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Efficacy of Pre- and Postemergent Herbicides in Field-Planted *Pinus eldarica*

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ABSTRACT

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Seven herbicides were evaluated in southern New Mexico for weed control and phytotoxicity on field-planted *Pinus eldarica* (Medw.) seedlings. Preemergent applications of (a) sulfometuron methyl, (b) hexazinone, (c) a combination of a and b, (d) oxyfluorfen, (e) terbacil and (f) trifluralin were evaluated. In a separate experiment, repeated postemergent applications of glyphosate were tested. Hexazinone at 0.56 and 1.12 kg a.i. ha^{-1} provided early season weed control of 65% and 90%, respectively without affecting seedling growth or condition. Sulfometuron methyl, with and without hexazinone, provided mid-season control of 76% to 99%, but all treatments caused significant seedling injury. Glyphosate caused unacceptable seedling injury with the rate required to control weeds (1.68 kg a.i./ha).

INTRODUCTION

Interest in planting eldarica pine — *Pinus eldarica* (Medw.) — in arid regions has increased over the past decade because the species tolerates drought, high temperatures and moderately alkaline soils (Fisher and Widmoyer, 1978). Eldarica pine's rapid, full growth habit is well suited to production of fuelwood, pulpwood, ornamentals, windbreaks and Christmas trees when provided supplemental irrigation.

Weed competition is one problem encountered in growing *P. eldarica* nursery seedlings and transplants. Seedlings fail, grow poorly and are malformed when weeds deprive them of moisture, nutrients and growing space (White, 1965). Weeds are particularly damaging in arid regions because moisture deficits accentuate competition effects. In New Mexico, perennial grasses and annuals quickly overtop transplants when seasonal rains and high soil temperatures arrive.

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TABLE 1

Major forb and grass species present in research plots

	Species	Common name
Forbs		
	Amaranthus palmeri	Palmer Amaranth
	Conyza canadensis	Horseweed
	Cyperus spp.	Nutsedge
	Helianthus ciliaris	Texas Blueweed
	Salsola kali	Russian Thistle
	Sisymbrium irio	London Rocket
	Spaeralcea spp.	Globemallow
Grasses		
	Cenchrus pauciflorus	Field Sandbar
	Echinochloa colonum	Junglerice
	Eragrostis pectinacea	Carolina Lovegrass
	Eriochloa gracilis	Southwestern Cupgrass
	Leptochloa filiformis	Red Spangletop
	Sorghum halepense	Johnsongrass

There is little published information on vegetation control in eldarica pine plantings in the United States. The work reported here evaluates several herbicides potentially suited to the soils and temperatures of the arid Southwest. Specific study objectives were to identify promising herbicides for weed control in Southwestern *P. eldarica* plantations and determine the tolerance of *P. eldarica* to herbicides.

MATERIALS AND METHODS

The study consisted of two separate experiments conducted throughout spring and summer 1984 on the Fabian Garcia Horticulture Farm in Las Cruces, New Mexico. Soil texture at the site ranges from sandy loam to sandy clay loam. Soil pH ranges seasonally from 7.8 to 8.2, while soil organic matter ranges from 0.8% to 1.1%. Broadleaf weed species, specifically *Amaranthus* and *Salsola*, constituted the major weed problem (Table 1).

Experiment 1

Nine-month-old containerized eldarica pine seedlings, grown in 160 cm^3 tubes, were hand planted in September 1983 on 0.6×0.6 m spacing. Each 4.4×2.7 m plot included 28 trees. Measurements were taken on only the 10 innermost trees, thus excluding the outer border rows of each plot. A 1 m buffer surrounded each plot. Each of the three replications consisted of 14 treatments with five herbicides (Table 2).

TABLE 2

Treatment effects on percent weed cover in plots and final shoot fresh weight for *P. eldarica* seedlings in experiment 1

Treatment	Rate (kg a.i. ha^{-1})	Weed cover (%)			Shoot F.W. (g)
		May	July	Sept	
Cultivation	—	0 A[a]	0 A	0 A	58 C
Untreated	—	20 D	94 H	95 F	183 A
Sulfometuron methyl[b]	0.28	0 A	8 ABC	57 C	83 BC
Sulfometuron methyl	0.56	0 A	1 AB	38 B	59 C
Hexazinone[c]/sulfometuron methyl	0.56/0.14	0 A	21 BCD	77 DE	79 BC
Hexazinone/sulfometuron methyl	0.56/0.28	0 A	22 BCD	68 CD	99 BC
Hexazinone	0.56	7 AB	73 EFG	95 F	65 BC
Hexazinone	1.12	2 B	79 EFGH	93 EF	100 BC
Oxyfluorfen[d]	0.56	19 CD	93 GH	94 F	71 BC
Oxyfluorfen	1.12	13 BCD	91 FGH	87 EF	90 BC
Terbacil[e]	2.24	4 AB	76 EFGH	86 EF	dead
Terbacil	4.48	1 AB	28 D	69 CD	dead
Trifluralin[f]	1.12	13BCD	73 EFG	90 EF	64 C
Trifluralin	2.24	8 ABC	64 E	90 EF	112 B

[a]Values in the same column with the same letter are not significantly different at $P=0.05$.
[b]Methyl 2-[[[[(4,6-dimethyl-2-pyrimidinyl)amino] carbonyl] amino] sulfonyl] benzoic acid.
[c]3-cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4(1H,3H)-dione.
[d]2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene.
[e]5-chloro-3-(1,1-dimethylethyl)-6-methyl-2,4(1H,3H)-pyrimidinedione.
[f]2,6-dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)benzenamine.

All herbicides were applied with a calibrated spray boom in late February and were mechanically incorporated into the soil. Each plot was lightly irrigated (50 to 100 mm basin irrigation) two days after the herbicide application. The cultivated plot was mechanically cleared monthly.

Weed control was evaluated by estimating percent weed cover per plot with a point sample method (Cain and Castro, 1959) in May, July and September 1983. Weeds were classified by species and grouped into forbs and grasses. The impact of weed competition on seedling quality was evaluated subjectively.

Herbicide phytotoxicity (Anderson, 1963) was evaluated at monthly intervals from May through October. Height and stem caliper were first recorded in January, then monthly from May through September. Shoot fresh weight was recorded in October on 8 of the 10 innermost plot trees.

Experiment 2

Seedlings were planted in September 1983 identically to those in experiment 1. Each of the three replications included four rates of the postemergent her-

bicide, glyphosate (*N*-(phosphonomethyl)glycine) and a control (shallow cultivation). Monthly broadcast applications of glyphosate at rates of 0.56, 1.12, 1.68 and 2.24 kg a.i. ha^{-1} were made with a calibrated spray boom over the tops of the seedlings from June through September 1984. The control was cultivated on the same dates.

Weed control was recorded monthly from June through September and was evaluated as in experiment 1. Phytotoxicity, tree height, stem caliper and shoot fresh weight were recorded as described in experiment 1.

RESULTS

Experiment 1

Sulfometuron methyl (1×, 2×) (Application rates are referred to as 1× (low rate) and 2× (high rate).), hexazinone/sulfometuron methyl (1×, 2×), hexazinone (2×) and terbacil (2×) reduced early-season weeds by at least 90% (Table 2). Terbacil (1×), hexazinone (1×) and trifluralin (2×) produced 80%, 65% and 50% control, respectively. By mid-season, sulfometuron methyl (1×, 2×) reduced weed competition by 90%, while hexazinone/sulfometuron methyl (1×, 2×), and terbacil (2×) reduced weed cover by 70% or better (Table 2).

Some treatments provided excellent weed control from February through May. However, none of the herbicides exhibited season-long control. Weed control effectiveness decreased across all herbicide treatments as the season progressed. Seedlings grown in clean-cultivated plots had 30% to 35% greater stem caliper, and 50% to 65% greater fresh weights than those grown in hexazinone (1×), oxyfluorfen (1×, 2×) and trifluralin (1×) plots (Table 2). Untreated seedlings and seedlings treated with hexazinone, oxyfluorfen, trifluralin or terbacil were spindly and had reduced stem caliper and shoot fresh weight. Tree height was not affected by weed competition.

Terbacil at both rates killed all seedlings by mid-season. Sulfometuron methyl and hexazinone/sulfometuron methyl treatments did not cause seedlings mortality, but caused severe reductions in height and shoot fresh weight (Table 2). Moderate reductions in stem caliper and seedling quality were also observed. For all other treatments, weed competition had a greater impact on the seedlings than did phytotoxicity.

Experiment 2

Adequate weed control was obtained only with the higher glyphosate rates (1.68 and 2.24 kg a.i. ha^{-1}) which, by September, had produced 65% and 72% control, respectively (Table 3). Neither seedling height nor stem caliper was significantly affected by glyphosate when compared to trees in the cultivated

TABLE 3

Monthly mean percent weed cover for glyphosate-treated plots in experiment 2[a]

Glyphosate (kg a.i. ha^{-1})	Weed cover (%)			
	June	July	Aug	Sept
0.56	28 C[b]	67 A	83 B	77 C
1.12	23 BC	54 A	73 B	59 BC
1.68	13 AB	33 A	32 A	35 AB
2.24	7 A	37 A	35 A	28 A

[a]The control plots were mechanically cleared of weeds each month.
[b]Values in the same column with the same letter are not significantly different at $P=0.05$.

treatment. Phytotoxic effects, however, were exhibited in the 1.12, 1.68 and 2.24 kg a.i. ha^{-1} treatments. The higher glyphosate rates provided adequate weed control, but also damaged pine seedlings.

DISCUSSION AND CONCLUSIONS

Hexazinone (1×, 2×) and trifluralin (2×) provided excellent early season weed control. Higher rates or multiple applications could result in safe and effective, season-long weed control. Sulfometuron methyl, applied alone or in mixed herbicide treatments, provided adequate weed control through mid-season, but suppressed seedling growth. Lower rates of sulfometuron methyl might provide effective weed control without adversely impacting growth.

Based on the results of both studies, preemergent applications of terbacil and broadcast applications of glyphosate during the active growing season should be eliminated from future tests. *Pinus eldarica* has been shown to tolerate autumn glyphosate spraying at rates up to 6 kg a.i. ha^{-1} (Marechal et al., 1981). Directed sprays of glyophosate provide safe, effective control. Granular hexazinone is available and should be evaluated because of its ease of application (no soil incorporation needed) and slow-release quality. Research with multiple applications of sulfometuron methyl at lower rates should be conducted.

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