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Imazaquin And Pendimethalin Provide Safe And Effective Weed Control In 1st-Year Hybrid Poplar Plantations In Michigan.

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ABSTRACT

Two hybrid poplar taxa treated with combinations of imazaquin and pendimethalin grew significantly taller after one growing season than untreated controls. Test plantations were located in both Upper and Lower Michigan. Herbicides were applied to cultivated, bare soil immediately after planting and before growth of the crop began. Weed control was acceptable for all treatments and improved with increasing application rates. Broadleaf weeds (principally common lambsquarters, velvetleaf, and Canada thistle) and grasses (principally giant foxtail and witchgrass) became established following application. No phytotoxicity was observed and no interaction between clones and chemical treatment was detected.

INTRODUCTION

Poplar fiber, used in paper and oriented strand board, is the eighth most valuable agricultural crop in Michigan (Miller, 1998). The amount of harvestable aspen has been declining throughout the Lake States, and this has resulted in increasing costs to the industries that use this fiber. Shortages are expected to continue for several more decades (Potter-Witter and Ramm, 1992). Efforts are now underway in the upper Lake States to develop alternative sources of this fiber. Work is concentrating on developing effective short-rotation production systems for hybrid poplars on abandoned farmland. The Michigan Department of Agriculture reports that there are more than 500,000 acres of abandoned farmland in Upper Michigan alone.

Efficient and effective weed control in these “fiber farms” is widely recognized as a prerequisite for maximizing productivity. Devising these controls can be difficult due to: (1) the limited number of chemicals labeled for this use, (2) the site specificity of some chemicals (Netzer, *et. al*., 1998), and (3) occasional interactions between chemicals and certain taxa (Netzer, *et. al*., 1997; Netzer *et. al*., 1996). Two herbicides (imazaquin and pendimethalin) have recently been added to the arsenal of chemicals available for use in poplar plantations. Preliminary tests demonstrate that they are effective and safe when used in combination on weed-free sites immediately after planting, while cuttings are still dormant.

Imazaquin can be safely applied to hybrid poplar before planting or after planting as a preemergence, or postemergence treatment (Quicke, 1998). When used alone it controls weeds best if applied several times over the course of the growing season (Quicke, *et. al*., 1999). Imazaquin is taken up by plants through either the roots or foliage and is translocated in the

xylem. The chemical inhibits synthesis of certain amino acid and may disrupt photosynthate translocation. Resistance may depend on a plant's ability to metabolize the compound to non-mobile products. (Ahrens, 1994).

Pendimethalin in combination with Imazaquin is phytotoxic when applied to actively growing poplar (Quicke and Hoien, 1997; Quicke *et. al*., 1997) but can be safely applied over dormant poplars (Quicke *et. al.*, 1998). It is not effective in eliminating established weeds and is best applied to bare ground or in mixture with a broad-spectrum, knockdown herbicide (Quicke *et. al.*, 1999). Pendimethalin is absorbed by plant roots and coleoptiles and is not readily translocated. Root development is inhibited in established plants and new seeds in the soil fail to emerge. Resistance may be due to oxidation of the compound or to root protein changes that prevent the chemical from binding (Ahrens, 1994).

American Cyanamid Company manufactures both chemicals. Imazaquin is labeled for use in poplar plantings as Scepter® 70 DG (dispersible granules with 70% active ingredient by weight). Pendimethalin is labeled for use in poplar plantings as Pendulum® 3.3 EC (emulsifiable concentrate with 3.3 pounds of active ingredient per gallon). A mixture of both chemicals is also labeled for use with poplar and is available as Squadron® (an emulsifiable concentrate with 2 pounds ai of pendimethalin and 0.33 pounds ai of imazaquin per gallon).

We applied several combinations of imazaquin and pendimethalin to new hybrid poplar plantings at two sites in Michigan and examined crop and weed response after one growing season. This paper summarizes the results of those trials.

MATERIALS AND METHODS

Two sites were selected for the trials; one in Michigan's Lower Peninsula near Lansing and the other in Michigan's Upper Peninsula near Escanaba. Both sites had previously been used for agriculture. The Lansing area has an average of 150 frost-free growing days each year. Soil at the test site is a sandy clay loam and had previously been used for corn production. The Escanaba area has approximately 140 frost-free growing days each year. Soil at this site is a fine sandy loam and had previously been used for hay production. Both sites received 7 to 10cm of rainfall each month during the 1999 growing season.

Because the Lansing site had been under cultivation for several years, it only required tilling to prepare it for planting. Sod covering the Escanaba site was eliminated by spraying with glyphosate in April of 1999 and rototilling two weeks later. Both sites were devoid of vegetation at the time of planting. The Lansing site was planted on 5/4/99 and the Escanaba site was planted one week later on 5/12/99. 25cm-long unrooted cuttings of DN-34 (*Populus euramericnana* cv. Eugenei [Carolina poplar]) and NM-6 (*P. nigra* x *P. maximowiczii*) were hand planted in a split-plot randomized block design with four blocks. Each block consisted of 10 planting rows, spaced 3m apart, forming the main plots. Ten cuttings of each taxa were grouped at either end of each row, spaced 1.2m apart, to form the sub-plots.

Herbicide treatments were applied the day after planting, before the cuttings began to grow. A small-plot, tractor-mounted, boom sprayer was used to apply 1.2m-wide bands of herbicide over each treated row. Mechanically weeded rows were kept free of weeds using a combination of hand weeding and rototilling every 30 days. Untreated plots received no weed control at all (Table 1).

Browsing from white-tailed deer was observed at both sites after about 30 days. Electric fences were subsequently erected to exclude the deer from the test areas. Deer damage was negligible for the remainder of the growing season.

Total height of all trees was measured every 30 days throughout the season. An ocular estimate of the proportion of weed-free ground, grass-covered ground, and broadleaf weed-covered ground was made every 30 days for the first 90 days. The principle weed species on both sites were identified at the end of the growing season. Diameter of all poplar stems, at 0.3m above the ground, was recorded after 120 days. Diameter was not measured on trees that were shorter than 0.3m. Growth data were analyzed using standard analysis of variance techniques at the end of the growing season. The LSD was used to separate means.

RESULTS AND DISCUSSION

Results were consistent across both sites. Trees (and weeds) grew larger in Lansing than in Escanaba, probably due to the higher night-time temperatures at the southern site. Survival was exceptionally high at both sites. Most plots had 100% survival and the poorest plots had 92% survival. No herbicide damage to the poplars was noticed.

Height differences among weed control treatments became statistically significant after 90 days in Escanaba and after 120 days in Lansing, although the rankings had become fairly well established in Lansing after 90 days. Specific growth trends among chemical treatments are difficult to discern after the first year but some general trends emerged. Trees in all treated plots grew substantially taller and larger in diameter than those in the untreated (control) plots (Tables 2 and 3). The better plots in Escanaba were 50% taller than untreated control plots (Figure 1) while in Lansing the better plots were 33% taller than the untreated controls (Figure 2).

Growth of poplar in chemically treated plots was never less than that of mechanically weeded plots. Height growth of poplar in four herbicide treatments at the Lansing site actually exceeded that of mechanically weeded trees. Avoiding mechanical weed control can drastically reduce the cost of plantation maintenance and reduce the amount of site disturbance from equipment.

No single herbicide treatment stands out as the best for controlling weeds (Tables 4 and 5). When weed control data are averaged over plots, however, some general trends emerge that are consistent at both sites. All herbicide treatments that included pendimethalin provided acceptable weed control during the first growing season (keeping well over 50% of the ground completely weed-free). Increasing levels of imazaquin improved weed control, particularly of broadleaf species (Figure 3) and increasing levels of pendimethalin also improved weed control, particularly of grass species (Figure 4). Broadly speaking, higher levels of both chemicals in combination improved weed control. Although this trend was not reflected in first-year growth data, we expect that lower weed populations at the end of the first growing season in the high chemical plots will provide an advantage to those trees during the second growing season.

No significant interactions were detected between taxa and weed control treatments. Thus the same herbicide prescription can be used in plantations of either taxa without fear of adverse reaction.

Both sites were nearly weed-free for the first 60 days but several weed species did eventually invade the treated plots. The principal broadleaf weed invaders at Escanaba were Canada thistle (*Cirsium arvense* L.), tumble pigweed (*Amaranthus cannabinum* L.), and curley dock (*Rumex crispus* L.). Lansing broadleaf weed species included velvetleaf (*Abutilon theophrasti* Medic.) and common lambsquarters (*Chenopodium album* L.). The most common grass at Escanaba was witchgrass (*Panicum capillare* L.) and at Lansing was giant foxtail (*Sataria feberi* Herrm.). Most of these weeds, with the exception of Canada thistle, probably could have been controlled with a postemergence application of imazaquin.

Height differences between the two taxa became apparent after 30 days in Lansing but did not appear until after 90 days in Escanaba. By the end of the growing season NM-6 had grown significantly taller and larger in diameter than DN-34 at both sites. On average NM-6 was 16% taller than DN-34 in Escanaba and 30% taller in Lansing. This is irrelevant when comparing weed control treatments but is useful information for selecting taxa to use in Michigan fiber farms. Using both the better growing taxa *and* the best weed control treatment can produce startling improvements in yield. Research to identify both the best taxa and optimal weed control systems for Michigan poplar plantations continues.

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

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Table 1. Weed control treatments applied to dormant hybrid poplar plantations in 1999 at Escanaba, MI and Lansing, MI.

Treatment Abbreviation*	Imazaquin applied (g ai / hectare)	Pendimethalin applied (Kg ai / hectare)
Control	No weed treatment applied	
Mechanical	Mechanically weeded every 30 days	
S1P0	140	0.0
S1P1	140	0.84
S1P2	140	1.68
S1P4	140	3.36
S2P0	280	0.0
S2P1	280	0.84
S2P2	280	1.68
S2P4	280	3.36

* -- The "S" in the abbreviation stands for imazaquin and the "P" stands for pendimethalin. "1" represents the base rate while "2" represents twice the base rate and "4" represents four times the base rate.

Table 2. Height and diameter growth of poplars in **Escanaba, MI** under 10 herbicide treatments. Treatment means (averaged across taxa and blocks) are ranked from smallest to largest and the **L**east **S**ignificant **D**ifference between means is included (ns = not significantly different).

Height (cm)								**Diameter (mm)**	
30-days		*60-days*		*90-days*		*120-days*		*120-days*	
Treatment*	Ht	Treatment*	Ht	Treatment*	Ht	Treatment*	Ht	Treatment*	Diam
S2P2	13	S2P2	27	Control	55	Control	59	Control	4
S1P1	15	Control	27	S2P2	72	S2P2	105	S2P2	9
S2P1	15	S2P0	28	S2P0	80	S2P0	116	S1P0	9
S2P0	15	S2P4	29	S2P4	83	S1P0	119	S2P0	9
S1P4	15	S1P1	30	S2P1	84	S2P1	119	S2P1	10
S2P4	15	S1P0	30	S1P0	86	S1P1	121	S2P4	10
Control	16	Mechanical	30	Mechanical	86	S2P4	122	S1P1	10
S1P0	16	S1P4	31	S1P1	87	Mechanical	127	Mechanical	11
Mechanical	16	S2P1	32	S1P4	90	S1P2	128	S1P2	11
S1P2	17	S1P2	32	S1P2	93	S1P4	129	S1P4	12
LSD	**-ns-**	**LSD**	**-ns-**	**LSD**	**17**	**LSD**	**26**	**LSD**	**3**

* -- See Table 1 for a description of the treatments applied.

Table 3. Height and diameter growth of poplars in **Lansing, MI** under 10 herbicide treatments. Treatment means (averaged across taxa and blocks) are ranked from smallest to largest and the **L**east **S**ignificant **D**ifference between means is included
(ns = not significantly different).

Height (cm)								**Diameter (mm)**	
30-days		*60-days*		*90-days*		*120-days*		*120-days*	
Treatment*	Ht	Treatment*	Ht	Treatment*	Ht	Treatment*	Ht	Treatment*	Diam
S1P1	14	Control	56	Control	117	Control	139	Control	10
S2P0	14	S2P1	58	S2P1	133	S1P0	173	S1P0	14
S2P1	14	S2P4	61	S1P0	138	S1P1	182	S1P1	15
S2P4	16	S1P4	63	S1P1	140	S2P1	189	S2P1	16
S1P2	16	S1P1	63	S2P4	142	S1P2	199	S1P4	17
S1P4	16	S1P2	63	S1P2	143	S1P4	199	S1P2	17
Mechanical	16	S2P2	63	S1P4	143	S2P4	207	S2P4	20
S2P2	17	S1P0	64	S2P0	148	S2P0	216	S2P2	21
Control	17	S2P0	64	Mechanical	148	S2P2	218	S2P0	21
S1P0	17	Mechanical	64	S2P2	149	Mechanical	231	Mechanical	24
LSD	**-ns-**	**LSD**	**-ns-**	**LSD**	**-ns-**	**LSD**	**27**	**LSD**	**4**

* – See Table 1 for a description of the treatments applied.

Table 4. Weed control during the first growing season in a poplar planting at **Escanaba, MI** treated with combinations of imazaquin and pendimethalin.

Treatment*	Weed-free			Broadleaves			Grasses		
	Days after treatment			*Days after treatment*			*Days after treatment*		
	30	60	90	30	60	90	30	60	90
	% cover			*% cover*			*% cover*		
Control	59	4	0	5	33	5	36	63	95
Mechanical	100	100	100	0	0	0	0	0	0
S1P0	97	83	7	0	11	13	3	6	80
S1P1	99	93	42	1	5	28	0	2	30
S1P2	100	97	41	0	2	16	0	1	43
S1P4	100	98	71	0	1	5	0	1	24
S2P0	100	98	57	0	1	13	0	1	30
S2P1	100	98	71	0	1	9	0	1	20
S2P2	100	98	85	0	1	11	0	1	4
S2P4	100	100	90	0	0	1	0	0	9

* -- See Table 1 for a description of the treatments applied.

Table 5. Weed control during the first growing season in a poplar planting at **Lansing, MI** treated with combinations of imazaquin and pendimethalin.

Treatment*	Weed-free			Broadleaves			Grasses		
	Days after treatment			*Days after treatment*			*Days after treatment*		
	30	60	90	30	60	90	30	60	90
	% cover			*% cover*			*% cover*		
Control	82	18	5	9	51	55	9	31	40
Mechanical	100	100	100	0	0	0	0	0	0
S1P0	94	59	45	4	35	45	2	6	10
S1P1	92	68	43	4	20	40	4	12	17
S1P2	93	76	50	3	14	29	4	10	21
S1P4	94	85	60	4	8	22	2	7	18
S2P0	94	85	65	3	9	24	3	6	11
S2P1	97	71	61	2	23	31	1	6	8
S2P2	97	90	75	1	7	19	2	3	6
S2P4	98	93	80	1	5	15	1	2	5

* -- See Table 1 for a description of the treatments applied.

Figure 1. Height growth of poplar at Escanaba

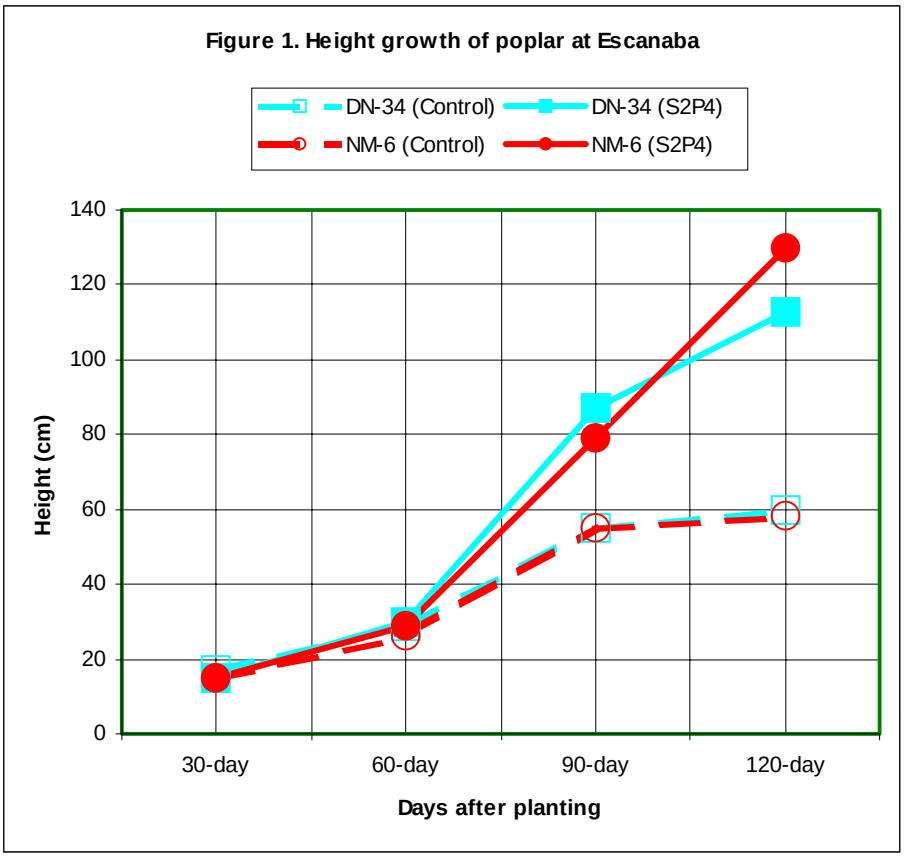


Figure 2. Height growth of poplar at Lansing

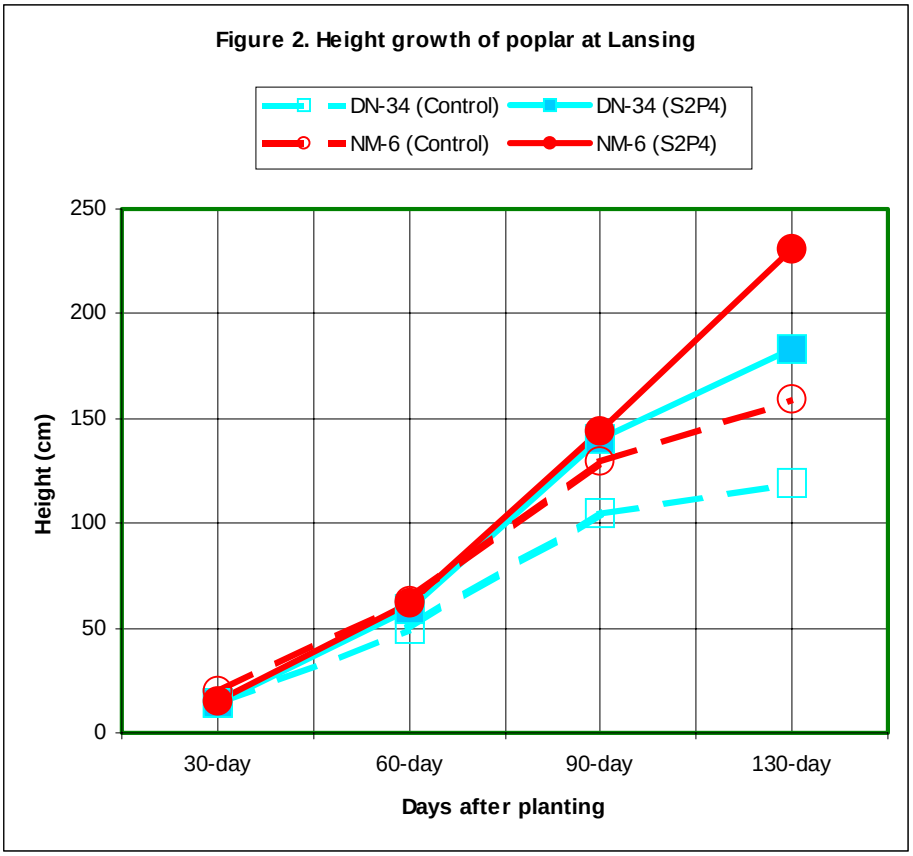
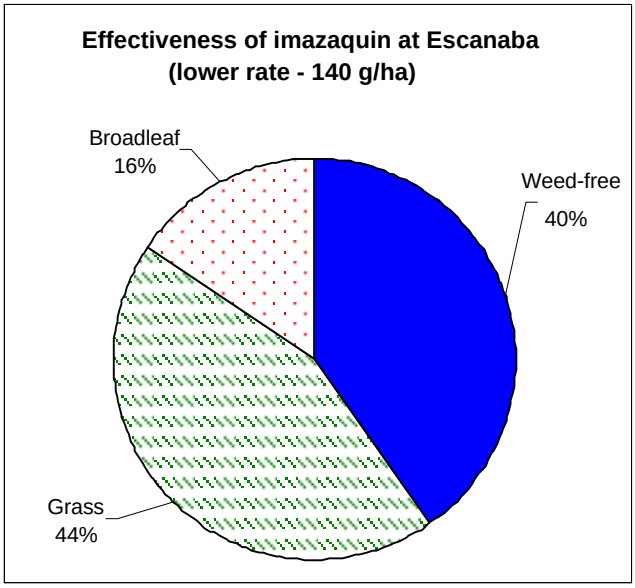


Figure 3. Weed control after 90-days increases with increasing levels of imazaquin as observed in a trial plantation at Escanaba, MI.



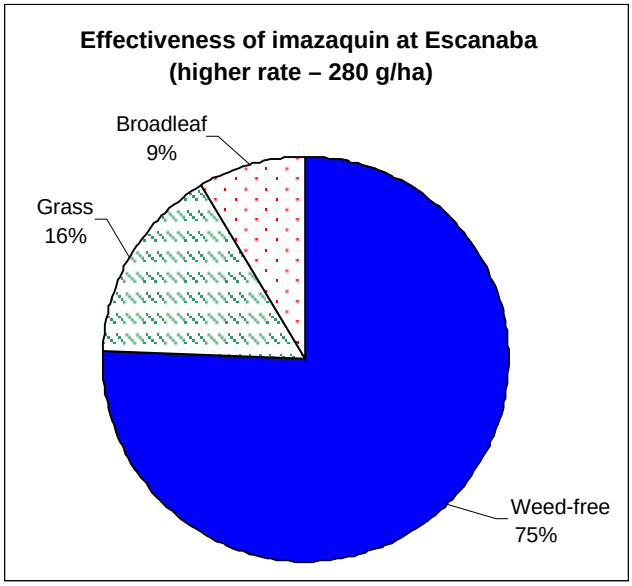


Figure 4. Weed control after 90-days increases with increasing levels of pendimethalin as observed in a trial plantation at Escanaba, MI.