very effective and similar efficacy observed at the 30- and 60-day evaluations (Table 1). New germinants of *Andropogon* spp. were controlled by imazapyr and mixtures of hexazinone. The

Table 1. Herbicide treatments and efficacy.

Treatment	kg ai/ha	Days After Treatment 30	60
		- - - - % - - - -	
glyphosate[1]	2.52	100 A[3]	97 AB
H[2]-hexazinone+sulfometuron methyl	0.84+0.16	98 AB	98 A
M-hexazinone+sulfometuron methyl	0.56+0.16	96 ABC	95 ABC
L-hexazinone+sulfometuron methyl	0.28+0.16	95 ABC	93 ABCD
H-imazapyr	0.34	93 BCD	93 ABCD
L-imazapyr	0.17	89 CD	87 CD
sulfometuron methyl	0.16	89 CD	87 CD
H-atrazine+sulfometuron methyl	2.24+0.10	93 BCD	85 D
L-atrazine+sulfometuron methyl	1.12+0.10	92 BCD	88 BCD
Check		-	-

[1] Only treatment with seedlings covered during the application of herbicide.

[2] L=low; M=medium; H=high.

[3] Means within a column sharing the same letter are not significantly different (Duncan's Multiple Range test).

Table 2. Mean seedling response to herbicide treatment.

Treatment	Height	Groundline Diameter	Survival
	cm	mm	%
glyphosate[1]	14.5 AB[2]	2.8 A	70.0 A
H[3]-hexazinone+sulfometuron methyl	6.2 D	1.2 D	28.3 C
M-hexazinone+sulfometuron methyl	6.1 D	1.2 D	30.0 C
L-hexazinone+sulfometuron methyl	12.4 ABC	2.6 AB	55.8 B
H-imazapyr	11.0 C	2.6 AB	68.3 A
L-imazapyr	12.3 ABC	2.4 AB	73.3 A
sulfometuron methyl	13.6 ABC	2.8 A	69.2 A
H-atrazine+sulfometuron methyl	11.7 BC	2.0 C	53.3 B
L-atrazine+sulfometuron methyl	15.2 A	3.0 A	70.8 A
Check	13.5 ABC	1.8 C	65.0 A

[1] Only treatment with seedlings covered during the application of herbicide.

[2] Means within a column sharing the same letter are not significantly different (Duncan's Multiple Range test).

[3] L=low; M=medium; H=high.

Table 3. Response of container-grown, loblolly (Lob) and shortleaf (Shlf) pine seedlings to treatments of herbicides for herbaceous control.

Treatment	Height Lob	Height Shlf	Groundline Diameter Lob	Groundline Diameter Shlf	Survival Lob	Survival Shlf
	- - - - (cm)	- - - -	- - - (mm)	- - -	- - - - (%)	- - - -
L[1]-atrazine+sulfometuron methyl	18.1 A[3]	12.2 AB*	3.8 A	2.2 A*	80.0 A	61.7 B*
sulfometuron methyl	16.6 A	10.7 B*	3.6 A	2.0 A*	80.0 A	58.3 B*
Hl-imazapyr	15.3 AB	6.8 CD*	3.1 AB	2.1 A	75.0 AB	61.7 B
Check	14.9 AB	12.0 AB	2.1 CD	1.6 A	70.0 AB	60.0 B
L-imazapyr	14.7 AB	10.0 BC*	2.6 BCD	2.1 A	75.0 AB	71.7 AB
glyphosate[2]	14.0 ABC	15.1 A	3.2 AB	2.4 A	58.3 BC	81.7 A*
L-hexazinone+sulfometuron methyl	14.0 ABC	10.8 B	2.8 ABC	2.3 A	56.7 BC	55.0 B
H-atrazine+sulfometuron methyl	11.6 BCD	11.9 AB	2.0 CD	2.0 A	50.0 C	56.7 B
H-hexazinone+sulfometuron methyl	9.8 CD	2.7 E*	1.9 CD	0.6 B*	41.3 C	13.3 C*
M-hexazinone+sulfometuron methyl	8.7 D	3.6 DE*	1.8 D	0.5 B*	41.7 C	18.3 C*
Species Mean	13.7A[4]	9.6 B	2.7 A	1.8 B	63.0 A	53.8 B

[1] L=Low; M=Medium; H=High.

[2] Only treatment with seedlings covered during the application of herbicide.

[3] Means within a column sharing the same letter are not significantly different (Duncan's Multiple Range test).

[4] Species means within a row sharing the same letter are not significantly different (Duncan's Multiple Range test).

* The loblolly versus shortleaf contrast is significant (Duncan's Multiple Range test).

July reapplication of glyphosate to treatment plots resulted in nearly total control of herbaceous competitors throughout the summer.

Seedling mortality in late July was not significantly different from that recorded in November; thus November values are presented (Table 2). Greatest survival was observed on imazapyr, check, sulfometuron methyl, glyphosate, and atrazine (low) plus sulfometuron methyl treated plots. Mixtures of hexazinone (low) or atrazine (high) with sulfometuron methyl were similar with intermediate survival while medium and high levels of hexazinone plus sulfometuron methyl were similar with the least survival. Mortality on atrizine (high) or hexazinone plus sulfometuron methyl treated plots was greater than for untreated check plots and was unacceptable.

For treatments with acceptable survival, similar and best growth was observed on plots treated with imazapyr (low), sulfometuron methyl, glyphosate (covered seedlings), and atrazine (low) mixed with sulfometuron methyl (Table 1).

Survival and growth of loblolly and shortleaf pine seedlings varied by herbicide treatment (Table 3). Seedlings of loblolly pine exhibited better survival and growth than those of shortleaf pine (Table 3). Acceptable shortleaf pine survival occurred on plots treated with imazapyr (low) and glyphosate (covered seedlings). Seedlings of shortleaf pine showed lower surival and growth than loblolly pine seedlings when plots were treated with medium and high hexazinone mixtures with sulfometuron methyl, sulfometuron methyl (alone), and atrazine (low) mixed with sulfometuron methyl. Shortleaf pine height growth was also less than loblolly on imazapyr treated plots. Data suggest seedlings of shortleaf pine may be more sensitive to herbicides than seedlings of loblolly pine.

Greatest survival and growth of loblolly pine seedlings occurred on plots treated with atrazine (low) + sulfometuron methyl, sulfometuron methyl (alone), and imazapyr (high). The best treatment for both species was covering seedlings and spraying plots with glyphosate. Worst growth and survival for loblolly and shortleaf seedlings occurred with treatments containing medium to high rates of hexazinone.

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