Western Nursery Herbicide Study - 1979 Update[1]

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Abstract.--Summarizes the progress to date and the work remaining in the westwide nursery herbicide study. Two previously used herbicides (DCPA and diphenamid) and two new ones (bifenox and napropamide) significantly reduced handweeding time while doing little damage to most tree species.

INTRODUCTION

The Western Nursery Herbicide Study is a cooperative study funded by State and Private Forestry and the six western Regions of the USDA Forest Service, the Soil Conservation District Association of North Dakota, and the 28 participating nurseries. The study[3] was started in 1976 by Steve McDonald, western nursery specialist; Dr. Larry Abrahamson, at that time western pesticide specialist; and, Dr. Ron Stewart, at that time with the Pacific Northwest Forest and Range Experiment Station.

There were good reasons for initiating the study. First, handweeding costs at most western forest tree nurseries are high and a substantial reduction in these costs will mean a large savings in the costs of producing the trees. McDonald and Isaacson (1974) reported a 75 percent reduction in handweeding costs as a result of using herbicides. At most nurseries such a savings in costs is desirable. At some nurseries it is essential. Second, there were several chemicals that seemed to have potential for weed control, but most were not registered for use in western tree nurseries. There had been sporadic testing of herbicides at several nurseries (Anderson 1968, Duffield and Rediske 1963, McDonald 1973, McDonald and Isaacson 1974, Van Den Driessche and Balderston 1974), but the transfer of that information to other nurseries was risky because of differences in soils, climate, and tree species grown (Stewart 1977).

It was generally agreed there was a need for this broad-based study, installed at many nurseries, with a variety of conditions. The study objectives were to identify promising herbicides, develop data for product registration, and demonstrate safe and effective weed control practices.

To conduct the study, the western United States was divided into three study areas:

Study Area	Principle Investigator	Period of Study
Pacific Coast	Dr. R.E. Stewart	1976-1977
	Dr. P.W. Owston	1977-1978
Rocky Mountain Great Basin	Mr. R.A. Ryker	1977-1979
Great Plains	Dr. L.P. Abrahamson	1978-1980

Creating three study areas shortened travel distances, and tended to group nurseries having similar environmental conditions and growing similar species. It also put a reasonable number of cooperating nurseries with each investigator.

STUDY PROCEDURES

As mentioned above, the study was divided into three segments based on geographic location and similarity of conditions. In each area a minimum of three years of work was planned.

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[1]Paper presented at the Intermountain Nurseryman's Association Meeting, Aspen, Colorado, August 13-16, 1979.

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[3]Steward, R. E., S. McDonald, and L. Abrahamson. 1976. An administrative study for herbicide screening and weed control demonstration in western forest tree nurseries, 1976-1980. Unpublished information on file at the Pacific Northwest Forest and Range Experiment Station, Forestry Sciences Laboratory, Corvallis, Oregon.

First Year

The first year of study was primarily a screening of 18 selected herbicides for weed control effectiveness and tolerance by tree species. Herbicides were selected on the basis of past use and test results in nurseries in the United States and Canada, and for the likelihood of getting the manufacturing company to register the product for minor crop use.

All treatments were applied to bed-width 3-foot-long plots with a 1-foot buffer between plots. The treatments were installed in a randomized complete block design with three replications per species. Liquid sprays were applied using a modified AZ[4] small-plot pressurized sprayer equipped with check valves and four flat fan #8001 stainless steel nozzles operated at 20 psi. The sprays were applied in a water carrier at a volume equivalent to 85 gallons per acre. Granular formulations were applied by hand in salt shaker fashion using a can covered with fine mesh screenwire. Post-seeding treatments were applied within one day after seeding, and post-germination treatments 4 to 5 weeks after conifer seedling emergence. Emergence was defined as the time when most seedlings had shed their seed coats.

Weed control effectiveness was evaluated by counting the number of weeds and by determining the oven dry weight of above-ground parts of weeds in each plot. Herbicide damage to tree species was evaluated at the end of the growing season using the 10-point scale (0 is all seedlings dead, 10 is no damage) proposed by Anderson (1963). Seedling density and heights were also measured.

Second Year

Herbicides showing promise during firstyear tests were tested further at different rates and time of application. Weed control effectiveness and damage to tree seedlings were determined in separate tests.

Weed Control

Weed control was evaluated on 20-foot long plots. All the herbicides were applied in water at a volume equivalent to 85 gallons per acre using the small-plot pressurized sprayer. Two measures of effectiveness were determined: (1) the amount of time required to weed each plot, and (2) the oven dry weight of the above ground portion of the weeds removed. Weeding was done just before the post-germination treatments were applied and thereafter as needed.

Seedling Damage

Tree phytotoxicity tests were done on 3-foot plots in a manner similar to first-year tests. Both 1X (recommended dosage for weed control) and 2X dosages of each herbicide were tested as post-seeding and post-germination sprays. Also tested was a 1X post-seeding application followed by a 1X post-germination application. The 2X dosage was included to establish the margin of safety for seedlings in case an accidental double spraying occurred during operational use of the herbicide.

Third Year

Third-year tests were designed for assessing reduction in handweeding costs by each herbicide surviving the first two years of tests. But, we also checked seedling survival and height growth, effects on mycorrhizae, and toxicity. We used large plots--200 feet of bed for each herbicide per replication. The herbicides were applied post seeding (Ps) and post germination (Pg) at the recommended dosage (1X) each time. They were applied in water at a volume equivalent to 50 gallons per acre using nursery spray equipment adjusted to deliver a 4.5-foot swath.

HERBICIDES TESTED

Of the 18 herbicides (Table 1) selected for screening during the first year, seven will probably be used in western nurseries. Some will be widely used while others will be restricted to a few species or to specific nurseries.

Bifenox will probably be used with most species at most nurseries. DCPA was successful with many of the conifer and hardwood species; however, during the third-year tests at coast nurseries seedling damage occurred to Douglas-fir and true firs. The nature and extent of this damage will be described in the following paper by Nancy Callan. Diphenamid has been used for several years, and although weed control has been erratic, it is effective for a short period (3 to 4 weeks). At nurseries making repeat applications on schedule, it will continue to be a useful herbicide. Glyphosate is not safe to use on seedling beds during active growth, but when applied in September it controls weeds germinating in late summer and early fall without damaging the trees. Napropamide is another general use herbicide, but it has been less effective than bifenox in controlling weeds. Oxyfluorfen was added to the study in 1978. It

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[4]Mention of brand names does not constitute an official endorsement by the U.S. Department of Agriculture of any product or service to the exclusion of others that may be suitable.

Table 1.--Herbicides selected for testing each year in each of the three study areas

Herbicide	Formulation	Pacific Coast			Rocky Mountain-Great Basin			Great Plains		
		1976	1977	1978	1977	1978	1979	1978	1979	1980
Chloramben	Ornamental Weeder	x			x			x		
DCPA	Dacthal W-75	x	x	x	x	x	x	x	x	
Diphenamid	Enide 50W	x	x		x		x	x	x	
Trifluralin	Treflan 4EC	x			x	x		x	x	
Bifenox	Modown 80WP	x	x	x	x	x	x	x	x	
Butralin	Amex 820	x	x		x	x		x		
Cloroxuron	Tenoran 50WP	x			x	x		x	x	
Cloropropham	Furloe 4EC	x			x					
Cyperquat	GCP - 1634	x								
Glyphosate	Roundup 4EC	x			x	x		x	x	
Methazole	Probe 75WP	x			x					
Napropamide	Devrinol 50W	x	x	x	x	x	x	x	x	
Oryzalin	Surflan 75W	x								
Oxadiazon	Ronstar 75WP	x			x	x		x		
Oxyfluorfen	Goal 2E						x	x	x	
Perfluidone	Destun 50WP	x								
Profluralin	Tolban 4E	x			x					
Propazine	Milogard 80W	x			x					
Velpar	Velpar 90WP	x	X		x					
Napropamide & Bifenox	Tank mix							x	x	

was not tested in Pacific Coast nurseries or for the first two years in Rocky Mountain-Great Basin nurseries. Trifluralin will be used mostly with hardwood species.

The candidate chemicals that were dropped from the tests were eliminated for several reasons. Some were toxic to many of the tree species, some did not kill the weed species, and others were withdrawn by the companies for various reasons.

RESULTS

To present a general summary of the progress of the study, the data in Tables 2, 3, and 4 are averages for all nurseries combined. When the results for each study area are published, the papers will include analyses of data for individual nurseries, each of which was set up as a separate experiment. Because of different conditions and cultural practices, the data are not always consistent for the same species from nursery to nursery. Generally, the preliminary conclusions suggested below apply to those nurseries normally producing good vigorous stock of the particular species.

Weed Control

Post-seeding herbicide treatments are consistently more effective in reducing total season handweeding time than are post-germination treatments (Table 2). Applying two sprays, post seeding and post germination, further decreased weeding time. The reduction was not consistent, however, and at some nurseries may not be needed

Post-seeding treatments of bifenox reduced handweeding time about 75 percent. DCPA, napropamide, and diphenamid were somewhat less consistent in controlling weeds. In a separate test in a June 1978 sowing of 4 species of hardwoods at the Montana nursery, trifluralin reduced handweeding time about 80 percent. In the first-year tests when trifluralin was applied earlier in the spring to conifer seedbeds, it was less effective and was not tested further with conifers. Glyphosate applied in mid- to late-September reduced handweeding a month later by about 80 percent.

Seedling Damage

Conifers

The pines, Douglas-fir, and true firs are generally tolerant to the seven herbicides mentioned above. Ponderosa pine and Douglasfir are the most tolerant species (Table 3). That is fortunate since these two species constitute most of the production in the larger western nurseries. Western larch appears to be the most sensitive species, but western hemlock and the spruces proved quite sensitive to some treatments.

Table 2.--Total season average handweeding times per plot as a percentage of untreated plots

Herbicide	Rate (lbs a.i./ acre)	Hand weeding time		
		Pacific Coast		Rocky Mountain-Great Basin
		2nd year	3rd year	2nd year
		--------Percent of untreated----------		
Untreated	--	100	100	100
Bifenox	3			
Ps+Pg		13	30	21
Ps		27	--	24
Pg		56	--	64
DCPA	10.5			
Ps+Pg		28	52	56
Ps		25	--	44
Pg		51		82
Diphenamid	4			
Ps+Pg		44	--	--
Ps		46	--	--
Pg		59	--	--
Napropamide	3			
Ps+Pg		24	--	32
Ps		40	--	70
Pg		64	--	84
Ps+Pg	1.5	--	59	--
Trifluralin	.75	--	--	22
(incorporated only)	1.5	--	--	20
Glyphosate (mid-September only)	.75	--	--	[1]18

[1]Not total season. The plots were weeded in late October, about one month after the herbicide was applied.

Bifenox did little damage to all conifer species tested except Engelmann spruce. The post-seeding sprays caused some mortality in this spruce; however, the post-germination spray did no damage.

The DCPA post-seeding spray excessively damaged western hemlock. The post-germination spray did no damage. Western larch did not tolerate either application. On the other conifers DCPA did little or no damage during the first two years of tests. But, during the third year in Pacific Coast nurseries it caused brittleness and swelling of the stem just below the soil surface. It occurred in Douglas-fir and the true firs, but not in the pines. We have not yet encountered this damage in Rocky Mountain-Great Basin nurseries.

Diphenamid and napropamide are generally safe to use on the pines and Douglas-fir, but both have reduced height growth of lodgepole pine (Stewart et al. 1978). Napropamide also reduced height growth of ponderosa pine. Oxyfluorfen is a new herbicide that shows promise for use on beds of Douglas-fir and the pine species. It was not included in the Pacific Coast tests nor in the first two years of Rocky Mountain-Great Basin tests. Further testing of this herbicide is desirable.

Glyphosate damaged conifers when used during the period of active seedling growth, but when applied in mid-September at the recommended rate (0.75 lbs a.i. per acre), it was safe on all conifers.

Trifluralin is generally unsafe for use with the conifer species tested except ponderosa pine.

The effects of herbicides on seedling survival and growth are more inconsistent between species of hardwoods than between species of conifers. For instance, bifenox severely reduced survival of green ash, mulberry, and Siberian peashrub; reduced height growth of bitterbrush and chokecherry; but, did no damage to honeysuckle and Russian olive (Table 4). DCPA appeared safe on all species except mulberry. Mulberry, however, was killed by all treatments.

Table 3.--Effect of herbicides on conifer seedlings at the end of the first growing season[1]

Herbicide	Timing	Rate (lb.a.j./A)	Average damage rating by species[2]								
			Douglas-fir	True firs	Pines	Western hemlock	Coast redwood	Engelmann spruce	Blue spruce	Eastern redcedar	Western larch
Untreated	----	----	9.3	9.0	8.8	9.7	8.6	9.8	9.2	10.0	10.0
Bifenox	PS	3	9.1	8.7	7.9	10.0	7.7	4.5	9.2	----	----
	PG	3	9.0	8.6	8.4	10.0	8.0	9.8	8.4	9.0	----
DCPA	PS	10.5	8.7	8.6	8.9	6.6	8.7	7.2	9.2	----	5.3
	PG	10.5	9.1	8.9	8.7	9.6	7.4	8.6	8.6	10.0	7.3
Diphenamid	PS	4	9.2	8.5	9.3	9.6	3.3	9.9	8.6	----	7.3
	PG	4	9.2	8.5	8.8	9.8	7.3	10.0	8.0	10.0	6.0
Napropamide	PS	3	9.2	8.9	9.0	7.7	6.3	8.3	5.7	----	0.4
	PG	3	9.2	9.4	9.1	9.8	7.0	9.2	9.0	----	3.8
Trifluralin	Incopr.	0.75	6.1	9.2	8.6	6.8	5.7	2.4	5.8	----	5.0
Glyphosate	PG	0.75	8.5	8.6	8.3	----	----	----	----	----	----
	Mid-Sept.	0.75	9.8	----	9.3	----	----	9.1	9.6	----	10.0
Oxyfluorfen	PS	0.25	----	----	9.2	----	----	----	9.3	----	----
	PG	0.25	----	----	8.6	----	----	----	8.3	9.3	----
Tank Mix of Bifenox & Napropamide	PS	3	----	----	6.9	----	----	----	8.7	----	----
	PG	1	----	----	8.3	----	----	----	7.4	9.3	----

[1] The values shown are averages for the first two years of phytoxicity tests at Pacific Coast and Rocky Mountain-Great Basin nurseries, and the first year at Great Plains nurseries.

[2] Ratings based on ocular estimate; 10 is no damage, 0 is all seedlings dead (Anderson 1963); dash means not tested.

Table 4.--Effect of herbicides on hardwood seedlings at the end of the first growing season[1]

			Average damage rating by species[2]							
Herbicide	Timing	Rate (lb.a.i./acre)	Bitterbrush	Black locust	Chokecherry	Green ash	Honeysuckle	Mulberry	Russian olive	Siberian peashrub
Untreated	----	----	9.5	10.0	9.3	9.5	9.5	5.0	9.0	8.9
Bifenox	PS	3	7.0	----	8.7	5.6	9.7	0.0	9.8	5.4
	PG	3	8.5	----	8.7	9.2	9.5	----	9.1	5.2
DCPA	PS	10.5	----	9.5	8.3	7.5	10.0	1.0	9.5	9.5
	PG	10.5	----	10.0	7.0	8.6	8.3	----	9.2	8.9
Diphenamid	PS	4	----	5.0	----	8.7	8.3	0.0	9.0	7.8
	PG	4	----	7.0	----	8.0	10.0	----	9.0	8.5
Napropamide	PS	3	----	----	----	----	----	----	5.5	7.7
	PG	3	----	----	----	----	----	----	8.8	8.7
Napropamide	PS	1.5	----	----	----	8.3	8.0	4.0	9.7	9.7
	PG	1.5	----	----	----	8.0	9.0	----	10.0	5.2
Trifluralin	Incorp.	0.75	----	8.5	----	9.0	9.0	2.3	9.4	9.0
Glyphosate	PG	0.75	----	----	----	----	----	----	----	----
	Mid-Sept.	0.75	----	7.0	----	----	----	----	8.3	10.0
Oxyfluorfen	PS	0.25	----	----	----	----	----	4.0	----	9.7
	PG	0.25	----	----	----	----	----	----	----	8.0
Tank mix of Bifenox & Napropamide	PS	3	----	----	----	7.7	9.0	0.0	10.0	8.2
	PG	1	----	----	----	7.3	6.5	----	8.7	6.5

[1] The values shown are averages for the first two years of tests at Rocky Mountain-Great Basin nurseries and the first year at Great Plains nurseries.

[2] Ratings based on ocular estimates; 10 is no damage; 0 is all seedlings dead (Anderson 1963); dash means not tested.

Some of the hardwoods were damaged more by the post-germination spray than by the post-seeding spray. The opposite occurred with conifers; the post-seeding application was usually the more damaging treatment.

FUTURE WORK

Pacific Coast Area

This fall, Dr. Owston will obtain samples of 2-0 seedlings from the plots in the thirdyear tests. The seedlings will be evaluated for height growth, dry weights of tops and roots, and recovery from the DCPA treatment. A research paper will be published as soon as all data are assembled and analyzed.

Rocky Mountain-Great Basin Area

Measurements of weed control, and seedling survival and growth will be completed in September for the third-year tests. Analyses of seedling samples from both 1978 and 1979 plots will be completed by December. Residual toxicity will also be determined this fall. The data will then be analyzed and a research paper written. Publication is planned for late 1980.

Great Plains Area

Dr. Abrahamson is in the second year of tests. Third-year tests will be completed in 1980. Publication of the results should follow in 1981.

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