Forest Tree Nursery Herbicide Studies in the Northern Great Plains: Herbicide Phytotoxicity Tables

Lawrence P. Abrahamson²

Abstract.--Eight herbicides (registered for similar uses in the U.S.) were extensively evaluated at 15 forest tree nurseries in Western and Northern United States for weed control on first year seedling nursery beds. Phytotoxicity evaluations of dcpa, napropamide, oxyfluorfen, diphenamid, bifenox, oxadiazon, trifluralin and prometryn on 38 different conifer and hardwood species are presented.

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

INTRODUCTION

The USDA Forest Service developed a number of nursery herbicide projects in the United States out of a recognition of the potential benefits of herbicidal control of weeds in nursery seedbeds. This paper will concentrate on projects conducted at 15 nurseries in the Great Plains, the Lake States and in New York. The forest tree nurseries were part of the following projects. The cooperative western nursery herbicide project, initiated in 1976, was 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

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"Lawrence P. Abrahamson is a Senior Research Associate, State University of New York College of Environmental Science and Forestry, Syracuse, NY. (Abrahamson and Jares 1984). 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 threeyear 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. Postgermination treatments (Pg) were applied four to six weeks after seedling emergence, except on the fallsown species which were applied in the spring after mulch was removed and seedlings had emerged.

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 nonphytotoxic to the species tested and have reasonable weed control of weeds present at that nursery. Phytotoxicity was evaluated by using herbicidal damage ratings (Anderson 1963), seedling survival (number/foot) and height growth (cm). Dosages of 1X, 2X, and 1X + 1X of these herbicides were applied post-seeding and/or postgermination using three-foot long plots in fourfoot wide beds with a one-foot untreated buffer between plots. All treatments were installed using a randomized block design with three replications per species. Herbicide treatments were applied by small pressurized sprayer or hand shaker as was done the first year of these studies.

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 100foot test plots. The herbicides were evaluated for weed control under operational use at the 1X rate of application applied post-seeding alone, or post-seeding and post-germination. 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 completed at 15 nurseries in the Great Plains, the Lake States and New York (Abrahamson 1984). Phytotoxicity data from these nurseries is presented in Tables 2-15, listed by herbicides tested under each species. 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 postgermination 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. In the Great Plains study (Abrahamson 1981) on spring sown species the post-seeding applications were as effective as the post-seeding plus postgermination 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.

Hand weeding time at the Norman Nursery 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. Based on minimum wage of \$3.35 per hour, this would amount to an average gross saving 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 untreated seedbeds at Norman (Abrahamson 1983).

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

					Application Ti	ming ¹
Herbicide	Formulation	Manufacturer	(1b ai/A)	Pre-Seeding Incorporation or Post-Seeding	Post- Germination	Post-Seeding Plus Post-Germination
Diphenamid	Enide 50W; 90W	Upjohn	4.0	×	x	×
Trifluralin	Treflan 4EC	Elanco	0.75	x	-	-
DCPA	Dacthal W-75	Diamond-Shamrock	10.5	×	×	×
Prometryn	Caparol 80W	Ciba-Geigy	1.0	x	×	×
Nap ropami de	Devrinol 50W	Stauffer	1.5/3.0	x	×	×
Bifenox	Modown 80W; 4F	Rhone-Poulenc	3.0	×	×	x
0xyfluorfen	Goal 2E; 1.6E	Rohm & Haas	0.5	x	×	×
0xadi azon	Ronstar G	Rhone-Poulenc	1.0	×	×	×
Napropamide & Bifenox	Tank mix		1.0+3.0	×	×	×

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

¹Pre-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.

Post-seeding plus post-germination: two separate applications at the full recommended rate.

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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napropanide	*	×	×	×
oxyfluorfen	*	×	×	×
diphenemid	*	×	×	×
bifenox	•	×	×	×
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bifenox	•	0	×	0

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TABLE 5: Phytotoxic effects of herbicides tested on first year white and Norway spruce nursery beds.

White Spruce

Herbicide			Post- I		Post-Seeding
	I Sown i	Sown I	Seeding	Germination	11& Germination
depa	*	*	×	×	x
napropamide	+		x	x	x
napropamide		*	0	x	0
oxyfluorfen	*	*	×	x	x
diphenamid			×	×	×
bifenox	*	*	×	x	x
oxadiazon	*		×	x	x
oxadiazon		*	0	x	0
trifluralin	*		x		
prometryn	*	=	×	×	x
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bifenox		*	х	x	x

Norway Spruce

Herbicide		Post- I Seeding		Post-Seeding
	·	 		
depa		×	×	x
napropamide		×	×	x
oxyfluorfen		×	×	x
diphenamid	*	x	×	x
bifenox	*	×	×	x
oxadiazon	*	×	×	x
trifluralin	+	×		
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 7: Phytotoxic effects of herbicides tested on first year Japanese larch, eastern red cedar, and white cedar nursery beds.

Japanese Larch

Herbicide			Post- 1		Post-Seeding
	I Sown I	Sown I	Seedingi	Germinatio	nl& Germination
dcpa		*	×	×	×
napropamide		*	0	x	0
oxyfluorfen		*	×	×	x
diphenamid		*	×	×	×
bifenox		*	×	×	x
oxadiazon		*	×	×	x
trifluralin			x		
prometryn			x	×	x

Eastern Red Cedar

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Herbicide	ISpringi	Fall	1	Post- I	Post -	Post-Seeding
	i Sown i	Sown	١	Seedingi	Germination	al& Germination

dcpa	*	x	x	x
napropamide	*	x	x	x
oxyfluorfen	*	x	x	x
diphenamid	*	x	×	x
bifenox	*	0	×	0
oxadiazon	*	x	×	x
trifluralin	*	x		
napropamide &				
bifenox		0	x	٥

White Cedar

Herbicide					Post-Seeding
	I Sown I	Sown I	Seeding	Germination	& Germination
dcpa		*	x	x	x
napropamide		*	0	×	0
oxyfluorfen		*	-	x	-
diphenamid		#	×	×	×
bifenox		#	-	×	-
oxadiazon		#	×	x	×
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 8: Phytotoxic effects of herbicides tested on first year caragana, Russian olive, and black locust nursery beds.

Caragana

TABLE 9: Phytotoxic effects of herbicides tested on first year hard and silver maple, and black walnut nursery beds.

Hard Maple

									•		
Herbicide					Post-Seeding & Germination	Herbicide			Post- Seeding		Post-Seeding
								ena tala ina data min ata ata			
dcpa	*		×	x	x	dcpa		*	-	x	-
napropamide	*		-	×	-	oxyfluorfen		*	0	-	-
oxyfluorfen	*		-	×	-	diphenamid			x	x	x
diphenamid	*		×	x	x	bifenox		*	-	x	-
bifenox	· •		-	x	-	oxadiazon		*	-	×	-
trifluralin	*		0			trifluralin		+	0		
napropamide &						prometryn		*	×	-	-
bifenox	*		-	x	-	napropamide &					
						bifenox		*	-	×	-
		Russ	ian Oliv	8							
								Silv	er Maple		
Herbicide					Post-Seeding						
	I Sown I	Sown i	Seeding	Germination	& Germination	Herbicide					Post-Seeding
depa			×	x	×						
napropamide			x	x	x	dcpa	*		-	x	-
diphenamid	*		x	x	x	napropamide	*		0	×	0
bifenox	*		-	x	-	oxyfluorfen			_		-
trifluralin	-		×			diphenamid	*		-	0	-
napropamide &						bifenox	*		-		-
bifenox	*		-	x	-	oxadiazon	*			x	
						napropamide &					
						bifenox	*		-		-
			k Locust								
Herbicide					Post-Seeding & Germination			Bla	ck Walnu	t	
						Herbicide			Post- I		IPost-Seeding
dcpa				×			I Sown I	Sown I	Seedingl	Germination	16 Germination
napropamide			×	×	x						
oxadiazon			~	x	**	dcpa		*	×	x	x
trifluralin			-	~		napropamide		*	õ	x	0
	-					oxyfluorfen		*	×	0	0
						diphenamid		*	×	x	x
	vtotovia	affacta	at nurse	ries tested.		bifenox		*	x	x	x
x = 110 pi	IT COLUXIC		ac nurse					-	~	~	

oxadiazon

trifluralin

o = some phytotoxic effects at one or more nurseries where tested, requires additional trials before operational use.

- = severe phytotoxic effects, Do Not Use.

x = no phytotoxic effects at nurseries tested.

o = some phytotoxic effects at one or more nurseries where tested, requires additional trials before operational use.

x

x

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x

- = severe phytotoxic effects, Do Not Use.

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TABLE 10: Phytotoxic effects of herbicides tested on first year cotoneaster, Siberian elm, and honeysuckle nursery beds.

Cotoneaster

TABLE 11: Phytotoxic effects of herbicides tested on first year white and green ash, and silky dogwood nursery beds.

White Ash

tested, requires additional trials before operational use.

- = severe phytotoxic effects, Do Not Use.

Cotoneaster						White HSh					
Herbicide			Post- Seeding		Post-Seeding nl& Germination	Herbicide	I Sown I	Sown	-		Post-Seeding & Germination
dcpa		*	×	×	×	dcpa		*	×	×	×
napropamide		*	0	×	0	napropamide		*	×	×	x
oxyfluorfen		*	0	-	-	oxyfluorfen		*	×	-	-
diphenamid		*	×	x	×	bifenox		*	0	x	0
bifenox		*	x	0	0	oxadiazon		*	-	x	-
oxadiazon		*		x		trifluralin		*	x		
napropamide &						prometryn		*	×	-	-
bifenox		*	0	0	0						
		Lace	bark Elm					Gr	een Ash		
Herbicide			Post- Seeding:		Post-Seeding n & Germination	Herbicide	Sown	Sown			Post-Seeding & Germination
									x	x	
dcpa	*		٥	x		dcpa napropamide			x		×
napropamide			-	×	-	diphenamid	-		×	×	×
oxyfluorfen	*				-		-		×		×
diphenamid	*			0	-	bifenox			-	×	-
bifenox	*		-	-	-	trifluralin	*		×		
oxadiazon	*			x		napropamide &					
trifluralin	*		0			bifenox	*		-	×	-
napropamide & bifenox			_								~~ ~ ~
DITENCE								Sil	ky Dogwo	od	
Honeysuckle									Post-		
Herbicide			Post- Seeding		Post-Seeding	Herbicide	I Sown I	Sown	Seeding		Post-Seeding
						depa		•	×		
dcpa			×	-	-	napropamide		*	-	x	-
napropamide			x	×	x	oxyfluorfen		*	-	-	-
oxyfluorfen			ô	-	-	diphenamid		*	x	×	×
diphenamid			0	0	0	bifenox			-	-	-
bifenox			×	0	0	oxadiazon		*	_	-	-
oxadiazon			^	-	-	trifluralin		*	x		
trifluralin		2	x	-	-				~		
napropamide &		-	~								
Hebrohewide e											
bifenox		-	×	0	0	v = n^ mh	VTOTOVIC	offort:		ries tested.	

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 euonymus, hackberry, sycamore, and choke cherry nursery beds.

TABLE 13: Phytotoxic	: effects	of he:	rbicides test	ed or	n first year
yellow birch,	American	plum,	honeylocust,	and	lilac nursery
beds.					

			Yellow Birch								
Herbicide	I Sown I	Sown I	Seeding	Germinatic	Post-Seeding on & Germination	Herbicide					Post-Seeding n & Germination
dcpa		*		 x		dcpa		*			-
napropamide		*		x		napropamide		*	-	×	-
diphenamid		*		0		oxyfluorfen		*	-	-	-
oxadiazon		*		x		diphenamid		*	x	×	x
			·····			bifenox		*	-	-	-
		Hac	:kberry			oxadiazon		*	-	-	-
						trifluralin		*	-		
Herbicide					Post-Seeding	prometryn		*	×	-	-
_								Amer	rican Plu	Im	
dcpa napropamide		*		- x	-	Wanhigida	ISpring	F=11	Post -		IPost-Seeding
diphenamid		*	0	×	0	VELDICIDE					ni& Germination
oxadiazon		*	0	x	0		1 50wii 1		- Seeding	Getwindere	nie Germinacio
		Syc	amore:			dcp a oxyfluorf e n				0	
	ISpringl	F=11-7		Poet-	Post-Seeding	oxyfluorien		*		0	
Nerbicide					nl& Germination						
								Hon	eylocust		
dcpa	*		-	0	-	Herbicide					Post-Seeding
napropamide			0	0	o		i Sown i	Sown	Seeding	Germinatio	nl& Germination
oxyfluorfen	*		-		-						
diphenamid bifenox			0	×	0	depa	-				
oxadiazon	-		-	0	-	oxyfluorfen				×	
napropazide &	-			0		ONYLIGOLIEN	-			_	
bifenox	*		_		-						
								1	Lilac		
		Chok	e Cherry								
*						Herbicide					Post-Seeding
Herbicide					Post-Seeding				-		ni& Germination
						dcpa	*			×	
dcpa		*		-	-	oxyfluorfen	*			-	-
oxyfluorfen		*		-	-						

O = some phytotoxic effects at one or more nurseries where tested, requires additional trials before operational use.

- = severe phytotoxic effects, Do Not Use.

tested, requires additional trials before operational use. - = severe phytotoxic effects, Do Not Use.

TABLE 14: Phytotoxic effects of herbicides tested on first year redbud and catalpa nursery beds. TABLE 15: Phytotoxic effects of herbicides tested on first year poplar and willow cutting nursery beds.

		Redbud			Poplar Cuttings					
Herbicide	iSpring Fal Sown Sown			Post-Seeding on & Germination	Herbicide	Spring Fall Plant Plant	Post- I Plant I	Post- Sproutin	iPost-Plant ngl& Sprouting	
dcpa	-		×		dcpa	*	×	x	×	
napropamide	*	-	×	-	napropamide	*	×	x	x	
diphenamid			0		oxyfluorfen	#	×	0	0	
oxadiazon	*		x		diphenamid		×	×	x	
trifluralin	*	0			bifenox	*	×	0	0	
Herbicide	Spring Fal	Catalpa	Post-	Post-Seeding	Willow Cuttings Herbicide (Spring) Fall (Post-) Post- (Post-Plant					
				onl& Germination		Plant Plant	Plant I		gi& Sprouting	
dcpa	•		×		dcpe		×	×	×	
napropamide	*	×	×	×	napropamide	+	0	x	0	
diphenamid	*		x		oxyfluorfen	*	×	0	0	
oxadiazon	*		×		diphenamid	*	×	x	×	
					bifenox					

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.

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.