HERBICIDE SCREENING FOR PHYTOTOXICITY IN HYBRID POPLARS, ASPEN, AND LARCH

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ABSTRACT

1. Clopyralid, imazaquin, sethoxydim, and fluazifop can all be safely applied to newly planted, actively growing poplars, aspens, and larches in Upper Michigan. None of these herbicides had adverse effects on the survival or the growth of the crop trees at the end of the first growing season in the field.
2. Prodiamine is not suitable for use as a pre-emergence herbicide in first-year hybrid poplar plantations. Three quarters of all poplar cuttings treated with this chemical died and those that survived grew poorly in relation to mechanically weeded control cuttings.
3. Unrooted cuttings of hybrid poplar treated with oxyfluorfen survive and grow as well as mechanically weeded trees in Upper Michigan.

INTRODUCTION

Weed control reduces forest stand rotation length by ensuring that crop trees have maximum access to site resources and consequently grow quickly. Shorter rotations improve financial returns from fiber producing plantations. Fast-growing taxa from the genus *Populus* and *Larix* are often used in short rotation "fiber farms." They are particularly sensitive to weed competition and, at the same time, susceptible to damage by most herbicides. Intensive production systems for these taxa currently rely to some extent on mechanical weed control, but this is costly and disrupts the root systems of the crop trees. An effective chemical weed control system for these taxa would reduce establishment costs and improve tree growth.

In order to identify an effective chemical weed control system for Populus and Larix fiber farms in our area, we must know: (1) which herbicides cause minimal damage to the crop trees, (2) which among these provide sufficient weed control, and (3) how these herbicides can be safely

Table 1. Taxa used in an herbicide screening trial for the intensive culture of wood fiber on an agricultural site near Escanaba, MI.

Taxa	Description	Source of growing stock
Aspen	*P. tremula* x *P. tremuloides* full sib hybrid, (Univ. of Minn. Aspen & Larch Genetics Coop. #XTA-T-2-96)	Michigan Dept. of Natural Resources, Brighton, MI Tree Improvement Center
European larch	*Larix decidua* Sudetan seed orchard (Univ. of Minn. Aspen & Larch Genetics Coop. #XLD-7-96)	Mead Corporation, Escanaba, MI greenhouse facility
DN-5	*P. euramericana* cv. 'Gelrica' (Dutch poplar)	Pope Soil and Water Conservation District, Western Minn. RC&D
DN-34	*P. euramericana* cv. 'Eugenei' (Carolina poplar)	Hramor Nursery, Manistee, MI
NE-222	*P. deltoides* x *P. nigra* var. *caudina*	Pope Soil and Water Conservation District, Western Minn. RC&D
NM-6	*P. nigra* x *P. maximowiczii*	Pope Soil and Water Conservation District, Western Minn. RC&D

applied. The objective of the trials described here was to determine if any of six commercial herbicides were safe to use on several taxa selected for fiber production at our site. We did not intend to fully screen the effectiveness of the herbicides on various weed species nor did we intend to explore the full range of application timing in these trials.

Two herbicides were applied to newly planted, dormant hybrid poplar cuttings (the "Dormant Crop Application Trial") and four herbicides were applied to actively growing seedlings of poplars, aspen, and larch (the "Active Crop Application Trial"). We assessed growth of the trees and weed control in the test plots after three months.

METHODS

Both the Active Crop and Dormant Crop Application Trials were conducted at Michigan State University's Upper Peninsula Tree Improvement Center, near Escanaba, Michigan. Soils at the test site are Onaway fine sandy loams. The field where the tests were conducted is level and had been used for hay production for many years. The sod was killed with two applications of glyphosate during the spring of 1997 and the area was plowed and cultivated repeatedly during the summer and fall of 1997. The site was surrounded by a 2.4m-tall electric fence that protected the trees from browsing deer.

The region where this study was conducted has growing seasons that are short (about 140 frost-free days), cool (average daily temperatures of about 20^{o}C), and moist (about 8cm of rainfall each month). The year of the study (1998) was exceptionally dry during the early part of the growing season. It was necessary to irrigate the trees in the Active Crop Application Trial to prevent their death.

Active Crop Application Trial. Cuttings and seedlings were planted on May 8th and 11th, 1998. Hybrid poplars were all planted as 25cm unrooted cuttings, the larch were small container-grown seedlings, and the aspen were large bare-root seedlings (Table 1). The plantation was installed as

Table 2. Herbicides and rates of application used in an herbicide screening trial for intensive culture of wood fiber on an agricultural site near Escanaba, MI.

Chemical Name	Weed Spectrum	Timing	Rates (ai/ha)	
			High	Low
Active Crop Application Trial				
clopyralid	Narrow	Post-emergence	280 g	140 g
imazaquin	Moderate	Pre- or Post-emergence	280 g	140 g
sethoxydim	Grasses	Post-emergence	426 g	213 g
fluazifop	Grasses	Post-emergence	426 g	213 g
Dormant Crop Application Trial				
oxyfluorfen	Moderate	Pre- or Post-emergence	2.24 kg	1.12 kg
prodiamine	Broad	Post-emergence	1.46 kg	0.73 kg

Table 3. Average height, diameter, and survival of taxa, 85 days after 9 herbicide treatments were applied over **actively growing trees** near Escanaba, MI in 1998.

Taxa	Height (cm)	Basal Diameter (mm)	Survival (%)
Aspen	74	13	92
NM-6	54	6	80
DN-5	45	6	74
NE-222	42	5	66
Larch	40	5	59
DN-34	36	5	49
LSD (p= 0.05)	***8***	***1***	***13***

Table 4. Average height, diameter, and survival within herbicide treatment plots, 85 days after herbicides were sprayed over **actively growing trees** of 6 taxa near Escanaba, MI in 1998.

Herbicide	Rate (g *ai/ha)*	Height (cm)	Basal Diameter (mm)	Survival (%)
Mechanically weeded control		75	13	84
fluazifop	426	45	6	63
	213	44	6	60
sethoxydim	426	46	6	69
	213	43	6	71
imazaquin	280	45	6	67
	140	44	6	68
clopyralid	280	47	6	72
	140	47	6	74
LSD (p= 0.05)		***22***	***3***	***No difference***

a split-plot randomized block design with three blocks. Herbicide treatments were applied in the main plots and different taxa were planted in the sub-plots in random order. Each main plot was a row 18.3m in length made up of six sub-plots. Each sub-plot contained five trees planted 0.6m apart.

Because of unusual drought conditions, the trees were immediately hand-watered with 4.5 liters/tree. They were watered a second time with 3.4 liters/tree on May 29th. Rains finally came on May 30th and although rainfall remained below average for the rest of the growing season no further irrigation was done.

Herbicides were applied when all taxa had produced at least 8cm of new growth. This occurred on June 17, 1998. Herbicides were applied at the rates indicated in Table 2 using an air pressurized, tractor-mounted boom spray rig designed for small plot work. All herbicides were mixed and applied with the equivalent of 113 liters of water per acre. A 1.2m-wide strip (centered over the row of trees) was sprayed over the actively growing trees. One main plot received no chemical application but was mechanically weeded throughout the growing season to serve as a control. Total height, basal diameter, and survival of all trees was measured on September 10, 1998. These data were analyzed using standard analysis of variance procedures. Weed growth in each sub-plot was recorded at the end of the growing season; noting the proportion of ground that was weed-free or covered by grasses or broadleaves.

Dormant Crop Application Trial. Unrooted cuttings of the four poplar clones (Table 1) were planted on June 11, 1998 in an area adjacent to the Active Crop Application Trial. Aspen and

Table 5. Average height, diameter, and survival of taxa, 90 days after 5 herbicide treatments were applied over **dormant cuttings** near Escanaba, MI in 1998.

Taxa	Height (cm)	Basal Diameter (mm)	Survival (%)
NM-6	45	6	58
DN-34	36	5	66
NE-222	34	5	56
DN-5	28	4	54
No significant differences			

Table 6. Average height, diameter, and survival within herbicide treatment plots, 90 days after herbicides were sprayed over **dormant cuttings** of 4 taxa near Escanaba, MI in 1998.

Herbicide	Rate (*kg ai/ha)*	Height (cm)	Basal Diameter (mm)	Survival (%)
Mechanically weeded control		52	7	80
oxyfluorfen	2.24	46	6	88
	1.12	45	6	72
prodiamine	1.46	18	2	25
	0.73	16	2	25
LSD (p= 0.05)		***34***	***5***	***53***

larch seedlings were not included in this trial because the stock was no longer dormant at the time of planting. The plantation was installed in a split-plot randomized block design with two blocks. Herbicide treatments were applied in the main plots and different taxa were planted in the sub-plots in random order. Each main plot was a row 12.2m in length made up of four sub-plots. Each sub-plot contained five trees planted 0.6m apart.

Rain had fallen prior to this plantation's establishment and so no irrigation was necessary in this planting. Rainfall remained below average, however, during the remainder of the growing season.

Herbicides were applied on the day after planting (June 12, 1998), while the cuttings were still dormant. Herbicides were applied at the rates indicated in Table 2 using the same procedure described above for the Active Crop Application Trial. A mechanically weeded control plot was included in each block, as before. Total height, basal diameter (just above ground line), and survival of all trees was measured on September 10, 1998. These data were analyzed using standard analysis of variance procedures. Weed growth in each sub-plot was recorded at the end of the growing season; noting the proportion of ground that was weed-free or covered by grasses or broadleaves.

RESULTS AND DISCUSSION

Active Crop Application Trial. Taxa differed in height, basal diameter, and survival (Table 3). Aspen was the largest of all taxa but this may be due to the fact that they began as large seedlings rather than cuttings. Of the hybrid poplars, NM-6 and DN-5 grew largest. DN-34 consistently ranked last among all taxa for height, basal diameter, and survival. Perhaps this clone is not as well suited to these growing conditions or perhaps the cuttings were not as healthy as the others

Table 7: Groundcover in herbicide screening trial plots 90 days after treatment near Escanaba, MI in 1998.

		Percent of ground covered (%)		
Herbicide	**Rate** *ai/ha*	**Grasses & sedges**	**Broadleaf species**	**Weed-free**
Dormant Crop Application				
oxyfluorfen	2.24 kg	14	74	12
	1.12 kg	14	66	20
prodiamine	1.46 kg	18	82	0
	0.73 kg	12	88	0
Active Crop Application				
clopyralid	280 g	44	51	5
	140 g	43	52	5
imazaquin	280 g	35	64	1
	140 g	13	84	3
Grass herbicides				
sethoxydim	426 g	11	These plots were scored for the amount of grass cover only.	
	213 g	13		
fluazifop	426 g	5		
	213 g	6		

used in this test (they were produced at a different nursery and shipped in a different way than the other poplar cuttings used).
There were no significant differences in survival among the herbicide treatments (Table 4). This suggests that these taxa are tolerant to these chemicals at the rates applied here. Mechanically weeded trees (control) grew significantly taller and larger in basal diameter than the other trees in the test, but there were no significant growth differences among the chemically treated trees. Better growth of control plot trees was probably due to superior weed control in these plots. Weeds had invaded all of the herbicide-treated plots by the middle of the growing season but the control plots were generally weed-free because of the regular hand weeding. Weed competition coupled with the dry growing season, undoubtedly put trees in the weedy, treated plots under moisture stress, and reduced their growth.

Dormant Crop Application Trial. No significant differences existed among taxa in this trial for any of the measured characteristics (Table 5) but significant differences between herbicide treatments did develop. All trees treated with oxyfluorfen grew equally as well as those that were mechanically weeded. Netzer *et. al*. (1998) reported favorable results on several poplar taxa using 1.4 kg ai/ha of oxyfluorfen in Minnesota. This trial demonstrates that oxyfluorfen is also safe for NE-222 (which they did not test) and at rates up to 2.24 kg ai/ha.

Only 25% of the trees in plots treated with prodiamine survived and these were severely stunted (Table 6). Prodiamine is not safe to use on these taxa at the rates used in this trial.

Weed Control In Both Trials. None of the herbicide treatments tested in this trial provided season-long control (Table 7). Clopyralid is a fairly narrow spectrum herbicide, notably used for thistle control, and so was not expected to maintain complete weed control by itself. Netzer, *et. al*. (1997) cautions that NM-6 may respond negatively to rates of clopyralid as high as those used here. Although we did not see this in our test, care should be exercised when choosing higher

rates. The two grass herbicides (sethoxydim and fluazifop) were effective at excluding grasses but, as expected, other weeds were able to invade.

Imazaquin is a broad-spectrum herbicide when used in pre-emergence applications. Its activity is obviously reduced when used, as a post-emergence treatment. Multiple applications throughout the season have proven to be more effective than the single application used here (Quicke, *et. al.*, 1999).

Neither oxyfluorfen nor prodiamine, as applied in this test, provided acceptable, season-long weed control on this site. However, oxyfluorfen did maintain adequate control for the first half of the growing season. Higher application rates may have produced longer-lasting weed control but phototoxicity would have to be retested before making this recommendation.

Michigan State University makes no endorsement or guarantee of the herbicides referred to in this publication.

LITERATURE CITED

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