DEVELOPING HERBICIDE USES FOR INDIANA'S FOREST NURSERIES

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INTRODUCTION

Successful artificial regeneration of our nation's forest land is dependent on adequate supplies of seedlings from forest nurseries. Wildlife habitat improvement programs, land reclamation, windbreak establishment and Christmas tree production also rely heavily on nursery seedling production. The production of these seedlings is accomplished at considerable expense. For most nurseries the major production cost is the hand labor necessary for tending seedlings, particularly for weeding nursery beds. Consequently, the use of herbicides for weed control has considerable financial incentive for the nursery manager.

Although this paper discusses weed control in nursery beds, a general sanitation program for adjacent areas is the most important factor in a successful weed control program. Control of weeds in the risers, on the bed ends and on adjacent non-crop areas is vital. Until the nursery manager accomplishes this, it is counter-productive to worry about weed control in the beds. Weed control, in this context, means prevention of seed production. This can be accomplished in a variety of ways. Mowing before seed head formation maintains vegetative cover while preventing seed production. Plant cover is obviously desirable in many situations. Applications of non-residual herbicides, such as paraquat, MSMA or glyphosate, provide weed free conditions without potentially damaging herbicide residues. For areas which remain undisturbed, i.e., the soil will not be incorporated into the nursery beds during bed preparation and tilling operations, residual herbicides, such as simazine, can provide extended weed control without frequent retreatments. Herbicides such as 2,4-D, silvex and dicamba, or their combinations, are effective in selectively removing undesired broadleaf weeds, such as dandelion, henbit, and chickweed, from grassy plant cover. In effect, there are a variety of methods and herbicides available to the nursery manager to control weeds outside the nursery beds which obviously reduces the potential for reinvasion. This should be the first priority in a weed control program.

Indiana's two forest nurseries are widely different in geographic location and soil conditions. The Vallonia nursery in southern Indiana is located approximately 50 miles north of Louisville, KY. The northern nursery, Jasper-Pulaski (J-P), is located near Medaryville approximately 75 miles southeast of Chicago, IL. The Vallonia soil is a Princeton fine sandy loam with 0.4% soil organic matter. The J-P nursery is a Boswell fine loamy sand with 4% soil organic matter.

METHODS

In 1975 an herbicide evaluation program for nursery weed control was begun in Indiana. Initially this involved only the nursery at Vallonia in southern Indiana but was later expanded to the northern Indiana nursery.

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Throughout this paper, certain notations should be understood. All hardwood species are grown from seed and sold at the end of the first growing season as 1-0 stock. This also applies to Virginia pine. Various age classes of white and red pine are produced at Indiana nurseries. Seedling age (1-0, 2-0, 2-1) refer to the age at end of the growing season of treatment. This report discusses only postemergence applications. All treatments on 1-0 stock were applied approximately one month after emergence. Other seedling age classes were also treated at the same time. All herbicides were applied in a broadcast manner without any attempt to protect the seedlings. Liquid herbicides were applied in approximately 80 gallons of water per acre.

A standard experimental design and data analysis have been used throughout the tests. All treatments were applied in a completely randomized experimental design with three replicates. Only the operational plots were unreplicated. The screening plots were approximately 15 feet long and the width of the bed. The operational plots were 100 feet in length and the width of the bed.

At the end of the season a sample of seedlings was collected across the bed in the center for the screening plots. This sample was within a sample frame either 0.5 or 1.0 foot in width. Data for each plot included, in order or priority, 1) total number of seedlings, 2) total number of shippable seedlings, and 3) average height of 10 randomly selected shippable seedlings. A herbicide treatment was not considered as a viable treatment if it significantly (5 percent level of probability) reduced any of these standards when compared with untreated seedlings. The data were statistically analyzed with analysis of variance and compared with tests of least significant differences with untreated seedlings. In this report, "no significant adverse effects" indicates that treated seedlings did not differ significantly from untreated seedlings. The operational plots were handled in a similar manner except that three samples were taken from each plot. Weed control data were not recorded for the screening trials, only for the operational tests.

RESULTS

1975 Postemergent Screening Tests at Vallonia

Test species in 1975 were black walnut, tulip poplar and 1-0 white pine.

Simazine, as Princep 80W, at 0.5 and 1 lb/acre had no significant effect on total number of black walnut seedlings or number of shippable seedlings. The height of treated walnut seedlings was significantly greater than untreated seedlings. The total number of tulip poplar and 1-0 white pine seedlings was reduced significantly.

Diphenamid, as Enide 50W, at 3 and 6 lb/acre had no significant adverse effects on black walnut. However, tulip poplar treated with the 3 lb rate was significantly lower in number of shippable seedlings, and 1-0 white pine was significantly lower in total number of seedlings. The 6 lb rate had no significant effects on tulip poplar or 1-0 white pine seedlings.

Napropamide, as Devrinol 2E, at 1 and 2 lb/acre had no significant adverse effects on black walnut, tulip poplar or 1-0 white pine.

Oxadiazon, as Ronstar 2E, at 1 and 2 lb/acre had no significant adverse effects on walnut or 1-0 white pine seedlings. Tulip poplar was significantly reduced in total number. The same is true for bifenox, as Mowdown 80W, at 1 and 2 lb/acre, except the walnut seedlings were significantly taller.

Hexazinone, as Velpar 90S, at 0.25 and 0.50 lb/acre significantly reduced the total number of seedlings of all three species.

DCPA, as Dacthal 75W, at 4 and 8 lb/acre had no significant adverse effects on the tulip poplar or 1-0 white pine seedlings. It was not applied to the black walnut.

1976 Postemergent Screening Tests at Vallonia and Jasper-Pulaski

Conifer test species were 1-0, 2-0 and 2-1 white pine. The 1-0 and 2-0 white pine were located at Vallonia and the 2-1 white pine at J-P. Hardwood test species were black walnut and tulip poplar at Vallonia, and black walnut and red oak at J-P.

Methazole, as Probe 75W, at 2, 4 and 8 lb/acre significantly reduced the total number of seedlings of 1-0, 2-0 and 2-1 white pine, as well as tulip poplar and red oak. Black walnut at both nurseries was more tolerant but tended to be significantly reduced in height.

Pronamide, as Kerb 50W, at 0.5 lb/acre had no significant adverse effects on 1-0, 2-0 and 2-1 white pine. At 1 lb/acre the total number of 1-0 white pine seedlings was significantly reduced while 2-0 and 2-1 seedlings were not adversely affected. Both rates of pronamide significantly reduced total number of tulip poplar seedlings. Both rates significantly reduced black walnut seedling height at Vallonia but had no significant adverse effects on black walnut seedlings at J-P. At the low rate of pronamide, 0.5 lb/acre, the number of shippable red oak seedlings was reduced significantly while the higher rate showed no significant adverse effects.

Oryzalin, as Surflan 75W, at 1 and 2 lb/acre significantly reduced the total number of 1-0 white pine seedlings. The lower rate reduced the total number of 2-0 white pine while the higher rate showed no adverse effects. Neither rate adversely Effected 2-1 white pine and black walnut at both nurseries. The 2 lb rate significantly reduced the total number of tulip poplar and red oak seedlings while the lower rate, 1 lb, did not adversely effect either species.

Diphenamid, as Enide 50W, at 4 and 8 lb/acre did not adversely effect 2-1 white pine or black walnut at J-P. Walnut actually increased in height significantly. The number of shippable red oak was significantly reduced at both rates of diphenamid.

Oxadiazon, as Ronstar 2G, was applied only at J-P at 3 and 6 lb/acre. Black walnut and 2-1 white pine were not adversely effected at either rate. The 6 lb rate significantly reduced the number of shippable red oak while the lower rate showed no adverse effects.

DCPA, as Dacthal 75W, was applied only at J-P at 12 and 18 lb/acre. Black walnut and 2-1 white pine were not adversely effected at either rate. The 18 lb rate significantly reduced the number of shippable red oak seedlings while the lower rate showed no adverse effects.

Simazine, as Princep 80W, was applied only at the J-P nursery at 1 and 2 lb/acre. Black walnut and 2-1 white pine showed no significant adverse effects. The lower rate significantly reduced, the total number of red oak seedlings and the higher rate significantly reduced the number of shippable red oak.

Napropamide, as Devrinoi 2E and 50W, at 3 and 6 lb/acre was applied only at J-P. Neither 2-1 white pine nor black walnut were adversely effected by either rate of each formulation. The 3 lb rate of the 2E formulation significantly reduced the total number of red oak seedlings while the 6 lb rate of the 2E formulation and both rates of the 50W formulation significantly reduced the number of shippable red oak seedlings.

USB-3153 as a 50W formulation was applied at Valionia at 2 and 4 lb/acre. The height of 1-0 white pine was significantly reduced, as was the height of black walnut, at both rates. The total number of tulip poplar seedlings was significantly reduced by both rates. At the lower rate, the total number of 2-0 white pine seedlings was significantly reduced while the higher rate showed no significant effects.

The 1976 results suggest that, during the first year in the transplant bed, 2-1 seedlings are subject to moisture stress and sensitive to weed competition. There were 17 treatments at J-P on 2-1 white pine seedlings which did not have a significant adverse effect on the seedlings. Forty percent of these treatments had a significantly greater total number of seedlings at the end of the growing season than the untreated seedlings in the control plots. These treatments include the higher rate of oryzalin (2 lb/acre), the higher rate of diphenamid (8 lb/acre), the higher rate of DCPA (18 lb/acre) and all rates of both formulations of napropamide (3 and 6 lb/acre). While numbers of weeds were not recorded in this screening program, these herbicide rates would be expected to provide satisfactory weed control.

1976 Postemergence Operational Test

The herbicides which were not injurious in the 1975 screening plots were applied in a more operational manner to selected species at Vallonia in 1976 to evaluate weed response: The plots were hand weeded by nursery anu Purdue University personnel. The number of weeds removed was recorded by plot. Time required for weeding was also recorded for many of the weeded plots. All treatments were applied approximately one month after seedling emergence with seedling data analyzed as previously discussed.

Oxadiazon, as Ronstar 20, was applied at 3 lb/acre to black walnut, tulip poplar, 1-0 and 2-0 white pine. Only tulip poplar showed a significant reduction in total number of seedlings.

Napropamide, as Devrinol 2E, at 3 lb had no adverse effects on black walnut, tulip poplar, and 1-0 and 2-0 white pine.

Simazine, as Princep 80W,at 1 and 2 lb/acre had no significant adverse effects on black walnut and 2-0 white pine.

DCPA, as Dacthal 75W, at 12 lb/acre had no significant adverse effects on black walnut, tulip poplar, Autumn olive, Virginia pine, and 1-0 and 2-0 white pine.

Diphenamid, as Enide 50W, at 4 lb/acre had no significant adverse effects on black walnut, tulip poplar, and 1-0 and 2-0 white pine. The height of Virginia pine and number of shippable seedlings of Autumn olive were significantly reduced.

The number of weeds in all plots receiving the same treatment was averaged for each weeding date. From these values, percent weed reduction was 'calculated

(Table 1). Although the number of observations vary, there is some basis for noting the excellent weed control, greater than 80 percent reduction, for nearly two months after treatment resulting from napropamide at 3 lb/acre, oxadiazon at 3 lb/acre and simazine at 1 and 2 lb/acre. Diphenamid at 4 lb/acre and DCPA at 12 lb/acre were effective, but to a lesser degree and for a shorter period of time.

The recorded times required to weed the 100 foot operational plots were regressed over the number of weeds per plot to generate a simple linear relationship, as follows:

$$\text{Time/plot} = 1.42 \pm 0.07 \text{ (weeds/plot)}$$

$$r = 0.96$$

Using the derived equation and the numbers of weeds for each weeding date and treatment, hand labor time for each treatment was calculated, along with percent labor reduction (Table 2). The potential savings in labor costs are readily apparent. However, this lumping of species does ignore the fact that nursery species have differing weed problems. Actual savings to a nursery will ultimately depend on species being produced. For example, black walnut and 2-0 white pine at Vallonia have very minimal weed problems by mid-summer as a result of intense shading. Species such as. Autumn olive and 1-0 white pine, which left the beds more exposed, tended to have weeds occurring continuously.

Table 1. Average number of weeds and percent weed reduction in operational plots at Vallonia nursery by treatment and weed date, 1976.

Herbicide	Rate (lb ai/A)	Weeks after treatment: 3 — Number of weeds	3 — % reduction	5 — Number of weeds	5 — % reduction	7 — Number of weeds	7 — % reduction
control (6)[a/]		155		37		22	
diphenamide (6)	4	78	50	13	65	11	50
DCPA (6)	12	74	52	10	73	8	64
napropamide (4)	3	13	92	5	86	3	86
oxadiazon (4)	3	10	94	4	89	1	95
simazine (2)	1	6	96	0	100	0	100
(2)	2	10	94	0	100	0	100

1/ Number in parentheses is the number of species treated with each herbicide rate, ie, the number of observations in the average number of weeds for each weeding date.

Table 2. Calculated weeding times and percent labor reductions for herbicide treatments on operational plots at Vallonia nursery, 1976.

Herbicide	Rate (lb ai/A)	Total weeding time/plot (minutes)	Labor reduction (%)
control		19	
diphenamid	4	11	42
DCPA	12	11	42
napropamide	3	6	68
oxadiazon	3	5	74
simazine	1	5	74
	2	5	74

1977 Tolerance Tests at J-P

The 1977 tests, applied only at J-P, were to evaluate species response to a 3X rate of napropamide and to evaluate a new formulation of methazole. The test series was handled exactly the same as the previous screening trials.

Napropamide, as Devrinol 50W, was applied at rates of 3 and 9 lb/acre. No significant adverse effects by either rate were detected in 1-0 and 2-1 white pine, 2-1 red pine, black walnut and Autumn olive. The low rate significantly reduced height of red oak while the upper rate (9 lb/acre) showed no adverse effects.

Methazole, as Probe 5G, at 2 and 4 lb/acre showed no adverse effects on 2-1 red and white pine, black walnut and Autumn olive. The lower rate had no significant adverse effects on red oak while the higher rate did significantly reduce red oak seedling heights.

CONCLUSIONS

Based on three years of testing at Indiana nurseries, postemergent herbicide rates and tolerant species are presented in Table 3. These generally are not labeled rates or uses of these herbicides but simply reflect our experience over the last three years. Because of the high potential value of the crop involved, herbicide programs for nursery bed treatment should have at least a 2X or greater safety margin. For several of the species we have incomplete knowledge of herbicide tolerance. Final analysis of 1978 test results will fill some of these gaps.

Table 3. Potential herbicide application rates for indicated species by [a/] percent soil organic matter based on Indiana nursery conditions.

Herbicide	Rate (lb ai/A)	Organic matter <1%	Organic matter 4%
simazine (Princep 80W)	1	black walnut 2-0 white pine	black walnut 2-1 white pine
diphenamid (Enide 50W)	4	black walnut[b/] tulip poplar[b/] 1-0 white pine[b/] 2-0 white pine[b/]	black walnut 2-1 white pine
napropamide (Devrinol 50W)	3	black walnut[c/] tulip poplar[c/] 1-0 white pine[c/] 2-0 white pine[c/]	black walnut Autumn olive 1-0 white pine 2-1 white pine 2-1 red pine
oxadiazon (Ronstar 2G)	3	black walnut[c/] 1-0 white pine[c/] 2-0 white pine[c/]	black walnut 2-1 white pine
bifenox (Mowdown 80W)	1	1-0 white pine	
DCPA (Dacthal 75W)	8	tulip poplar[b/] 1-0 white pine[b/]	
	12		2-1 white pine[b/]
oryzalin (Surflan 75W)	1	black walnut	black walnut 2-1 white pine

[a/] Unless noted otherwise, a 2X safety factor is known for the species and herbicide rate at the respective soil organic matter content.

[b/] 1.5X safety factor known.

[c/] Safety factor unknown.