EVALUATION OF SIX HERBICIDES FOR WEED CONTROL IN PACIFIC COAST FOREST NURSERIES [1/]

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Herbaceous weeds, especially forbs, are a serious problem in western forest nurseries. Weeds reduce the efficiency of irrigation and fertilization, and habor tree-damaging insects and pathogens; weeds thus reduce survival and growth of tree seedlings. Nurserymen presently use fumigation, repeated sprays of diphenamid, and extensive hand weeding to mitigate the effects of weeds. Considerable improvement in weed control practices and reduction in seedling production costs are possible, however, through use of more effective herbicides with a corresponding reduction in hand weeding.

A study was installed at 14 Pacific Coast forest nurseries during 1977 to evaluate weed control and conifer phytotoxicity of bifenox, butralin, DCPA, diphenamid, napropamide, and hexazinone on lst-year seedlings of nine species of conifers. These herbicides were identified as promising for use in forest nurseries in an earlier study (Stewart 1977). Diphenamid is the only one that is registered by the Environmental Protection Agency for preemergence use in forest nursery weed control in the Western United States.

METHODS

Effects of herbicides on a variety of conifer species, herbaceous weeds, nursery management practices, climatic conditions, and soil types were evaluated at four nurseries in California, five in Oregon, and five in Washington (Table 1). An analysis of soils at 13 of the nurseries showed that soils were generally light textured; pH ranged from 4.90 to 6.02 and organic matter contents from 1.2 to 9.6 percent (Stewart 1977).

[1/] This publication reports research involving pesticides. It does not contain recommendations for their use nor does it imply that the uses discussed have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can he recommended.

Table 1. Ownership and location of Pacific Coast forest nursery weed control cooperators for 1977 tests

State	Ownership	Name	Location
California	U.S. Forest Service	Humboldt	McKinleyville
	U.S. Forest Service	Placerville	Placerville
	State of California	Ben Lomond	Santa Cruz
	State of California	Magalia	Magalia
Oregon	U.S. Forest Service	Bend	Bend
	State of Oregon	D. L. Phipps	Elkton
	Weyerhaeuser Company	Aurora	Aurora
	Weyerhaeuser Company	Klamath Forest	Bonanza
	Lava Nursery, Inc.	Lava	Parkdale
Washington	U.S. Forest Service	Wind River	Carson
	State of Washington	L. T. Webster	Olympia
	Industrial Forestry Assn.	W. B. Greeley	Olympia
	Industrial Forestry Assn.	Toledo	Toledo
	J. Hofert Company	Hofert	Olympia

Bifenox, butralin, DCPA, and diphenamid were tested at seven nurseries, napropamide at six nurseries, and hexazinone at eight nurseries. Three herbicides and an untreated control were compared at each nursery. Chemicals were applied to 4-foot-wide fumigated nursery beds using a small plot pressurized sprayer at three application times: (1) postseeding (ps)--within 2 days after sowing and before seed emergence; (2) postgermination (pg)--4 to 5 weeks after conifer seedling emergence and 1 week or less after weeding; and (3) a combination of postseeding and postgermination applications (ps + pg).

Weed control was evaluated in 20-foot-long plots treated with herbicide applied in water at a volume equivalent to 85 gallons per acre (gpa). The dosages tested (hereafter termed 1X dosages) were: 3 lb active ingredient (ai) per acre of bifenox, 2 lb ai per acre butralin, 10.5 lb ai per acre DCPA, 4 lb ai per acre diphenamid, 3 lb ai per acre napropamide, and 0.5 lb ai hexazinone per acre. Dosages for the first five herbicides were manufacturers' recommendations and were confirmed as effective in previous tests (Stewart 1977). Dosage for hexazinone was lower than recommended and was based on previous nursery tests (Stewart 1977). The 10 treatments (untreated + 3 herbicides X 3 application times) were assigned to three adjacent nursery beds in a randomized block design with three replications. Plots were hand weeded twice, once during the week before application of the postgermination sprays and again at the end of the growing season.

Conifer phytotoxicity was evaluated in 3-foot-long plots with a 1-foot untreated buffer between plots. Both 1X and 2X (a dosage twice that recommended for weed control) dosages of each herbicide were compared as postseeding and postgermination sprays; only the 1X dosage was applied to plots treated at both postseeding and postgermination. The 2X dosage was used to establish the margin of safety in conifers in the event of an accidental double spraying during operational use of the herbicide. All 16 treatments (untreated + 3 herbicides X 5 combinations of timing and dosage) were installed in three contiguous 64-foot-long sections of bed in a randomized block design with three replications per species. Effects of treatments on one to four species were tested at each nursery. Herbicides were applied in water at a volume equivalent to 85 gpa. Phytotoxicity was estimated at the end of the first growing season (October and November), using a 10-point damage rating scale (0 is complete kill, 10 is no effect) incorporating mortality, stunting, and needle color changes as proposed by Anderson (1963) for nursery weed control studies.

In this paper, data are presented as averages for all nurseries combined. The final summary paper for 3 years of testing in West Coast nurseries will include statistical analyses of the data for individual nurseries, each of which constituted a separate experiment.

RESULTS AND DISCUSSION

As shown previously (Stewart 1977), postseeding sprays were more effective than postgermination sprays for total season weed control (Figure 1). This reflects the greater number and vigor of weeds germinating and emerging earlier in the season and suggests that postseeding weed control is critical.

All herbicides except napropamide produced effective weed control (at least 70-percent reduction in weed dry weight) when applied as postseeding or postseeding + postgermination sprays. Applied as a postseeding spray, bifenox produced effective total season weed control at 100 percent of the nurseries where it was tested, hexazinone at 88 percent, butralin and diphenamid at 71 percent, napropamide at 67 percent, and DCPA at 57 percent. This difference in performance between nurseries probably is related to variable soil conditions and weed populations. It is apparent that a variety of herbicides is needed to provide satisfactory weed control for the range of conditions found in Pacific Coast forest nurseries.

Amount of reduction in total season hand weeding time should be a useful measure of expected savings in weed control costs. For postseeding and postseeding + postgermination sprays, the saving in weeding time compared with untreated plots was:

Active ingredient per acre	Percent reduction of time	
	ps	ps+pg
3 lb bifenox	73	87
2 lb butralin	77	68
10.5 lb DCPA	75	72
4 lb diphenamid	54	56
3 lb napropamide	60	76
0.5 lb hexazinone	88	88

Table 2. Effect of herbicides on seedling Douglas-fir, true firs, pines, western hemlock, and coast redwood

Herbicide	Timing	Dosage	Average damage rating by species[a]										
			Douglas-fir	Noble fir	Red fir	White fir	Ponderosa pine	Lodgepole pine	Sugar pine	Monterey pine	Scotch pine	Western hemlock	Coast redwood
		lb											
Untreated			8.8	9.5	7.0	8.5	9.5	10	6.7	8.0	9.0	9.7	7.3
Bifenox	ps	3	8.0	---[a]	6.0	9.0	9.0	10	6.7	8.0	---	10	7.7
		6	7.5	---	6.0	9.0	9.3	10	6.7	8.3	---	9.5	6.3
	pg	3	8.5	---	6.3	9.0	9.0	10	6.3	7.3	---	10	8.0
		6	8.2	---	6.3	9.0	9.3	10	7.0	7.0	---	10	8.0
	ps+pg	3	8.2	---	7.7	9.0	9.3	10	5.7	7.3	---	8.5	7.0
Butralin	ps	2	8.5	10	7.3	8.0	9.3	10	---	---	10	6.3	---
		4	7.5	10	7.5	7.3	9.7	10	---	---	10	2.3	---
	pg	2	8.5	10	7.0	8.5	9.3	10	---	---	10	10	---
		4	8.3	10	6.0	8.5	9.3	10	---	---	10	9.3	---
	ps+pg	2	8.2	10	7.0	8.0	9.7	10	---	---	10	4.3	---
DCPA	ps	10.5	8.2	10	7.0	---	10	10	7.0	7.3	---	3.7	7.7
		21	7.8	10	6.7	---	10	10	6.7	8.0	---	2.7	7.3
	pg	10.5	9.0	10	7.3	---	9.8	10	7.0	7.3	---	10	7.7
		21	8.4	10	7.3	---	10	10	7.0	8.0	---	9.3	7.3
	ps+pg	10.5	8.8	10	7.3	---	10	10	6.3	8.3	---	2.3	6.7
Diphenamid	ps	4	8.2	7.3	6.0	8.5	8.8	9.7	---	---	9.5	10	---
		8	8.6	8.7	8.0	8.0	9.0	10	---	---	8.5	9.5	---
	pg	4	8.6	7.0	7.7	8.0	9.0	7.7	---	---	9.5	10	---
		8	8.4	8.3	7.3	8.5	8.8	9.7	---	---	9.5	9.5	---
	ps+pg	4	8.4	9.0	7.3	8.0	9.2	9.3	---	---	9.0	9.5	---
Napropomide	ps	3	8.5	9.5	---	---	10	10	---	7.7	9.0	5.4	6.3
		6	8.2	9.5	---	---	10	10	---	7.3	9.0	4.5	6.3
	pg	3	8.5	8.5	---	---	10	9.3	---	7.7	9.0	9.5	7.0
		6	8.5	9.0	---	---	10	9.3	---	8.7	9.0	10	5.7
	ps+pg	3	8.2	9.5	---	---	10	10	---	8.0	7.3	5.4	6.7
Hexazinone	ps	0.5	8.3	6.0	6.0	7.0	9.4	1.7	4.0	---	8.0	4.7	---
		1	5.3	4.0	3.0	6.7	9.4	.7	2.0	---	7.5	4.0	---
	pg	0.5	7.8	.7	6.0	4.7	9.8	8.7	5.3	---	9.5	4.3	---
		1	7.3	0	6.0	2.3	9.6	3.7	3.7	---	9.5	1.0	---
	ps+pg	0.5	7.0	.3	4.0	3.3	9.4	.3	2.0	---	8.0	.7	---

a Ratings based on visual estimates; 10 is no effect, 0 is complete kill (Anderson 1963); dash means not tested.

Bifenox at 3 lb al per acre and DCPA at 10.5 lb ai per acre have been shown to he the most generally useful for weed control in 1st-year conifer nursery beds after 2 years of testing. The phytotoxicity assessment used in this study indicated that, except for DCPA on western hemlock, both had a 2X dosage margin of safety on eight species of conifers when applied immediately after sowing or 4 to 5 weeks after seedling emergence. Other herbicides tested, except hexazinone, were only safe on most conifer species at the 1X dosage. Recently, however, several nurseries have reported stem swellings at the ground line on Douglas-fir and true fir seedlings treated with DCPA. This will be thoroughly investigated on beds treated both in 1977 and 1978. In addition, one nursery reports that Douglas-firs sown too deeply were slightly damaged by bifenox applications.

Even after a chemical is registered for use, small scale trials should be established before widespread adoption at a particular nursery to determine responses under local weed populations, climate, and soil conditions.

LITERATURE CITED

Anderson, H. W.
1963. A system for evaluating effective weed control in forest nurseries. Tree Plant. Notes 61:19-23.

Auburn University.
1976. 1976 annual report of the forest nursery weed control cooperative. Dep. For., Auburn Univ., Auburn, Ala. 90 p.

Kelley, Walter D., and David B. South.
1977. In vitro effects of selected herbicides on growth of mycorrhizal fungi. Abstr. 3d North Am. Conf. Mycorrhizae, August. 23-25, 1977. Athens, Ga.

South, David B., Dean H. Gjerstad, and R. Hugh Crowley.
1978. Bifenox: A promising new herbicide for southern pine nurseries. South. J. Appl. For. 2(1):11-14.

Stewart, R. E.
1977. Herbicides for weed control in western forest nurseries. Proc. West. Soc. Weed Sci. 30:78-89.