Preemergence Weed Control in Southeastern Forest Nurseries[1]

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Abstract. Weed control trials were conducted on loblolly pine (*Pinus taeda* L.) or slash pine (*Pinus elliottii* Engelm.) seedbeds at 12 locations in the southeastern United States. Good weed control was obtained from 2,4-bis-(isopropylamino)-6-(methylthio)-*s*-triazine (prometryne) at 2.2 and 4.5 kg/ha; *N*,*N*-dimethyl-2,2-diphenylacetamide (diphenamid) at 4.5 and 9 kg/ha; α,α,α-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine (trifluralin) at 1.1 and 2.2 kg/ha; and 2-ethylthio-4,6-bis-isopropylamino-*s*-triazine (GS-16068) at 2.2 and 4.5 kg/ha as preemergence applications immediately followed by irrigation. Diphenamid and trifluralin treatments were not injurious to either pine species at either rate. GS-16068 was only slightly injurious at the high rate at one location. Prometryne was injurious at two locations at the high rate and at one location at the low rate.

INTRODUCTION

FOREST nurseries in the southeastern United States have relied heavily on handweeding for weed control. But the increasing cost and shortage of labor has prompted a need for less expensive and more available methods. Unfortunately, the high crop value and low production acreage have restricted experimentation in chemical weed control for forest nurseries.

Several commercial herbicides have received limited testing on forest tree species (1, 2, 3, 4, 6). Prometryne, diphenamid, and trifluralin have appeared promising as preemergence applications on loblolly pine and slash pine seedbeds (1, 2). The need for more extensive testing led to the formation in 1970 of a cooperative program covering a 12-state area. This report covers the results of a series of uniform experiments conducted during the 1971 growing season.

METHODS AND MATERIALS

Twelve experiments were established at state nurseries in the Southeast during the 1971 growing season (Table 1). Seedbeds were prepared, sown, and mulched according to normal nursery practices (5), *i.e.*, beds were prepared with a bedshaper or rotary tiller, sown broadcast or in drill rows, and either mulched with wheat straw, pine needles, or sawdust or left unmulched. Slash pine was planted at the Mississippi and Florida locations and loblolly pine at the other nurseries. Herbicide treatments were applied within 48 hr after sowing and mulching, and the beds were immediately sprinkler irrigated with 1.3 to 1.9 cm of water. Herbicides were applied with a carbon dioxide pressurized, hand sprayer calibrated to deliver 187 L/ha. Each plot was 1.8 m (one bed) wide and 6.1 m long. The experimental design was a randomized block with four replications. Composite soil samples from the top 15 cm were collected from each replication. Normal rainfall was supplemented when necessary with sprinkler irrigation to insure approximately 2.5 cm of water per week throughout the growing season.

Each location except Virginia included ten treatments: prometryne at 2.2 and 4.5 kg/ha, trifluralin at 1.1 and 2.2 kg/ha, diphenamid at 4.5 and 9 kg/ha, GS-16068 at 2.2 and 4.5 kg/ha, and two controls. Because of the extremely sandy soil at the nursery in Virginia, rates at this location were reduced to: prometryne at 1.1 and 2.2 kg/ha, trifluralin at 0.8 and 1.6 kg/ha, and GS-16068 at 1.7 and 3.4 kg/ha. Diphenamid rates, however, were not reduced.

Plots were handweeded when necessary and weeding time was recorded for each plot. At some nurseries only one weeding was required while at others several weedings were needed throughout the season. Only annual weeds and grasses were removed during the recorded weedings. Nutsedge (*Cyperus rotundus* L. and *C. esculentus* L.) occurred at some locations but was removed before or after the recorded weedings and time to remove this weed is not included in total weeding times. Table 2 is a list of weeds and their occurence in the Southeastern forest nurseries.

Seedling production was evaluated after the growing season (December to February) by selecting two 9.3 dm^2 samples at random within each plot. Number of plantable seedlings (morphological grades 1 and 2 (5)) and total dry weight of these samples were determined.

Separate analyses of variance and multiple range tests were calculated for number of plantable seedlings, dry weight production, and weeding time at each location.

RESULTS AND DISCUSSION

At two locations herbicide treatment reduced the number of plantable seedlings (Table 3). In Tennessee, prometryne at 2.2 and 4.5 kg/ha, trifluralin at 1.1 kg/ha, and GS-16068 at 4.5 kg/ha reduced the number of plantable trees below the numbers for control plots. The effect of trifluralin at 1.1 kg/ha is questionable since the higher rate did not reduce the number of plantable seedlings. Only prometryne-treated trees exhibited visible symptoms of herbicide injury. In Kentucky, prometryne at 4.5 kg/ha reduced the number of plantable seedlings.

High rates of trifluralin and GS-16068 in Florida increased dry weight production (Table 4). In Louisiana, prometryne at 4.5 kg/ha controlled a troublesome annual sedge (*Cyperus compressus* L.) more effectively than other treatments and increased dry weight production in these plots. Prometryne at 2.2 kg/ha and diphenamid at 9 kg/ha resulted in increased dry weight production at the Oklahoma nursery. In Kentucky, prometryne at 4.5 kg/ha reduced the dry weight of plantable seedlings. This was the only incidence where dry weight of plantable seedlings was reduced by herbicide treatment.

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Table 1. Locations and planting dates of weed control experiments in slash or loblolly pine seedbeds.

Nursery	City	State	Planting date	Soil texture	Organic[a] matter
					(%)
John R. Miller Nursery	Autaugaville	Alabama	4/20/71	Sandy loam	3.3
Bluff City Nursery	Bluff City	Arkansas	4/13/71	Loamy sand	1.6
Munson Nursery	Milton	Florida	4/19/71	Loamy sand	2.6
Walker Nursery	Reidsville	Georgia	4/12/71	Loamy sand	1.7
Kentucky Dam Nursery	Gilbertsville	Kentucky	4/27/71	Sandy loam	2.6
Columbia Nursery	Columbia	Louisiana	4/13/71	Sandy loam	2.3
Waynesboro Nursery	Waynesboro	Mississippi	4/21/71	Sandy loam	5.5
Claridge Nursery	Goldsboro	North Carolina	4/30/71	Sandy loam	2.7
State Tree Nursery	Broken Bow	Oklahoma	4/5/71	Sandy loam	1.9
Horace L. Tilghman Nursery	Wedgefield	South Carolina	3/25/71	Sandy loam	4.2
Pinson Nursery	Jackson	Tennessee	4/27/71	Loam	2.8
New Kent Forestry Center	Providence Forge	Virginia	4/29/71	Loamy sand	3.1

[a]Loss on ignition.

Table 2. Weeds found in the Southeastern forest nurseries during the 1971 growing season.

Scientific name	Common name	Occurence
Amaranthus retroflexus L.	Redroot pigweed	General
Ambrosia artemisiifolia L.	Common ragweed	General
Cassia obtusifolia L.	Sicklepod	Fla.
Chenopodium album L.	Common lambsquarter	General
Cyperus compressus L.		Ga., La.
Cyperus iria L.	Rice flatsedge	La.
Digitaria sanguinalis (L.) Scop.	Large crabgrass	General
Diodia teres Walt.	Poorjoe	Ark., Fla.
Eclipta alba (L.) Hassk.	Eclipta	La.
Elusine indica (L.) Gaertn.	Goosegrass	General
Eupatorium capillifolium (Lam.) Small	Dogfennel	General
Geranium carolinianum L.	Carolina geranium	Va.
Gnaphalium sp.	Cudweed	Miss., Ok.
Ipomoea purpurea (L.) Roth	Tall morningglory	General
Jaquemontia tamnifolia (L.) Griseb.	Smallflower morningglory	Ala., Miss.
Lamium amplexicaule L.	Henbit	Va., Ky., Tenn.
Lepidium virginicum L.	Virginia pepperweed	Ky.
Mollugo verticillata L.	Carpetweed	General
Oxalis stricta L.	Common yellow woodsorrel	Ky., Tenn.
Polygonum pensylvanicum L.	Pennsylvania smartweed	Tenn.
Portulaca oleracea L.	Common purslane	General
Richardia scabra L.	Florida pusley	Fla.
Salix nigra Marsh.	Black willow	Ky.
Sida spinosa L.	Prickly sida	Ark., Fla.

Table 3. Pine seedling numbers following preemergence herbicide applications at state forest nurseries in southeastern United States.

		Plants per 9.29 dm²[a]											
		State											
Herbicide	Rate	Ala.	Ark.	Fla.[b]	Ga.	Ky.	La.	Miss.[b]	N.C.	Okla.	S.C.	Tenn.	Va.[c]
	(kg/ha)	(no.)	(no.)	(no.)	(no.)	(no.)	(no.)	(no.)	(no.)	(no.)	(no.)	(no.)	(no.)
Prometryne	2.2	16.7	38.7	18.6	33.2	23.4	18.0	19.2	39.9	37.2	23.0	14.1*	25.4
Prometryne	4.5	17.5	31.0	21.4	31.1	16.6*	26.2	18.2	32.2	44.5	38.7	13.4*	18.1
Trifluralin	1.1	19.6	37.6	25.7	25.2	32.5	13.4	20.7	36.9	28.0	28.1	16.1*	25.6
Trifluralin	2.2	23.0	36.0	24.0	34.6	28.5	18.6	15.9	34.2	36.7	28.7	18.4	22.7
Diphenamid	4.5		41.0	26.1	34.6	32.6	22.2	19.0	35.9	37.5	24.9	18.4	25.6
Diphenamid	9.0		33.0	19.9	32.4	35.1	22.7	19.7	41.4	31.6	27.2	20.4	26.9
GS-16068	2.2	18.9	32.5	25.0	24.7	28.2	26.6	19.6	29.0	43.6	26.4	17.1	25.2
GS-16068	4.5	21.9	37.9	23.0	30.6	26.9	26.6	18.7	39.5	36.4	25.0	16.2*	27.0
Control	0.0	14.7	36.4	22.6	30.7	31.0	13.9	16.7	33.6	29.4	28.9	20.9	25.7
Control	0.0	17.6	40.5	20.0	25.7	26.1	18.7	20.4	32.4	23.1	28.1	21.0	24.6

[a]An asterisk indicates a significant difference from both controls at the 5% level of probability. Means were compared by a multiple range test, but only comparisons with controls are shown.
[b]Slash pine were planted at these locations.
[c]Due to an extremely sandy soil, rates were reduced to: prometryne at 1.1 and 2.2 kg/ha, trifluralin at 0.8 and 1.7 kg/ha, and GS-16068 at 1.7 and 3.4 kg/ha. The rates of diphenamid were not reduced.

Prometryne gave the most consistent results of any herbicide tested. The low rate gave significant reduction in weeding time at nine out of twelve locations (Table 5). Diphenamid at the low rate gave significant weed control at six out of eleven locations. Low rates of trifluralin and GS-16068 resulted in good weed control at six of twelve locations. Weed control, as expected, differed between nurseries since weed populations, soil types, and organic matter levels varied. In Louisiana, for example, only prometryne and GS-16068 controlled the annual sedge mentioned previously. Diphenamid at this location gave some weed control but the sedge still dominated the plots. At the Waynesboro Nursery in Mississippi soil organic matter was 5.5%, considerably higher than the other nurseries. This apparently reduced herbicide effectiveness. A low weed population at the Tilghman Nursery in South Carolina influenced the first weeding times. Data from the second weeding, which are not presented, indicated reduced weeding times with prometryne, diphenamid, and GS-16068 treatments. Weed populations within the experiment at New Kent Forestry Center were so variable that the differences between treatments were not significant.

The duration of effective weed control varied with locations. Results are given from three locations where several

Table 4. Pine seedling dry weight production following preemergence herbicide applications at state forest nurseries in southeastern United States.

Herbicide	Rate	Dry weight production per 9.29 dm²[a]											
		State											
		Ala.	Ark.	Fla.[b]	Ga.	Ky.	La.	Miss.[b]	N.C.	Okla.	S.C.	Tenn.	Va.[c]
	(kg/ha)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)	(g)
Prometryne	2.2	67.3	104.3	62.7	55.3	100.5	67.0	88.6	77.3	165.9*	91.1	51.3	54.5
Prometryne	4.5	72.4	101.5	58.3	57.3	86.5*	116.4*	87.1	65.4	149.6	102.1	51.2	42.8
Trifluralin	1.1	80.7	111.2	63.0	43.1	133.0	44.8	88.1	75.6	142.6	96.0	49.8	60.5
Trifluralin	2.2	94.7	100.6	71.5*	58.7	127.5	47.7	85.9	70.0	149.2	93.4	61.2	53.8
Diphenamid	4.5		91.6	58.4	57.6	117.2	47.1	86.3	66.7	133.3	102.4	61.2	58.2
Diphenamid	9.0		89.9	57.3	55.5	134.5	67.3	78.7	74.4	166.8*	89.3	59.3	56.3
GS-16068	2.2	79.8	103.2	68.3	48.8	114.5	74.4	83.1	57.6	139.5	92.7	49.9	54.3
GS-16068	4.5	87.0	113.2	72.5*	56.9	118.1	87.0	84.2	74.0	140.9	93.2	54.5	53.1
Control	0.0	69.7	89.9	53.4	50.0	125.9	28.9	82.6	71.6	131.9	97.7	57.4	60.3
Control	0.0	72.4	91.0	52.7	45.2	120.2	51.9	85.4	68.3	133.2	103.7	66.3	59.5

[a]An asterisk indicates a significant difference from both controls at the 5% level of probability. Means were compared by a multiple range test, but only comparisons with controls are shown.
[b]Slash pine were planted at these locations.
[c]Due to an extremely sandy soil, rates were reduced to: prometryne at 1.1 and 2.2 kg/ha, trifluralin at 0.8 and 1.7 kg/ha, and GS-16068 at 1.7 and 3.4 kg/ha. The rates for diphenamid were not reduced.

Table 5. Weed control in pine seedbeds following preemergence herbicide applications at state forest nurseries in southeastern United States.

Herbicide	Rate	Handweeding Time[a, b]											
		State											
		Ala.	Ark.	Fla.	Ga.	Ky.	La.	Miss.	N.C.	Okla.	S.C.	Tenn.	Va.[c]
		Days between treatment and first handweeding											
		41	40	29	49	37	56	43	50	58	29	52	57
	(kg/ha)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)
Prometryne	2.2	0.4*	0.8*	8.0*	8.8*	0.4*	32.5*	11.2	3.9*	13.0*	1.3	1.4*	6.3
Prometryne	4.5	0.3*	0.5*	4.4*	2.2*	0.3*	17.0*	12.5	1.3*	10.2*	0.8	1.2*	3.5
Trifluralin	1.1	0.9*	1.4*	5.3*	53.2*	1.7*	155.0	11.0	7.0	15.0*	1.2	19.5	16.4
Trifluralin	2.2	0.6*	0.5*	4.5*	17.5*	0.6*	144.0	6.8*	6.0	9.7*	1.3	3.0*	10.2
Diphenamid	4.5		0.6*	11.3*	18.2*	0.5*	155.0	14.0	2.9*	8.5*	1.0	14.0	13.1
Diphenamid	9.0		2.7*	4.6*	15.0*	0.4*	139.0*	11.3	4.1*	3.2*	0.8	10.5	8.6
GS-16068	2.2	0.9*	2.0*	21.2	12.3*	0.9*	72.0*	13.7	4.7	10.8*	1.3	13.5	8.6
GS-16068	4.5	0.4*	0.3*	9.5*	3.2*	0.3*	47.0*	15.1	4.1*	6.7*	0.7	1.1*	3.1
Control	0.0	2.8	27.5	30.3	100.3	6.3	176.0	17.6	9.6	84.5	1.9	13.5	37.5
Control	0.0	4.0	23.3	25.5	158.9	6.1	176.5	16.0	9.4	68.0	1.3	31.0	48.8

[a]Handweeding time expressed as average time in minutes to weed one plot (11.2 m²).
[b]An asterisk indicates a significant difference from both controls at the 5% level of probability. Means were compared by a multiple range test, but only comparison with controls are shown.
[c]Due to an extremely sandy soil, rates were reduced to: prometryne at 1.1 and 2.2 kg/ha, trifluralin at 0.8 and 1.7 kg/ha, and GS-16068 at 1.7 and 3.4 kg/ha. The rates for diphenamid were not reduced.

weedings were recorded. In Arkansas prometryne at 2.2 kg/ha was effective for 80 days and diphenamid at 4.5 kg/ha for 97 days (Table 6). At the Kentucky Dam Nursery, all herbicide treatments significantly reduced weeding times for 57 days after treatment (Table 7). Prometryne

Table 6. Weed control in pine seedbeds following preemergence herbicide applications at Bluff City Nursery, Bluff City, Arkansas.

Herbicide	Rate	Handweeding Time[a, b]				
		Days after treatment				
		40	62	80	97	118
	(kg/ha)	(min)	(min)	(min)	(min)	(min)
Prometryne	2.2	0.8*	1.3*	1.0*	1.5	1.2
Prometryne	4.5	0.5*	0.7*	0.5*	0.8*	0.8
Trifluralin	1.1	1.4*	2.1*	1.9	2.2	2.0
Trifluralin	2.2	0.5*	1.3*	3.0	2.5	1.9
Diphenamid	4.5	0.6*	1.4*	0.8*	1.0*	1.0
Diphenamid	9.0	2.7*	0.7*	0.4*	0.6*	0.6
GS-16068	2.2	2.0*	3.2*	1.8	1.7	1.2
GS-16068	4.5	0.3*	1.2*	1.5*	1.5	1.7
Control	0.0	27.5	8.0	2.9	3.3	2.5
Control	0.0	23.3	7.0	2.4	2.6	1.7

[a]Handweeding time expressed in minutes required to weed one plot (11.2 m²).
[b]An asterisk indicates a significant difference from both controls at the 5% level of probability. Means were compared by a multiple range test, but only comparisons with controls are shown.

at 2.2 kg/ha and GS-16068 at 2.2 kg/ha reduced weeding times for 79 days, and the 4.5 kg/ha treatment of GS-16068 gave significant weed control for 132 days. At the Claridge Nursery, none of the treatments were effective after the first weeding at 50 days (Table 8).

Table 7. Weed control in pine seedbeds following preemergence applications at Kentucky Dam Nursery, Gilbertsville, Kentucky.

Herbicide	Rate	Handweeding Time[a, b]			
		Days after treatment			
		37	57	79	132
	(kg/ha)	(min)	(min)	(min)	(min)
Prometryne	2.2	0.4*	0.4*	2.1*	6.5
Prometryne	4.5	0.3*	0.3*	0.7*	5.8
Trifluralin	1.1	1.7*	5.2*	36.1	11.9
Trifluralin	2.2	0.6*	3.9*	22.8	11.0
Diphenamid	4.5	0.5*	4.3*	21.4	14.8
Diphenamid	9.0	0.4*	2.2*	19.3*	11.7
GS-16068	2.2	0.9*	0.8*	3.0*	4.3
GS-16068	4.5	0.3*	0.5*	0.7*	2.9*
Control	0.0	6.3	17.3	27.1	10.3
Control	0.0	6.1	22.7	36.5	11.7

[a]Handweeding time expressed in minutes required to weed one plot (11.2 m²).
[b]An asterisk indicates a significant difference from both controls at the 5% level of probability. Means were compared by a multiple range test, but only comparisons with controls are shown.

Preemergence weed control in slash and loblolly pine seedbeds appears feasible. Diphenamid and trifluralin were not injurious to pine seedlings at twice the rate needed for good control of grasses. Sprinkler irrigation gave adequate

Table 8. Weed control in pine seedbeds following preemergence applications at Claridge Nursery, Goldsboro, North Carolina.

Herbicide	Rate	Handweeding Time[a, b] Days after treatment 50	66	87	114
	(kg/ha)	(min)	(min)	(min)	(min)
Prometryne	2.2	3.9*	14.8	14.6	13.5
Prometryne	4.5	1.3*	4.4	6.0	14.8
Trifluralin	1.1	7.0	8.7	9.5	11.2
Trifluralin	2.2	6.0	7.8	12.0	11.9
Diphenamid	4.5	2.9*	12.8	13.4	13.8
Diphenamid	9.0	4.1*	19.6	24.5	18.7
GS-16068	2.2	4.7	9.0	14.3	15.6
GS-16068	4.5	4.1*	20.1	16.0	19.4
Control	0.0	9.6	13.7	13.5	10.2
Control	0.0	9.4	7.3	9.6	8.8

[a]Handweeding time expressed in minutes required to weed one plot (11.2 m^2).
[b]An asterisk indicates a significant difference from both controls at the 5% level of probability. Means were compared by a multiple range test, but only comparisons with controls are shown.

incorporation of trifluralin for good early season grass control, but residual activity might have been increased by a more thorough soil incorporation. In this study diphenamid exhibited a longer residual activity than trifluralin at all locations.

Loblolly pine seedlings were less tolerant of prometryne than of any of the other herbicides. Tolerance varied between locations and did not appear to be associated with any of the soil properties measured nor the cultural practices used. Weed control with prometryne was correlated with soil organic matter ($r = -.77$) but seedling tolerance was not. Additional information is needed concerning the factors affecting pine seedling tolerance to prometryne.

GS-16068 appeared to be a good broad spectrum herbicide for pine seedbeds. No seedling injury was observed with this compound at 2.2 kg/ha, and weed control was nearly as good as that obtained with prometryne.

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