Forest Tree Nursery Herbicide Studies in the Lake States and New York:

Highlights of Research Results

by

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Abstract: Eight herbicides (registered for similar uses in the U.S.) were extensively evaluated at 42 forest tree nurseries in Western and Northern United States for weed control on first year seedling nursery beds. This paper will concentrate on research at 9 nurseries in the Lake States and in New York. Phytotoxicity evaluations of dcpa, napropamide, oxyfluorfen, diphenamid, bifenox, oxadiazon, trifluralin and prometryn on 15 different conifer and hardwood species are presented.

Additional keywords: Enide®, treflan®, Dacthal®, Caparol®, Devrinol®, Modown®, Goal®, and Ronstar®.

The USDA Forest Service's nursery herbicide projects in the United States 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 8 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; Owston and Abrahamson, 1984), the Intermountain-Great Basin in 1977 (Ryker and Abrahamson, 1980), and the Great Plains in 1978 (Abrahamson, 1981; Abrahamson and Burns, 1979). 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 (Abrahamson, 1983) 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 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

The nursery herbicide screening and demonstration projects were initiated as part of a three-year study. During the first year of the three-year study up to ten herbicides (eight of which are represented in Table 1) were screened on two to four major species of spring- and/or fall-sown conifers and/or hardwoods depending on the nursery involved in the study.

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. 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 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 species which were 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 species which were applied in the spring after mulch was removed and 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 as needed during the remainder of the growing season. Weeds were counted from each plot 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 germination, seedling growth and survival.

The objectives of the second-year studies were to evaluate the phytotoxicity and weed control effectiveness of three to four herbicides screened from the first-year study to be non-phytotoxic to the species tested and have reasonable weed control of weeds present at that nursery. 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 evaluated by using herbicidal damage ratings (Anderson, 1963), seedling survival (number/foot) and height growth (cm) with dosages of IX, 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 plots, 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 acre of nursery bed.

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. The herbicides were evaluated for weed control under operational use at the IX 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. Phytotoxicity rating, survival and height measurements were also recorded from these operational plots.

RESULTS AND DISCUSSION

Since each nursery is a study in itself, this paper will only concentrate on studies in progress at 9 nurseries in the Lake States and New York. Phytotoxicity data from these nurseries is presented in Tables 2-6, listed by seedling species tested under each herbicide, Tables 7-12, listed by herbicides tested under each species, and Table 13, a summary of species and herbicides used at each nursery. The tables are summaries of all the phytotoxicity studies and indicate; 1) those fall- and/or spring-sown seedlings where the herbicide has been safely applied at rates indicated without stunting or germination reduction (x); 2) herbicides that appear to be promising at rates indicated, but because of possible phytotoxic problems implied in some of our studies, these should be thoroughly tested before using at your nursery (o); 3) herbicides that should not be used at rates indicated because of severe phytotoxic damage (-). One herbicide that should be elaborated on is napropamide. Napropamide is used at the lower rate (1.5 lbs ai per acre) when the nursery soil has below 1 percent organic matter, otherwise the

higher rate (3.0 lbs ai per acre) is normally used. Napropamide is safe to use post-seeding on most spring-sown conifer species tested, but caused severe stunting when applied post-seeding to fall-sown conifer species in the Lake States study. Napropamide applied post-germination to both spring- and fall-sown conifers caused no phytotoxic problems.

Weed control expressed in terms of hand-weeding time, or "how much time can herbicides save you versus hand-weeding" is one of the most important aspects of these studies. Since the third year of study in the Lake States has not been completed, we will summarize some of the weed control results from earlier studies. In the Great Plains study (Abrahamson, 1981) on spring-sown species the post-seeding applications were as effective as the post-seeding plus post-germination applications for total season weed control. The Norman Nursery in Oklahoma is an example (Abrahamson, 1983) of the type of savings in time and money that can be expected from these herbicides when used in forest tree nurseries (Figure 1).

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 four-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 four-foot plot) for untreated seedbeds at Norman (Abrahamson, 1983).

Additional Studies

Mixing herbicides with hydromulch and applying them both over the top of

the seedbeds after sowing (Ps) was tested at two nurseries with excellent results. Oxyfluorfen, bifenox, napropamide, and the napropamide plus bifenox tank mix (all at the recommended rates) were mixed with hydromulch and tested on spring-sown conifers and oxyfluorfen was mixed with hydromulch and tested on fall-sown conifers. There were no phytotoxic problems on conifers tested when the herbicides were applied mixed with the hydromulch or when they were applied under the hydromulch. Weed control was slightly less when the herbicides were mixed with the hydromulch but not significantly different from when they were not mixed. This application technique looks very promising and could save additional time and money by eliminating one of the steps required in preparing and tending seedbeds.

Glyphosate, Roundup ®, has been tested for four years on ten conifer species at the New York nursery and at various times in the Great Plains nurseries over the top of first year conifer seedlings (Abrahamson, 1981). The following summary will provide a guideline to the use of glyphosate over first-year conifer seedlings:

Glyphosate at 0.5 lbs ai per acre (isopropylamine salt) will control most annuals and some perennials in the following conifer seedbeds without any phytotoxic damage; red and Jack pines (most sensitive - must be careful with these species), Austrian pine, white pine, Scotch pine, ponderosa pine and Douglas-fir; 0.5 to 0.75 lbs ai per acre (up to 1.0 lbs ai per acre if heavy weeds are present) can be used on the additional conifer species - Japanese black pine, white spruce, Norway spruce, Colorado blue spruce, balsam fir, eastern red cedar and Rocky Mountain juniper. Japanese larch is the only conifer tested that could not tolerate glyphosate at any rate during any month of application. Conifer species are more tolerant of glyphosate in late summer or fall and during cool temperature periods. Glyphosate should not be tank mixed with oxyfluorfen or bifenox and applied over the top of conifer seedlings. Glyphosate tank mixed with oxyfluorfen or bifenox seems to produce a synergistic effect on each other and can cause severe

injury to the seedlings that are normally tolerant to either product when used separately. Hot weather can also cause a greater phytotoxic effect by glyphosate on conifers. Glyphosate should not be applied during extemely hot weather in the summer months.

SUMMARY

There have been numerous trials, studies and tests of various herbicides at many different nurseries that have demonstrated the safe and effective use of dcpa, napropamide, oxyfluorfen, diphenamid, bifenox, oxadiazon, trifluralin, and prometryn on various conifer and/or hardwood first year seedling nursery beds. These herbicides have reduced the time required to hand-weed nursery beds by 80-87 percent when applied at sowing time alone or with a second application four to six weeks later. Over $4,000-$7,000 per acre of seedbed could be saved by using these herbicides over hand-weeding alone.

However, the safety and effectiveness of any herbicide should be tested at each nursery before operational use. These herbicide trials are urged because there is a strong possibility of differential results from varied interactions of different mixtures of tree and weed species, soil and climatic factors, and cultural practices at different nurseries. If a particular herbicide has never been used at your nursery, several years of trials are advisable because of variations in effects caused by different weather conditions. Trials should include "double doses" to evaluate the safety limits on crop seedlings and leave an untreated control to properly evaluate the effects of the herbicide.

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Table 1. Herbicides, rates, and application timings used in the Nursery Herbicide Studies Conducted by SUNY.

Herbicide	Formulation	Manufacturer	(lb ai/A)	Application Timing[1]		
				Pre-Seeding Incorporation or Post-Seeding	Post-Germination	Post-Seeding Plus Post-Germination
Untreated						
Diphenamid	Enide 50W; 90W	Upjohn	4.0	x	x	x
Trifluralin	Treflan 4EC	Elanco	0.75	x	-	-
DCPA	Dacthal W-75	Diamond-Shamrock	10.5	x	x	x
Prometryn	Caparol 80W	Ciba-Geigy	1.0	x	x	x
Napropamide	Devrinol 50W	Stauffer	1.5/3.0	x	x	x
Bifenox	Modown 80W; 4F	Rhone-Poulenc	3.0	x	x	x
Oxyfluorfen	Goal 2E; 1.6E	Rohm & Haas	0.5	x	x	x
Oxadiazon	Ronstar G	Rhone-Poulenc	1.0	x	x	x
Napropamide & Bifenox	Tank mix		1.0+3.0	x	x	x

[1] Pre-seeding incorporation: incorporated into top 2 inches of soil immediately before seeding.
Post-seeding: broadcast applied to soi I immediately after seeding.
Post-germination: broadcast applied to soil 4 to 5 weeks after seedling emergence.
Post-seeding plus post-germination: two separate applications at the full recommended rate.

TABLE 2: Phytotoxic effects of DCPA (Dacthal W-75) at 10.5 lbs. ai. per acre, diphenamid (Enide 50W, 90W) at 4.0 lbs. ai. per acre and different application times on conifer and hardwood first year seedling nursery beds.

DCPA (Dacthal W-75)

Species	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
White Pine	*	*	x	x	x
Red Pine	*	*	x	x	x
Jack Pine	*	*	x	x	x
Scotch Pine	*		x	x	x
White Spruce	*	*	x	x	x
Norway Spruce	*		x	x	x
Colorado Blue		*	x	x	x
Japanese Larch		*	x	x	x
White Cedar		*	x	x	x
White Ash		*	x	x	x
Black Walnut		*	x	x	x
Hard Maple		*	-	x	-
Honeysuckle		*	x	-	-
Silky Dogwood		*	x	-	-
Yellow Birch		*	-	-	-

Diphenamid (Enide 50W, 90W)

Species	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
White Pine	*	*	x	x	x
Red Pine	*	*	x	x	x
Jack Pine	*	*	x	x	x
Scotch Pine	*		x	x	x
White Spruce	*	*	x	x	x
Norway Spruce	*		x	x	x
Japanese Larch		*	x	x	x
White Cedar		*	x	x	x
Black Walnut		*	x	x	x
Hard Maple		*	x	x	x
Honeysuckle		*	o	o	o
Silky Dogwood		*	x	x	x
Yellow Birch		*	x	x	x

x = no phytotoxic effects at nurseries where tested.
o = some phytotoxic effects at one or more nurseries where tested requires additional trials before operational use.
- = severe phytotoxic effects, Do Not Use.

TABLE 3: Phytotoxic effects of oxyfluorfen (Goal 2E, 1.6E) at 0.5 lbs. ai. per acre, trifluralin (Treflan 4EC) at 0.75 lbs. ai. per acre and different application times on conifer and hardwood first year seedling nursery beds.

Oxyfluorfen (Goal 2E, 1.6E)

Species	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
White Pine	*	*	x	x	x
Red Pine	*	*	x	x	x
Jack Pine	*	*	x	x	x
Scotch Pine	*		x	x	x
White Spruce	*	*	x	x	x
Norway Spruce	*		x	x	x
Colorado Blue		*	x	x	x
Japanese Larch		*	x	x	x
White Cedar		*	-	x	-
White Ash		*	x	-	-
Black Walnut		*	x	o	o
Hard Maple		*	o	-	-
Honeysuckle		*	o	-	-
Silky Dogwood		*	-	-	-
Yellow Birch		*	-	-	-

Trifluralin (Treflan 4EC)

Species	Spring Sown	Fall Sown	Pre-Seeding Incorporation
White Pine	*		x
Scotch Pine	*		x
White Spruce	*		x
Norway Spruce	*		x
Japanese Larch		*	x
White Cedar		*	x
White Ash		*	x
Black Walnut		*	x
Hard Maple		*	o
Honeysuckle		*	x
Silky Dogwood		*	x
Yellow Birch		*	-

x = no phytotoxic effects at nurseries where tested.
o = some phytotoxic effects at one or more nurseries where tested requires additional trials before operational use.
- = severe phytotoxic effects, Do Not Use.

TABLE 4: Phytotoxic effects of oxadiazon (Ronstar 2G) at 1.0 lbs. ai. per acre, prometryn (Caparol 80W) at 1.0 lbs. ai. per acre and different application times on conifer and hardwood first year seedling nursery beds.

Oxadiazon (Ronstar 2G)

Species	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
White Pine	*	*	x	x	x
Red Pine	*	*	x	x	x
Jack Pine	*	*	x	x	x
Scotch Pine	*		x	x	x
White Spruce	*		x	x	x
White Spruce		*	o	x	o
Norway Spruce	*		x	x	x
Colorado Blue		*	x	x	x
Japanese Larch		*	x	x	x
White Cedar		*	x	x	x
White Ash		*	-	x	-
Black Walnut		*	x	x	x
Hard Maple		*	-	x	-
Honeysuckle		*		-	-
Silky Dogwood		*	-	-	-
Yellow Birch		*	-	-	-

Prometryn (Caparol 80W)

Species	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
White Pine	*	*	x	x	x
Red Pine	*	*	x	x	x
Jack Pine	*	*	x	x	x
Scotch Pine	*		x	x	x
White Spruce	*	*	x	x	x
Norway Spruce	*		x	x	x
Colorado Blue		*	x	x	x
Japanese Larch		*	x	x	x
White Ash		*	x	-	-
Hard Maple		*	x	-	-
Yellow Birch		*	x	-	-

x = no phytotoxic effects at nurseries where tested.
o = some phytotoxic effects at one or more nurseries where tested requires additional trials before operational use.
- = severe phytotoxic effects, Do Not Use.

TABLE 5: Phytotoxic effects of bifenox (Modown 4F, 80W) at 3.0 lbs. ai. per acre, napropamide plus bifenox (tank mix) at 1.0 plus 3.0 lbs. ai. per acre, respectively, and different application times on conifer and hardwood first year seedling nursery beds.

Bifenox (Modown 4F, 80W)

Species	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
White Pine	*	*	x	x	x
Red Pine	*	*	x	x	x
Jack Pine	*	*	x	x	x
Scotch Pine	*		x	x	x
White Spruce	*	*	x	x	x
Norway Spruce	*		x	x	x
Colorado Blue		*	x	x	x
Japanese Larch		*	x	x	x
White Cedar		*	-	x	-
White Ash		*	o	x	o
Black Walnut		*	x	x	x
Hard Maple		*	-	x	-
Honeysuckle		*	x	o	o
Silky Dogwood		*	-	-	-
Yellow Birch		*	-	-	-

Napropamide plus Bifenox (tankmix)

Species	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
White Pine		*	o	x	o
Red Pine	*		x	x	x
Red Pine		*	-	x	-
Jack Pine	*		x	x	x
Jack Pine		*	-	x	-
White Spruce		*	o	x	o
Colorado Blue		*	o	x	o
Hard Maple		*	-	x	-
Honeysuckle		*	x	o	o

x = no phytotoxic effects at nurseries where tested.
o = some phytotoxic effects at one or more nurseries where tested requires additional trials before operational use.
- = severe phytotoxic effects, Do Not Use.

TABLE 6: Phytotoxic effects of napropamide (Devrinol 50W) at 3.0 or 1.5 lbs. ai. per acre and different application times on conifer and hardwood first year seedling nursery beds.

Napropamide (Devrinol 50W)

Species	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
White Pine	*		x	x	x
White Pine		*	-	x	-
Red Pine	*		x	x	x
Red Pine		*	-	x	-
Jack Pine	*		x	x	x
Jack Pine		*	-	x	-
Scotch Pine	*		x	x	x
White Spruce	*		x	x	x
White Spruce		*	o	x	o
Norway Spruce	*		x	x	x
Colorado Blue		*	o	x	o
Japanese Larch		*	o	x	o
White Cedar		*	o	x	o
White Ash		*	x	x	x
Black Walnut		*	o	x	o
Honeysuckle		*	x	x	x
Silky Dogwood		*	-	x	-
Yellow Birch		*	-	x	-

x = no phytotoxic effects at nurseries where tested.
o = some phytotoxic effects at one or more nurseries where tested requires additional trials before operational use.
- = severe phytotoxic effects, Do Not Use.

TABLE 7: Phytotoxic effects of herbicides tested on first year white and Scotch pine nursery beds.

White Pine

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*	*	x	x	x
napropamide	*		x	x	x
napropamide		*	-	x	-
oxyfluorfen	*	*	x	x	x
diphenamid	*	*	x	x	x
bifenox	*	*	x	x	x
oxadiazon	*	*	x	x	x
trifluralin	*		x		
prometryn	*	*	x	x	x
napropamide & bifenox		*	o	x	o

Scotch Pine

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*		x	x	x
napropamide	*		x	x	x
oxyfluorfen	*		x	x	x
diphenamid	*		x	x	x
bifenox	*		x	x	x
oxadiazon	*		x	x	x
trifluralin	*		x		
prometryn	*		x	x	x

x = no phytotoxic effects at nurseries tested.
o = some phytotoxic effects at one or more nurseries where tested requires additional trials before operational use.
- = severe phytotoxic effects, Do Not Use.

TABLE 8: Phytotoxic effects of herbicides tested on first year red and jack pine, and Colorado blue spruce nursery beds.

Red and Jack Pine

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*	*	x	x	x
napropamide	*		x	x	x
napropamide		*	-	x	-
oxyfluorfen	*	*	x	x	x
diphenamid	*	*	x	x	x
bifenox	*	*	x	x	x
oxadiazon	*	*	x	x	x
prometryn	*	*	x	x	x
napropamide & bifenox	*		x	x	x
napropamide & bifenox		*	-	x	-

Colorado Blue Spruce

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa		*	x	x	x
napropamide		*	o	x	o
oxyfluorfen		*	x	x	x
bifenox		*	x	x	x
oxadiazon		*	x	x	x
prometryn		*	x	x	x
napropamide & bifenox		*	o	x	o

x = no phytotoxic effects at nurseries tested.
o = some phytotoxic effects at one or more nurseries where tested requires additional trials before operational use.
- = severe phytotoxic effects, Do Not Use.

TABLE 9: Phytotoxic effects of herbicides tested on first year white and Norway spruce nursery beds.

White Spruce

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*	*	x	x	x
napropamide	*		x	x	x
napropamide		*	o	x	o
oxyfluorfen	*	*	x	x	x
diphenamid	*	*	x	x	x
bifenox	*	*	x	x	x
oxadiazon	*		x	x	x
oxadiazon		*	o	x	o
trifluralin	*		x		
prometryn	*	*	x	x	x
napropamide & bifenox		*	x	x	x

Norway Spruce

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*		x	x	x
napropamide	*		x	x	x
oxyfluorfen	*		x	x	x
diphenamid	*		x	x	x
bifenox	*		x	x	x
oxadiazon	*		x	x	x
trifluralin	*		x		
prometryn	*		x	x	x

x = no phytotoxic effects at nurseries tested.
o = some phytotoxic effects at one or more nurseries where tested requires additional trials before operational use.
- = severe phytotoxic effects. Do Not Use.

TABLE 10: Phytotoxic effects of herbicides tested on first year Japanese larch and white cedar nursery beds.

Japanese Larch

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*	x	x	x	
napropamide	*	o	x	o	
oxyfluorfen	*	x	x	x	
diphenamid	*	x	x	x	
bifenox	*	x	x	x	
oxadiazon	*	x	x	x	
trifluralin	*	x			
prometryn	*	x	x	x	

White Cedar

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*	x	x	x	
napropamide	*	o	x	o	
oxyfluorfen	*	-	x	-	
diphenamid	*	x	x	x	
bifenox	*	-	x	-	
oxadiazon	*	x	x	x	
trifluralin	*	x			

x = no phytotoxic effects at nurseries tested.
o = some phytotoxic effects at one or more nurseries where teated requires additional trials before operational use.
- = severe phytotoxic effects, Do Not Use.

TABLE 11: Phytotoxic effects of herbicides tested on first year hard maple, black walnut and white ash nursery beds.

Hard Maple

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*	-	x	-
oxyfluorfen	*	o	-	-
diphenamid	*	x	x	x
bifenox	*	-	x	-
oxadiazon	*	-	x	-
trifluralin	*	o		
prometryn	*	x	-	-
napropamide & bifenox	*	-	x	-

Black Walnut

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*	x	x	x
napropamide	*	o	x	o
oxyfluorfen	*	x	o	o
diphenamid	*	x	x	x
bifenox	*	x	x	x
oxadiazon	*	x	x	x
trifluralin	*	x		

White Ash

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*	x	x	x
napropamide	*	x	x	x
oxyfluorfen	*	x	-	-
bifenox	*	o	x	o
oxadiazon	*	-	x	-
trifluralin	*	x		
prometryn	*	x	-	-

x = no phytotoxic effects at nurseries tested.
o = some phytotoxic effects at one or more nurseries where tested requires additional trials before operational use.
- = severe phytotoxic effects, Do Not Use.

TABLE 12: Phytotoxic effects of herbicides tested on first year yellow birch, honeysuckle and silky dogwood nursery beds.

Yellow Birch

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*	-	-	-	
napropamide	*	-	x	-	
oxyfluorfen	*	-	-	-	
diphenamid	*	x	x	x	
bifenox	*	-	-	-	
oxadiazon	*	-	-	-	
trifluralin	*	-			
prometryn	*	x	-	-	

Honeysuckle

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*	x	-	-	
napropamide	*	x	x	x	
oxyfluorfen	*	o	-	-	
diphenamid	*	o	o	o	
bifenox	*	x	o	o	
oxadiazon	*		-	-	
trifluralin	*	x			
napropamide & bifenox	*	x	o	o	

Silky Dogwood

Herbicide	Spring Sown	Fall Sown	Post-Seeding	Post-Germination	Post-Seeding & Germination
dcpa	*	x	-	-	
napropamide	*	-	x	-	
oxyfluorfen	*	-	-	-	
diphenamid	*	x	x	x	
bifenox	*	-	-	-	
oxadiazon	*	-	-	-	
trifluralin	*	x			

x = no phytotoxic effects at nurseries tested.
o = some phytotoxic effects at one or more nurseries where tested requires additional trials before operational use.
- = severe phytotoxic effects, Do Not Use.

TABLE 13: Nursery summary of tree species and herbicides utilized in studies at the Lake States nurseries from 1978 to 1984.

Nursery (Ownership)	Species Studied	Sown F/S	Herbicides Tested
Saratoga Nursery (State of New York)	White Pine	F	DCPA
	White Pine[1]	S	bifenox
	Scotch Pine	S	napropamide
	Norway Spruce	S	oxyfluorfen
	White spruce	S	oxadiazon
	Japanese Larch	F	prometryn
	Balsam Fir[1]	F	diphenamid[1]
			trifluralin[1]
			ethofumesate[1]
J. W. Toumey Nursery (U.S.D.A. Forest Service)	Red Pine	F&S	DCPA
	Jack Pine	F&S	oxyfluorfen
	White Spruce	F	napropamide
	Yellow Birch	F	bifenox
			trifluralin
			oxadiazon
			diphenamid
			prometryn
Wyman Nursery (State of Michigan)	Red Pine	S	DCPA
	Jack Pine	S	bifenox
			oxyfluorfen
			prometryn
			napropamide[1]
			napropamide+bifenox[1]
			ethofumesate[1]
General Andrews Nursery (State of Minnesota)	White Pine	F	DCPA
	Red Pine	F	bifenox
	Jack Pine	F	napropamide
			oxyfluorfen
			prometryn
			ethofumesate[1]
			napropamide+bifenox[1]
Badoura Nursery (State of Minnesota)	Red Pine	F	DCPA
	White Spruce	F	bifenox
	Honeysuckle	F	napropamide
			oxyfluorfen
			oxadiazon
			diphenamid
			ethofumesate[1]
			trifluralin[1]

[1] Tested only one year or less.

TABLE 13: Nursery summary, Lake States nurseries continued.

Nursery (Ownership)	Species Studied	Sown F/S	Herbicides Tested
Hayward Nursery (State of Wisconsin)	Jack Pine	F	DCPA
	White Spruce	F	oxyfluorfen
	White Ash	F	napropamide
			bifenox
			prometryn
			oxadiazon
			ethofumesate[1]
			trifluralin[1]
Wilson Nursery (State of Wisconsin)	White Cedar	F	DCPA
	Black Walnut	F	bifenox
	Silky Dogwood	F	oxyfluorfen
			diphenamid
			napropamide
			oxadiazon
			trifluralin[1]
			ethofumesate[1]
Griffith Nursery (State of Wisconsin)	White Pine	F	DCPA
	Red Pine	F	bifenox
	Hard Maple	F	prometryn
			oxyfluorfen
			diphenamid[1]
			oxadiazon[1]
			napropamide[1]
			napropamide+bifenox[1]
			trifluralin[1]
Nepco Lake Nursery (Nekoosa Papers, Inc.)	Red Pine	F	DCPA
	Jack Pine	F	bifenox
	Col. Blue Spruce	F	napropamide+bifenox
			oxyfluorfen
			oxadiazon[1]
			napropamide[1]
			prometryn[1]

[1] Tested only one year or less.

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