HERBICIDES, AN IMPORTANT COMPONENT OF THE WEED CONTROL PROGRAM AT OKLAHOMA STATE (NORMAN) NURSERY

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Abstract.--Ten herbicides were evaluated at the Oklahoma State Nursery for weed control on raising one-year seedling nursery beds. Phytotoxicity of DCPA, napropamide, oxyfluorfen, bifenox, and a napropamide plus bifenox tank mix was studied for three years on spring-sown Austrian and loblolly pine, and fall-sown eastern redcedar. Bifenox (on loblolly and Austrian pine) and oxyfluorfen (on Austrian pine) reduced germination when applied at time of sowing, but not when applied post-germination. Time required to hand weed nursery beds was reduced by 80-87 percent when using the above herbicides applied at sowing time alone or with a second application four to six weeks later. Over $4,500 per acre of seedbed could be saved by using herbicides over hand-weeding at the Norman Nursery.

Additional keywords: Dacthal®, Modown®, trifluralin, Treflan®, Devrinol®, Goal®, Pinus taeda, P. nigra, Juniperus virginiana.

Nursery herbicide screening and demonstration projects were initiated at the Norman Nursery in 1978 as part of a three-year study sponsored by State and Private Forestry (S & PF), U.S. Forest Service for the Great Plains forest tree nurseries (Abrahamson, 1981; Abrahamson and Burns, 1979). The USDA Forest Service's nursery herbicide projects developed out of a recognition of the potential benefits of herbicidal control of weeds in nursery seedbeds. The first of these projects started in 1970 when the Southeastern Area, S & PF and Auburn University began the Cooperative Forest Nursery Weed Control Project for the 13-state southeastern area (Gjerstad et al., 1980). In 1976, a cooperative western nursery herbicide project was initiated with cooperation among state, private and federal nurseries, Forest Service Research, State and Private Forestry, National Forest Systems, and State University of New York out of Syracuse. Twenty-eight nurseries in 12 states were involved in this effort which was broken down into three segments, each of three-year duration; the Pacific Coast started in 1976 (Stewart, 1977, Owston et al., 1980), the Intermountain-Great Basin in 1977 (Ryker and Abrahamson, 1980), and the Great Plains, of which Oklahoma was a part, in 1978. In 1979 the Northeastern (NE) Area started an eastern nursery herbicide project in five states cooperating with Purdue University and State University of New York (SUNY) at Syracuse (Holt and Abrahamson, 1980). In 1981 the NE Area expanded the eastern nursery herbicide project to the Great Lakes area with eight nurseries (state, federal and private) in three Lake States cooperating with SUNY. During 1982 Oklahoma State also sponsored a nursery herbicide project of their own in cooperation with SUNY to help the nursery expand on the herbicide studies using different herbicides, tree species and

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sowing times. What is important in these projects is that all studies have similar objectives and methodologies and that information developed from one region or study project is supportive of that from other regions. In all these studies the objectives were to identify promising herbicides, develop data for product registration, and demonstrate safe and effective weed control practices for nursery seed beds.

METHODS

During the first year of the three-year study initiated in 1978, ten herbicides (Table 1) were screened on two species of spring-sown conifers, Austrian (Pinus nigra) and loblolly pine (P. taeda), one species of spring-sown hardwood, mulberry (Morus rubra), and on fall-sown redcedar (Juniperous virginiana). Analysis of soils at the Norman Nursery shows soil types of loam to sandy loam and a range in pH from 6.0 to 8.3 (Table 2).

Treatments were applied to three-foot long plots in four-foot wide nursery beds with a one-foot untreated buffer between plots. All treatments were installed in a randomized block design with three replications per species. The fall-sown redcedar plots were installed using the same method. Herbicides were applied with a modified AZ plot pressurized sprayer equipped with check valves and four flat fan 8001 nozzles operated at 20 psi in a water carrier at a volume equivalent to 85 ppa (100 ml/plot). Granular formulations were ocularly applied from a hand shaker uniformly over the plot.

Pre-seeding incorporated treatments (INC) were applied no more than one day before seeding and incorporated into the top two inches of soil using a garden rake. Post-seeding treatments (Ps) were applied within two days after seeding, except on the fall-sown redcedar which was applied any time after fall seeding but before mulching. Post-germination treatments (Pg) were applied four to six weeks after seedling emergence, except on the fall-sown redcedar which was applied in the spring after mulch was removed and most seedlings had emerged.

All plots were hand-weeded before application of post-germination treatments to obtain weed pre-emergence applications. Plots were then periodically weeded during the remainder of the growing season. Weeds were collected from each plot, counted, and/or weighed after drying for 72 hours at 65° C to estimate weed control. Herbicidal damage to conifers/hardwoods at the end of the first growing season was evaluated using a ten-point rating scale (0 is complete kill, 10 is no effect) proposed by Anderson (1963). Height of nine randomly selected seedlings and number of seedlings per foot in three randomly selected rows in each plot were also measured to determine chemical effects on seedling growth and survival.

The objectives of the second-year studies were to evaluate the phytotoxicity and weed control effectiveness of DCPA, oxyfluorfen, napropamide, bifenox and a napropamide + bifenox tank mix on first year spring-sown Austrian and loblolly pine species and on fall-sown redcedar. Weed control effectiveness of these herbicides was determined by the time required to hand-weed nursery beds (min) or weed number at the normal rate of application applied post-seeding and/or post-germination. Phytotoxicity was

Table 1. Herbicides, rates, and application timings used at Norman Nursery as Part of the Western Nursery Herbicides Study.

Herbicide	Formulation	Manufacturer	Rate (lb. ai./A)	Application timing[1]		
				Pre-seeding Incorporation	Post-Seeding	Post-Germination
Untreated						
Diphenamid	Enid 50W	Upjohn	4	--	x	x
Trifluralin	Treflan 4EC	Elanco	0.75	x	--	--
DCPA	Dacthal W-75	Diamond-Shamrock	10.5	--	x	x
Chloramben	Ornamental Weeder (Granule)	Amchem	4	--	--	x
Napropamide	Devrinol 50W	Stauffer	1.5	--	x	x
Butralin	Amex-820 (4EC)	Amchem	3	--	x	--
Bifenox	Modown 80WP	Mobil	3	--	x	x
Oxyfluorfen	Goal 2E	Rohm & Haas	0.5	--	x	x
Oxadiazon	Ronstar 2G	Rhodia	1	--	x	x
Napropamide & Bifenox	Tank mix		1 + 3	--	x	x

[1] Pre-seeding incorporation: incorporated into top 2 inches of soil immediately before seeding.
Post-seeding: broadcast applied to soil immediately after seeding.
Post-germination: broadcast applied to soil 4 to 5 weeks after seedling emergence.

Table 2. Properties of soils at the Norman Nursery.

Soil Type	pH	Percent Organic Matter	Percent Particle Size Distribution			Cation Exchange Capacity (meg/100g)
			Sand	Silt	Clay	
Loam	8.3	1.00	47.0	40.4	12.6	14.5
Loam	6.8	1.40	39.4	48.0	12.6	16.9
Loam	6.6	0.97	48.7	41.0	10.3	16.5
Sandy loam	6.0	1.19	72.7	22.0	5.3	15.4

evaluated by using herbicidal damage ratings (Anderson 1963), seedling survival (number/foot, and height growth (cm)) with dosages of 1X, 2X, and 1X + 1X) of these herbicides applied post-seeding and/or post-germination. The weed control plots were evaluated as a separate study using twenty-foot long plots in four-foot wide beds while the phytoxicity plots were evaluated using three-foot long plots in four-foot wide beds with a one-foot untreated buffer between plots. All treatments were installed using a randomized block design with three replications per species (phytotoxicity study) or study (weed control study).

Herbicide treatments were applied by small pressurized sprayer or hand shaker as was done the first year of these studies. The liquid sprays were applied in a water carrier at a volume equivalent to 85 gpa (100 ml/plot) in the phytotoxicity plots and a volume equivalent to 64 gpa (500 ml/plot) on the weed control plots.

All plots were weeded when necessary based on weed development on the most weedy plot, but the plots were weeded before post-germination treatments. The time of hand weeding the weed control plots was determined by using the same weeding crew for all plots. Each replication was completed before starting the next and all weeding was completed within a two-day period. The time was recorded to the nearest tenth of a minute and computed to man hours per 60 feet of nursery bed. A similar weed control had been installed the first year on loblolly pine using only bifenox which was registered for use on loblolly pine in other southern states. All other nursery operations including irrigation and fertilization were conducted by nursery personnel as needed.

Weed control effectiveness of the best treatments selected from the second year study were evaluated the third year under operational use using nursery application equipment on 100-foot test plots. DCPA, napropamide, bifenox, oxyfluorfen, and the napropamide + bifenox tank mix were evaluated for weed control under operational use at the 1X rate of application applied post-seeding alone, or post-seeding and post-germination. Weed control effectiveness was determined by time required to hand weed the 100-foot treatment plots in the same way as during the second-year weed control study using twenty-foot plots. However, in this study the time was converted to man hours per 100-feet of nursery bed instead of 60 feet. Phytotoxicity rating, survival and height measurements were also recorded from these operational plots.

RESULTS AND DISCUSSION

Phytotoxicity

The spring-sown conifer species evaluated at Norman were Austrian and loblolly pine (Tables 3, 4, 5 and 6). Mulberry was also evaluated the first year (Table 3), but due to seed germination problems was dropped from the study after the first year. Redcedar as the fall-sown species was evaluated the first two years (Tables 7 and 8), but not the third year because of a germination failure.

Table 3. Phytotoxic effects[1] of herbicide treatments on conifer/hardwood species at Norman Nursery in 1978.

		Austrian Pine					Loblolly Pine					Mulberry[2]				
		Damage rating		Percent Survival			Damage rating		Percent Survival			Damage rating		Percent Survival		
Treatment		Spring	Fall	Spring	Fall	Height	Spring	Fall	Spring	Fall	Height	Spring	Fall	Spring	Fall	Height
Control		9.7	5.7	100	100	100	9.3	9.7	100	100	100	---	5.0	---	100	100
Diphenamid	Ps	8.7	9.0	214	264	145	8.7	10.0	84	96	122	---	0.0*	---	0.0*	---
Diphenamid	Pg	---	7.7	163	156	144	---	8.7	121	117	103	---	---	---	---	---
Trifluralin		8.7	9.0	226	248	174*	9.0	8.7	143	119	126	---	2.3*	---	12*	147
DCPA	Ps	8.0	7.3	186	132	122	9.7	9.3	97	96	125	---	1.0*	---	0.0*	---
DCPA	Pg	---	6.3	116	164	110	---	9.7	95	98	124	---	---	---	---	---
Chloramben	Pg	---	8.0	228	200	124	---	9.3	96	87	106	---	---	---	---	---
Oxyfluorfen	Ps	9.0	8.7	202	224	127	8.7	9.7	87	77	106	---	4.0	---	30*	145
Oxyfluorfen	Pg	---	7.7	202	232	140	---	9.3	85	73	112	---	---	---	---	---
Chloroxuron	Ps	---	---	---	---	---	---	---	---	---	---	---	0.0*	---	0.0*	---
Napropamide	Ps	9.0	7.0	186	184	143	9.0	9.7	92	101	122	---	4.0	---	18*	106
Napropamide	Pg	---	6.7	181	172	134	---	10.0	86	89	130*	---	---	---	---	---
Butralin	Ps	8.7	6.3	181	208	123	8.7	9.3	110	112	119	---	7.3	---	44*	104
Bifenox	Ps	8.7	5.0	133	124	131	8.0	7.7*	73	63	111	---	0.0*	---	0.0*	---
Bifenox	Pg	---	7.7	186	260	148	---	9.3	111	115	115	---	---	---	---	---
Napropamide + Bifenox	Ps	8.3	4.7	147	132	120	9.0	7.3*	61	60	103	---	0.0*	---	0.0*	---
Napropamide + Bifenox	Pg	---	6.7	153	176	129	---	9.7	107	96	114	---	---	---	---	---

[1]Damage ratings shown are the means of all plots of each treatment for each species. Survival and height are expressed as percent of the untreated plots.

[2]Two sowings of mulberry were attempted due to poor germination of the first sowing. The second sowing also had germination problems, but some phototoxicity data was collected. Post-germination treatments were not done.

*Significantly different from the untreated plots at the 5% level of probability.

Table 4. Phytotoxic effects[1] of herbicide treatments on conifer species at Norman Nursery in 1979.

Treatment		Austrian Pine					Loblolly Pine					
		Damage rating		Survival			Damage rating		Survival Seedlings per foot		Total trees[2] in plot	
		Spring	Fall	Spring	Fall	Height	Spring	Fall	Spring	Fall	Spring	Fall	Height
		Percent							Percent				
Control		9.7	8.3	100	100	100	9.3	9.3	-	100	100	100	100
DCPA	Ps 1X	10.0	10.0	110	118	119	9.0	9.0	-	73	93	105	95
DCPA	Ps 2X	9.3	9.3	115	122	117	8.7	9.3	-	40	98	111	99
DCPA	Ps+Pg 1X+1X	9.0	9.0	126	135	119	9.3	9.7	-	47	99	121	120
DCPA	Pg 1X	9.3	8.3	83	89	97	9.7	9.0	-	80	120	123	119
DCPA	Pg 2X	9.0	9.0	131	150	121	9.7	7.7	-	60	86	88	87
Oxyfluorfen	Ps 1X	8.7	7.7	77	76	107	9.3	8.3	-	60	95	111	78
Oxyfluorfen	Ps 2X	9.0	5.7	38	35*	81	8.3	7.7	-	53	84	82	57
Oxyfluorfen	Ps+Pg 1X+1X	9.0	7.7	81	82	109	9.0	7.3	-	80	81	91	91
Oxyfluorfen	Pg 1X	9.7	9.7	101	104	117	9.3	9.7	-	153	127	118	101
Oxyfluorfen	Pg 2X	9.3	9.3	114	107	104	9.7	8.7	-	93	111	126	76
Napropamide	Ps 1X	9.3	8.7	111	115	126	9.3	9.0	-	80	114	119	95
Napropamide	Ps 2X	9.3	8.7	118	127	107	8.7	7.0	-	67	102	107	67
Napropamide	Ps+Pg 1X+1X	9.3	8.7	104	109	110	9.7	7.7	-	87	74	89	81
Napropamide	Pg 1X	9.3	8.7	137	138	98	9.7	9.3	-	107	114	128	100
Napropamide	Pg 2X	9.3	9.0	102	101	109	10.0	8.0	-	73	98	89	82
Bifenox	Ps 1X	9.3	8.0	100	105	107	9.3	8.0	-	67	94	105	89
Bifenox	Ps 2X	8.7	5.7	72	76	104	9.7	9.0	-	60	68	84	94
Bifenox	Ps+Pg 1X+1X	9.0	6.7	71	74	105	9.3	9.3	-	80	94	118	76
Bifenox	Pg 1X	9.7	8.3	89	97	103	9.0	8.7	-	40	98	114	92
Bifenox	Pg 2X	9.0	9.0	99	100	110	9.0	8.3	-	33	117	135	91
Nap/bif[3]	Ps 1X	9.0	7.0	74	72	110	9.0	8.0	-	67	94	109	88
Nap/bif[3]	Ps 2X	8.7	7.0	69	61	109	8.7	6.0*	-	47	67	65	66
Nap/bif[3]	Ps+Pg 1X+1X	8.7	7.0	60	61	108	9.3	9.7	-	113	102	118	105
Nap/bif[3]	Pg 1X	9.7	9.7	116	123	122	9.7	9.3	-	67	101	121	94
Nap/bif[3]	Pg 2X	9.3	9.3	117	121	113	9.7	7.3	-	47	93	86	91

[1] Damage ratings shown are the means of all plots of each treatment for each species. Survival and height are expressed as percent of the untreated plots.

[2] Because of poor germination in most of the Loblolly Pine plots, total trees per plot was also recorded.

[3] Tank mix of napropamide plus bifenox.

*Significantly different from the untreated plots at the 5 percent level of probability.

Table 5. Phytotoxic effects of herbicide treatments on conifer species at the Norman Nursery during the 1980 weed control study.

Treatment		Loblolly pine damage rating	Austrian pine damage rating
Untreated		7.5	8.0
Oxyfluorfen	ps	7.5	3.5*
	ps+pg	8.0	4.5*
Napropamide	ps	6.0	6.5
	ps+pg	6.5	7.0
Bifenox	ps	4.0*	5.0*
	ps+pg	5.0*	5.0*
Napropamide + Bifenox	ps	4.0*	5.5*
	ps+pg	4.0*	5.0*

*Significantly different from the untreated plots at the 5 percent level of probability.

Table 6. Weed control and phytotoxic effects of bifenox treatments on Loblolly Pine in a special weed control timing study at Norman Nursery on 20' by 4.5' plots during 1978.

	Phytotoxic effects[1]					Weed control based on weeding time[2]		
	Damage rating		Percent Survival		Height	First weeding	Subsequent weeding	Total weeding
Treatment	Spring	Fall	Spring	Fall		time/plot	time/plot	time/plot
Untreated	---	9.3	100	100	100	1.14 mh[3]	0.53 mh	0.68 mh
Bifenox at 3# ai/acre post-seeding	---	7.0*	51*	56*	119	0.01 mh*	0.19 mh*	0.14 mh*
Bifenox at 3# ai/acre post-germination	---	9.3	112	110	101	1.50 mh	0.10 mh*	0.45 mh*
Bifenox at 6# ai/acre 3# ai post-seeding 3# ai post-germination	---	6.0*	37*	40*	100	0.01 mh*	0.05 mh*	0.04 mh*

[1]Damage ratings shown are the means of all plots of each treatment for each species. Survival and height are expressed as percent of the untreated plots.

[2]Weed control is expressed in mean man hours requires to hand weed the treatment plots (20' by 4.5') based on 6 hand weeders per weeding time.

[3]mh = man hours

*Significantly different from the untreated plots at the 5% level of probability.

Table 7. Phytotoxic effects[1] of herbicide screening treatments on Eastern Redcedar at Norman Nursery in 1978-79.

Treatment		Eastern Red Cedar				
		Damage rating		Survival		
		Spring	Fall	Spring	Fall	Height
		Percent				
Applied Fall 1978 (Ps plots)						
Control		8.0	9.7	100	100	100
Diphenamid	Ps	8.0	9.0	100	86	80
DCPA	Ps	8.0	7.7	158	138	95
Trifluralin	Inc.	8.0	9.3	118	122	96
Napropamide	Ps	8.0	8.3	125	103	80
Bifenox	Ps	8.0	6.0*	92	92	72
Oxyfluorfen	Ps	7.7	7.7	72	86	84
Napropamide + Bifenox	Ps	8.0	7.7	105	108	78
Applied Spring 1979 (Pg plots)						
Control		10.0	9.3	100	100	100
Diphenamid	Pg	8.7	5.7*	123	93	82
DCPA	Pg	9.3	8.7	114	94	95
Napropamide	Pg	10.0	9.0	131	101	94
Bifenox	Pg	10.0	8.3	140*	103	101
Nap/bif[2]	Pg	9.3	8.7	103	99	97
Oxyfluorfen	Pg	10.0	8.3	106	91	91
Oxadiazon	Pg	10.0	7.3	126	97	91

[1] Damage ratings shown are the means of all plots of each treatment for each species. Survival and height are expressed as percent of the untreated plots.

[2] Tank mix of napropamide plus bifenox.

* Significantly different from the untreated plots at the 5 percent level of probability.

Table 8. Phytotoxic effects[1] of herbicide treatments on eastern redcedar at Norman Nursery in 1979-80.

Treatment		Damage rating Spring[2]	Damage rating Fall[2]	Survival Fall[2]	Percent Height[2]
Control		7.0	7.0	100	100
DCPA	Ps	5.7	3.7	51	76
DCPA	Pg	5.0	5.0	78	85
DCPA	Ps+Pg	6.0	5.3	69	96
DCPA	Pg+Pg	6.7	7.0	88	105
DCPA	Ps(2x)	5.7	5.7	64	102
DCPA	Pg(2x)	7.7	7.0	103	108
Oxy fluorfen	Ps	5.3	5.7	60	94
Oxyfluorfen	Pg	7.3	6.7	85	101
Oxyfluorfen	Ps+Pg	6.3	4.3	74	99
Oxyfluorfen	Pg+Pg	6.7	5.3	60	87
Oxyfluorfen	Ps(2x)	4.7	3.7	40	78
Oxyfluorfen	Pg(2x)	5.0	3.7	31	75
Napropamide	Ps	6.7	5.7	92	94
Napropamide	Pg	8.0	7.0	87	107
Napropamide	Ps+Pg	5.0	5.0	76	83
Napropamide	Pg+Pg	6.7	5.7	104	98
Napropamide	Ps(2x)	5.7	5.7	54	90
Napropamide	Pg(2x)	5.7	4.0	67	90
Bifenox	Ps	4.3	3.7	31	78
Bifenox	Pg	5.7	4.3	56	91
Bifenox	Ps+Pg	7.3	8.0	108	118
Bifenox	Pg+Pg	5.0	3.7	47	77
Bifenox	Ps(2x)	6.7	6.0	70	102
Bifenox	Pg(2x)	7.0	6.7	89	100

[1] Damage rating, shown are the means of all plots of each treatment for each species. Survival and height are expressed as percent of the untreated plots.

[2] No significant differences; wide variability in data, due to germination problems and adverse climatic conditions (water) which affected only parts of the study area.

DCPA, napropamide, oxyfluorfen, bifenox and the napropamide + bifenox tank mix were the promising herbicides that were tested for the full three years at Norman.

Austrian pine was tolerant of all the herbicides and application timing tested, except oxyfluorfen and bifenox applied post-seeding (Tables 4 and 5) which reduced the percent germination. Oxyfluorfen and bifenox produced no phytotoxic effects when applied post-germination to Austrian pine.

Loblolly pine was tolerant of all herbicides and application timing tested except bifenox and the bifenox + napropamide tank mix when applied post-seeding (Tables 3, 4, 5 and 6) which reduced the percent germination. Post-germination applications of these treatments produced no phytotoxic effects on loblolly pine.

These phytotoxic effects of bifenox on loblolly and Austrian pine were not recorded from other southern nurseries where it was being used and oxyfluorfen has been applied post-seeding to Austrian pine in other nurseries without any phytotoxic problems. The Norman Nursery experienced very heavy rains after application of the herbicides and before germination of these pines in all three years of the study. This and the low organic matter present at the Norman Nursery may have led to these phytotoxic effects with oxyfluorfen and bifenox on Austrian pine and bifenox (and the bifenox plus napropamide tank mix) on loblolly pine.

Fall-sown redcedar was tolerant of all herbicides and application timing tested (Tables 7 and 8). This was true of redcedar at four other Great Plain's nurseries where these herbicides were also tested without all the variability in data due to germination problems and heavy rains. Bifenox and oxyfluorfen applied post-seeding were the only herbicides in all the tests on redcedar at five Great Plains nurseries that may have produced a slight reduction in survival, however, this was not a significant reduction.

None of the post-germination applications of the herbicides tested the full three years at Norman caused any significant phytotoxic effects on spring-sown Austrian and loblolly pine or on fall-sown redcedar. DCPA and napropamide are the only herbicides tested for the full three years which did not cause any phytotoxic effects on any species when applied post-seeding (Table 9).

Weed Control Studies

The herbicides DCPA, napropamide, oxyfluorfen, bifenox and the napropamide + bifenox tank mix were evaluated all three years on spring-sown species at Norman with promising results in the reduction of herbaceous weeds, mainly broad leaf type which occurred about six times as numerous as the grass type (Tables 6, 10, 11 and 12). The results from the large operational study the third year reflect the true value of these weed control chemicals in actual time saved which can be converted into dollars saved.

Table 9. Herbicides producing acceptable weed control at the Norman Nursery without significant seedling damage by tree-species and application timing.

Species	Application timing: Post-seeding or Soil incorporation	Post-Germination	Post-seeding or Soil incorporation plus Post-germination
Austrian pine	Trifluralin	--	--
	DCPA	DCPA	DCPA
	Napropamide	Napropamide	Napropamide
	--	Bifenox	--
	--	Oxyfluorfen	--
Loblolly pine	Trifluralin	--	--
	DCPA	DCPA	DCPA
	Napropamide	Napropamide	Napropamide
	Oxyfluorfen	Oxyfluorfen	Oxyfluorfen
	--	Bifenox	--
Eastern redcedar (fall-sown)	Trifluralin	--	--
	DCPA	DCPA	DCPA
	Oxyfluorfen	Oxyfluorfen	Oxyfluorfen
	Napropamide	Napropamide	Napropamide
	Bifenox	Bifenox	Bifenox
	Oxadiazon	Oxadiazon	Oxadiazon

Table 10. Weed control[1] of herbicide treatments[2] at the Norman Nursery expressed in terms of oven-dry weight of herbaceous weeds during 1978.

Treatment		Weed control rating by weeding(s) 1st	2nd	3rd	Percent Dry weight of weeds 1st weeding	Subsequent weedings	Total season
Control		0.0	---	---	100.0	100.0	100.0
Diphenamid	Ps	8.5*	---	---	9.1*	84.8	58.2*
Diphenamid	Pg	---	---	---	-----	93.1	95.5
Trifluralin		8.2*	---	---	5.8*	84.5	56.9*
DCPA	Ps	9.5*	---	---	0.2*	93.5	60.8*
DCPA	Pg	---	---	---	---	92.4	95.0
Chloramben	Pg	---	---	---	---	91.5	94.5
Oxyfluorfen	Ps	9.8*	---	---	0.03*	88.8	57.7*
Oxyfluorfen	Pg	---	---	---	----	88.3	92.4
Napropamide	Ps	7.0*	---	---	16.2*	86.9	62.1*
Napropamide	Pg	---	---	---	----	63.8	76.5
Butralin	Ps	9.0*	---	---	1.5*	110.0	71.9*
Bifenox	Ps	9.7*	---	---	0.3*	100.6	65.4*
Bifenox	Pg	---	---	---	----	58.1*	72.8*
Napropamide + Bifenox	Ps	9.3*	---	---	2.1*	83.4	53.9*
Napropamide + Bifenox	Pg	---	---	---	---	59.5*	73.7*

[1]Weed control ratings shown are the means of all plots of each treatment. Dry weight of weeds are expressed as percent of the untreated plots.

[2]Weed control data compiled from the loblolly and Austrian pine treatments only.

*Significantly different from the untreated plots at the 5% level of probability.

Table 11. Weed control study of herbicide treatments at Norman Nursery expressed in actual weeding times during 1979.

Treatment		1st[1] Weeding Time (60 ft. bed)			2nd[2] Weeding Time (60 ft. bed)			3rd[2] Weeding Time (40 ft. bed)			Season Totals (160 ft. bed)	
		Weeding time	No. of Weeders	Total man hours	Weeding time	No. of Weeders	Total man hours	Weeding[3] time	No. of weeders	Total man hours	Weeding time	Total man hours
Control		2.58	4	0.17	4.34	4	0.29	2.67	4	0.18	9.59	0.64
DCPA	Ps	0.41	4	0.03	6.08	4	0.41	3.08	4	0.21	9.57	0.65
DCPA	Ps+Pg	0.75	4	0.05	14.73	4	0.98	10.91	4	0.73*	26.39	1.76
DCPA	Pg	15.92	4	1.06	10.42	4	0.69	5.09	4	0.34	31.43	2.09
Oxyfluorfen	Ps	0.83	4	0.05	14.17	4	0.94	8.83	4	0.59*	23.83	1.58
Oxyfluorfen	Ps+Pg	0.99	4	0.07	3.34	4	0.22	5.09	4	0.34	9.42	0.63
Oxyfluorfen	Pg	4.34	4	0.29	4.92	4	0.33	3.16	4	0.21	12.42	0.83
Napropamide	Ps	0.33	4	0.02	4.42	4	0.29	2.08	4	0.14	6.83	0.45
Napropamide	Ps+Pg	0.66	4	0.04	3.92	4	0.26	4.75	4	0.32	9.33	0.62
Napropamide	Pg	13.00	4	0.87	9.92	4	0.66	7.84	4	0.52	30.76	2.05
Bifenox	Ps	0.49	4	0.03	5.08	4	0.34	4.50	4	0.30	10.07	0.67
Bifenox	Ps+Pg	0.49	4	0.03	4.00	4	0.27	2.67	4	0.18	7.16	0.48
Bifenox	Pg	10.00	4	0.67	5.83	4	0.39	2.83	4	0.19	18.66	1.25
Nap/Bif[4]	Ps	0.33	4	0.02	3.08	4	0.21	3.75	4	0.25	7.16	0.48
Nap/bif[4]	Ps+Pg	0.24	4	0.02	0.41	4	0.03	0.42	4	0.03	1.07	0.08
Nap/bif[4]	Pg	13.92	4	0.93	1.67	4	0.11	4.08	4	0.27	19.67	1.31

Note: Weeding times are expressed in minutes and hundredths of minutes.

[1] Weeded after 1st application (Ps).

[2] Weeded after 2nd application (Pg).

[3] Weeding times are for white and blue plots only (No data for red block).

[4] Tank mix of napropamide plus bifenox.

*Significantly different from the untreated plots at the 5 percent level of probability.

Table 12. Weed control time study of herbicide treatment at Norman Nursery for 100' plots expressed in actual weed times during 1980.

Treatment		Post seeding application (2)[1] Average number of weeders	Man hours	Percent reduction	Post germination application (4)[1] Average number of weeders	Man hours	Percent reduction	Season total (6)[1] Total Man hours	Percent reduction
Control		5.5	9.89	0	6	6.05	0	15.94	0
Oxyfluorfen	Ps	5.5	0.41*	96	6	2.98*	51	3.39*	79
Oxyfluorfen	Ps + Pg	5.5	0.34*	97	6	1.68*	72	2.02*	87
Napropamide	Ps	5.5	0.43*	96	6	3.18*	47	3.61*	77
Napropamide	Ps+Pg	5.5	0.32*	97	6	2.16*	64	2.48*	84
Bifenox	Ps	5.5	0.56*	94	6	3.28*	46	3.84*	76
Bifenox	Ps+Pg	5.5	0.53*	95	6	1.67*	72	2.20*	86
Napropamide + Bifenox	Ps	5.5	0.21*	98	6	1.72*	71	1.93*	88
Napropamide + Bifenox	Ps+Pg	5.5	0.24*	98	6	1.06*	82	1.30*	92

[1]Number of weedings

*Significantly different from the control at the 5 percent level of probability.

Weed control of these herbicides expressed in hand-weeding time are summarized in Figure 1 and Table 12. In general, post-seeding applications were as effective as the post-seeding plus post-germination treatments for total season weed control. This reflects the greater number and vigor of weeds germinating and emerging earlier in the season and suggests that post-seeding weed control is the most critical. All herbicides and herbicide combinations produced effective weed control (at least 75 percent reduction in hand-weeding time) when applied as post-seeding, or post-seeding plus post-germination applications.

Hand weeding time was reduced by an average of 80 percent for all herbicides applied only in the spring (Ps) while those applied in both the spring and a second application five to six weeks later (Ps + Pg) reduced hand weeding time by an average of 87 percent. This amounted to an average saving of 12.6 man hours per 100 by four-foot plot per year, or based on minimum wage of $3.35 per hour, a saving of $42.21 for a 100 by 4 foot plot weeded up to six times per year. This would amount to an average gross savings of $4,600 per acre of seedbed (without figuring in cost of herbicide or application costs) weeded six times with a mean weeding time of 283 man hours per acre (2.6 man hours per 100 by 4 foot plot) for untreated seedbeds at Norman.

The third year weed control data from the 100 foot plots on eastern redcedar was lost in the fire which destroyed the office building at the Norman Nursery in 1981. However, in a companion study with bifenox, oxyfluorfen, and napropamide at the Big Sioux Conifer Nursery at Watertown, SD, oxyfluorfen (Ps + Pg) reduced weeding time by 88% and bifenox (Ps + Pg) by 77%. Similar reductions in weeding times have been shown at other Great Plains nurseries. The first two years of study at Norman (Tables 13 and 14) on weed control in fall-sown redcedar have shown variable results with up to 60-80% reduction in weeds and/or weeding time. Similar studies at the other Great Plains nurseries on fall-sown redcedar demonstrated consistent weed time reduction of 80-90 percent with these same herbicides.

Continuing studies with herbicides are being conducted by SUNY at the Norman Nursery. Studies looking into the possibility of mixing herbicides with the hydromulch are being conducted, earlier studies have shown promising results. We are also conducting screening studies of the more promising herbicides on the many hardwood species being grown here at the Nursery. These studies are in progress and no results will be presented here.

SUMMARY

Three years of herbicide studies on spring-sown Austrian and loblolly pine and fall-sown eastern redcedar were completed between 1978 and 1981 at the Oklahoma State Nursery (Norman Nursery) located at Washington, OK. Results from these studies have been incorporated into the Nursery's weed control program. On conifers (both spring- and fall-sown) the nursery is using treflan® (trifluralin) as an incorporated preplant treatment followed by post-germination applications of Devrinol®(napropamide) plus Modown® (bifenox) tank mix or Goal®(oxyfluorfen).

Figure 1. Mean weeding times for Norman Nursery. Season totals based on 100' plots.

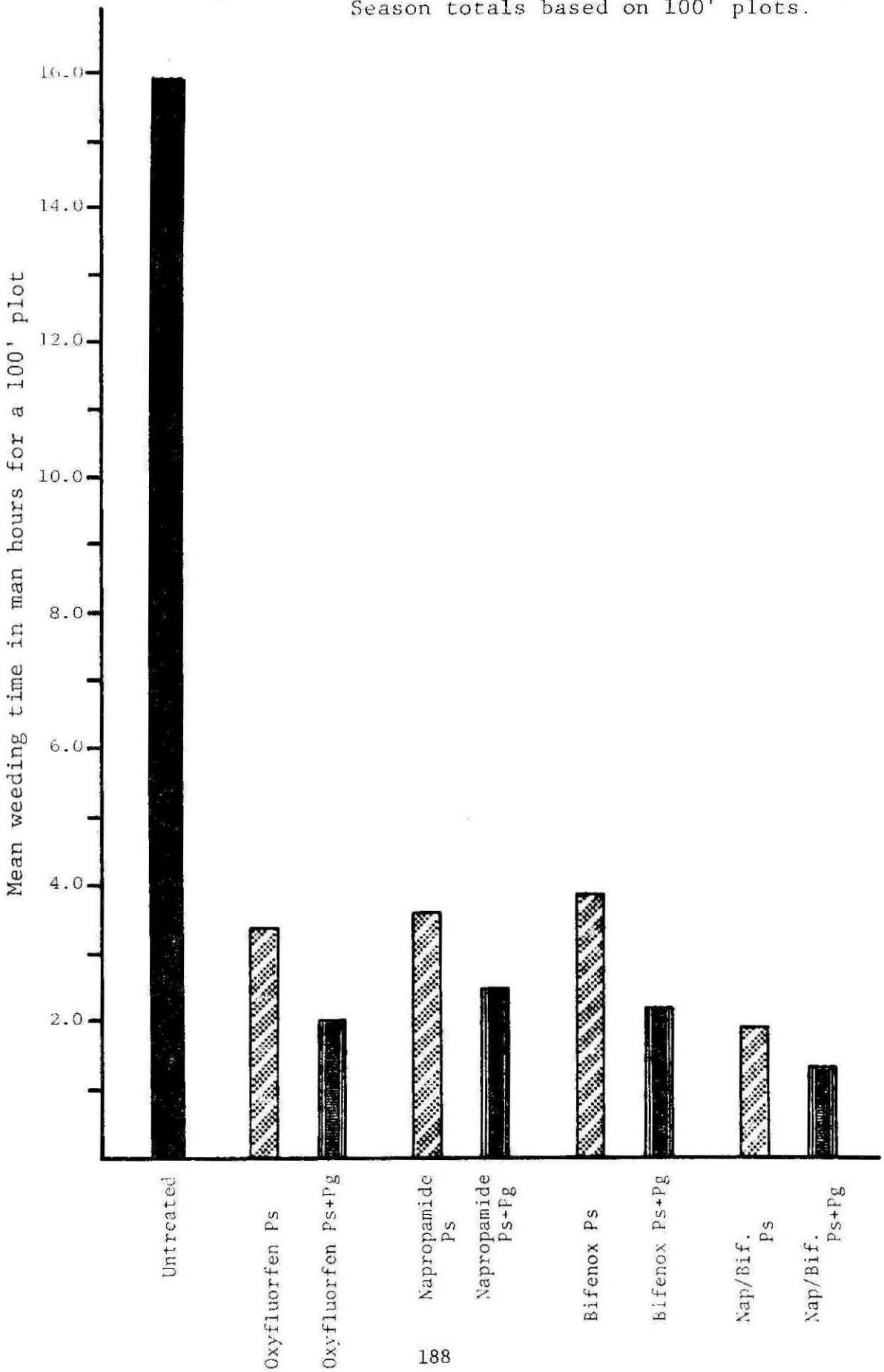

Table 13. Weed control[1] of herbicide screening treatments on Eastern Redcedar at the Norman Nursery expressed in terms of number and/or oven-dry weight of herbaceous weeds during 1978-79.

Treatment		Weed control rating by weedings 1st	2nd	3rd	4th	Percent Number of Weeds 1st Weeding	2nd Weeding	3rd Weeding	4th Weeding	Total Season
Applied Fall 1978 (Ps plots)										
Control		2.7	1.7	2.0	6.0	100.0	100.0	100.0	100.0	100.0
Diphenamid	Ps	6.7*	1.0	6.0*	6.0	36.6*	91.9	69.0	142.1	71.1*
DCPA	Ps	9.0*	5.0	6.0*	7.0	4.9*	44.6*	69.0	73.7	34.8*
Trifluralin	Inc.	8.7*	7.3*	9.3*	8.3	7.3*	23.0*	10.3*	42.1	16.7*
Napropamide	Ps	9.3*	1.3	4.3	6.3	3.7*	68.9	82.8	121.0	49.5*
Bifenox	Ps	9.3*	3.7	7.7*	4.3	2.4*	44.6*	51.7*	136.8	37.3*
Oxyfluorfen	Ps	8.3*	3.0	7.3*	8.0	13.4*	52.7	37.9*	42.1	33.8*
Nap/bif[2]	Ps	9.0*	5.3	6.7*	6.3	4.9*	29.7*	51.7*	63.2	26.0*
Applied Spring 1979 (Pg plots)										
Control		-	8.0	8.7	9.0	-	100.0	100.0	100.0	100.0
Diphenamid	Pg	-	8.0	9.3	8.3	-	85.7	60.0	160.0	100.0
DCPA	Pg	-	7.0	6.3	5.7	-	142.9	360.0	2200.0	811.8
Napropamide	Pg	-	9.3	8.0	6.0	-	28.6	140.0	1800.0	582.4
Bifenox	Pg	-	8.3	8.3	6.7	-	85.7	160.0	1780.0	605.9
Nap/bif[2]	Pg	-	9.0	10.0	8.3	-	42.9	0.0	940.0	294.1
Oxyfluorfen	Pg	-	8.3	9.7	9.3	-	85.7	20.0	40.0	52.9
Oxadiazon	Pg	-	8.3	9.3	9.0	-	71.4	40.0	120.0	76.5

[1] Weed control ratings shown are the means of all plots of each treatment. Numbers of weeds are expressed as percent of the untreated plots.

[2] Tank mix of napropamide plus bifenox.

* Significantly different from the untreated plots at the 5 percent level of probability.

Table 14. Weed control study of herbicide treatments at Norman Nursery on fall-sown eastern redcedar expressed in actual weeding times during 1979-80.

Treatment		Post seeding application (1)[1]			Post germination application (4)[1]			Season total (5)[1]	
		Average number of weeders	Man hours	Percent reduction	Average number of weeders	Man hours	Percent reduction	Total Man hours	Percent reduction
Control		5	0.22	0	6	1.84	0	2.06	0
DCPA	Ps	5	0.14	36	6	1.17	36	1.31	36
DCPA	Ps+Pg	5	0.28	0	6	0.99	46	1.27	38
Oxyfluorfen	Ps	5	0.08	64	6	0.75	59	0.83	60
Oxyfluorfen	Ps+Pg	5	0.10	55	6	0.94	49	1.04	50
Napropamide	Ps	5	0.15	32	6	2.23	0	2.38	0
Napropamide	Ps+Pg	5	0.12	45	6	1.24	33	1.36	34
Bifenox	Ps	5	0.19	14	6	2.40	0	2.59	0
Bifenox	Ps+Pg	5	0.14	36	6	1.35	27	1.49	28

[1]Number of weedings.

*Significantly different from the control at the 5 percent level of probability.

We are presently working in cooperation with the nursery on herbicide treatments for the many hardwood species grown there and on replacement treatments for preplant incorporated trifluralin.

The herbicide treatment are reducing the nursery's hand-weeding times (and costs) by 60-87%. In one large study at the nursery this amounted to a savings of approximately $4,500 per acre of seedbed if minimum wage was paid.

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