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Imazaquin, Imazapic and Pendimethalin for Weed Control in hybrid Poplar: The 1998 Clatskanie, Oregon Study

Harry Quicke, Ernie Hoien and Lew Beaudrot

EXECUTIVE SUMMARY

This study was established in a high rainfall area of northwestern Oregon to test hybrid poplar tolerance to SCEPTER® 70 DG herbicide (imazaquin) applied prior to planting crop trees and at different stages of tree development. Secondary objectives included testing imazapic as a preplant or prebud-break treatment and SCEPTER + PENDULUM® 3.3 EC herbicide (pendimethalin) as a stand-alone prebudbreak treatment.

• SCEPTER provided excellent selectivity in hybrid poplar when used in the tree row prior to planting and over the top after planting at three timings, including prebud-break, after first shoot development and midseason on actively growing trees.

• All sequential applications of SCEPTER following a preplant application of SCEPTER + ROUNDUP® (glyphosate), improved weed control and increased hybrid poplar growth over the preplant treatment alone.

• Sequential applications of SCEPTER following a preplant application of OUST® (sulfometuron) + ROUNDUP did not improve tree growth, even though the sequential applications slightly improved weed control.

• Following mechanical site preparation in the fall, winter weed development was substantial. Weeds were grazed by geese during the winter, thereby reducing the above ground foliage through which herbicides could be absorbed. Under these conditions SCEPTER + PENDULUM + surfactant did not work as a stand-alone postplant treatment due to poor weed control. Also, imazapic at rates as high as 0.4 lb ae/acre did not provide adequate weed control as a standalone preplant or prebud-break treatment.

INTRODUCTION

The greatest emphasis in research and commercial scale development of high production hardwood fiber farms in the USA has been with hybrid poplar. Effective weed control is essential to ensure the survival and maximum growth of newly planted hybrid poplar. The use of mechanical cultivation to control weeds has limitations: tree roots and above ground portions may be damaged, cultivation must be repeated several times during the growing season, inclement weather sometimes prevents timely cultivation, and on cutover sites, extensive land clearing is required. One-way cultivation leaves a band of weeds within the row. Two-way cultivation alleviates some of the problem, but trees must be planted on a perfect grid pattern and some weeds will still be left at the base of the tree. On irrigated or bedded sites, two-way cultivation may not be feasible.

The study was established in a high rainfall area of northwestern Oregon. A 1997 study on a nearby site indicated that hybrid poplar was tolerant to SCEPTER applied over the top soon after leafout (Quicke and Hoien, 1997). Even at the highest SCEPTER rate tested of 1.6 lb ae/acre (over sixfold more than the currently labeled maximum use rate of 0.25 lb ae/acre) minimal damage was recorded. Imazapic applied after leafout caused extensive tree injury and mortality.

The 1998 study was installed to test hybrid poplar tolerance to SCEPTER, applied prior to planting and at different stages of tree development. Secondary objectives included testing imazapic as a preplant and prebud-break treatment and SCEPTER + PENDULUM as a stand-alone treatment on a site with prolific weed development at the time of application.

METHODS

The study was established in cooperation with Fort James Corporation on a second rotation hybrid poplar site that was disked in August and bedded in September 1997. Soil texture was a loam with a pH of 5.1. Following the mechanical treatments, winter weed development was prolific. Weeds present at the preplant application included fescue, perennial rye, bull thistle, Canada thistle and buttercup with an average height of 6 to 10 inches. The weeds were kept short by grazing by geese during the winter months. All treatments were applied in a 6-foot-wide band centered over the tree rows. A CO2 pressurized backpack sprayer was used to apply 18 gallons of spray solution per acre. A single hybrid poplar clone (Populus trichocarpax Populus deltoides) was planted as 12-inch cuttings on March 17, 1998.

Hybrid poplar tolerance to imazaquin applied at different stages of tree development was tested by applying 5.6 oz SCEPTER 70 DG at three different timings following a preplant treatment of SCEPTER + ROUNDUP or OUST + ROUNDUP. Preplant treatments were used to limit the interference of weeds on crop tree development prior to the later application timings. ROUNDUP was added to the preplant treatments to provide burndown of the winter weeds, while SCEPTER or OUST provided residual control of germinating weeds. SCEPTER timings included prebud-break (6 days after planting), after first sprout development and midseason on actively growing trees.

Additional treatments included:

- Imazapic applied at three different rates with the middle rate also applied in a tank mix with pendimethalin. The imazapic treatments were applied prior to planting or prebud-break (6 days after planting). A nonionic surfactant at 0.25% by volume was added to these treatments.
- High rates of SCEPTER 70 DG + PENDULUM 3.3 EC applied prebud-break (6 days after planting) as a stand-alone treatment. There are operational advantages to avoiding a preplant treatment for burndown of the prolific winter weed development. This is not, however, the optimum timing for SCEPTER in terms of weed development. SCEPTER controls the broadest spectrum when applied preemergence to weeds. A nonionic surfactant at 0.25% by volume was added to these treatments.

Experimental design was a randomized complete block with four blocks. Each treatment plot was a row of 12 measurement trees with a buffer tree on each end. Weed control, herbicide symptoms and crop injury were assessed 60, 90 and 120 days after the initial preplant treatments (DAI). Weed-free area and percent cover for grasses and broadleaf weeds was ocularly estimated. Control of dominant weed species was assessed as cover reduction in comparison to the unsprayed area between treated strips. At each assessment, the status of each tree was recorded as normal, dead, missing, showing herbicide symptoms, animal or mechanical damage or resprout from the root collar. If any herbicide symptoms or injury were present, the severity was rated as very light (1%-5%), light (6%-35%), moderate (36%-65%), severe (66%-95%) or very severe (96%-99%). Crop height and diameter were recorded on August 10 and September 25, at the end of the first growing season.

All live trees were used to calculate mean height and groundline diameter. Statistical analysis was limited to treatments that included preplant OUST + ROUNDUP or SCEPTER + ROUNDUP. Due to a misapplication on one of the treatment plots, replicate B was excluded from the statistical analysis. Analysis of variance was used with contrast statements for preplanned comparisons.

WEED CONTROL

Control of main vegetation components

The imazapic treatments did not provide adequate control of grasses or broadleaf weeds with all treatments having less than 34% weed-free area at the 120-day assessment (Table 1). The stand-alone SCEPTER + PENDULUM prebud-break treatments also did not provide adequate weed control, with grass cover decreasing and broadleaf cover increasing between the 60 and 120 day assessments.

Grass cover for all treatments that included a preplant application of ROUNDUP was <5% at all assessments. When no sequential SCEPTER treatment was applied, weed-free area on the OUST + ROUNDUP treatment decreased from 98% to 84% and that on the SCEPTER + ROUNDUP treatment decreased from 89% to 33% between the 60- and 120-day assessments. Sequential SCEPTER treatments after OUST + ROUNDUP did not have a major impact on weed development, with only a 7% to 8% increase in weed-free area at 120 days for the March 23 or June 18 applications and no change for the April 28 application. Sequential SCEPTER treatments after SCEPTER + ROUNDUP had a major impact on weed development with a 31% increase in weedfree area at 120 days for the March 23 application and over 40% increase in weed-free area for the April 28 and June 18 applications.

Individual species control
Control of individual species is presented for treatments that included a preplant treatment of ROUNDUP (Table 2). The remaining treatments did not provide good weed control and levels of individual species were greatly influenced by competition between species.

White clover (Trifolium repens)
OUST + ROUNDUP provided good control of white clover with >96% control at 120 days, even without sequential SCEPTER treatments. For SCEPTER + ROUNDUP without sequential SCEPTER treatments, control decreased from 97% to 80% between 60 and 120 days. Sequential SCEPTER treatments on April 28 or June 18 increased white clover control to 93%.

Fescue
Good control by all treatments at all assessments.

Cutleaf geranium (Geranium dissectum)
For OUST + ROUNDUP or SCEPTER + ROUNDUP with no sequential SCEPTER treatment, cutleaf geranium control was poor. Sequential applications of SCEPTER on March 23 and April 28 improved cutleaf geranium control to over 98% at the 120-day assessment. Sequential SCEPTER applications on June 18 did not improve cutleaf geranium control.

HYBRID POPLAR RESPONSE

Herbicide symptoms and mortality
Herbicide symptoms were characterized as leaf discoloration or leaf deformation (Table 3). Over 40% of trees with prebud-break treatments of imazapic at rates over 0.1 lb ae/acre showed symptoms. Preplant applications of imazapic affected fewer trees. For March or April applications of SCEPTER following preplant OUST + ROUNDUP, the number of trees affected was 21%, compared to 7% without the sequential SCEPTER treatments. For March application of SCEPTER following preplant SCEPTER + ROUNDUP, the number of trees affected was 13% compared to 7% without the sequential SCEPTER treatment. For April and June applications of SCEPTER following preplant SCEPTER + ROUNDUP, the number of affected trees was reduced to 5% and 0%, respectively.

Mortality resulted from some or all of the following: failure of cuttings to sprout, early heavy deer browsing, weed competition and herbicide phytotoxicity. March and April applications of SCEPTER following preplant OUST + ROUNDUP increased mortality over the preplant treatment alone. Sequential SCEPTER applications following preplant SCEPTER + ROUNDUP tended to reduce mortality over the preplant treatment alone.

Tree Growth
Growth on the imazapic treatments and SCEPTER + PENDULUM prebud-break treatments was suppressed due to poor weed control (Table 4). For the sequential treatments, there was an interaction between the preplant treatment and sequential treatment ($p<0.022$ — Table 5). Sequential SCEPTER applications following preplant OUST + ROUNDUP did not improve growth even though the sequential treatments slightly improved weed control ($p>0.170$). Sequential SCEPTER applications following preplant SCEPTER + ROUNDUP resulted in good growth responses ($p<0.046$). The best treatments were

preplant SCEPTER + ROUNDUP followed by sequential SCEPTER applications on April 28 or June 18. The mean height for these treatments at the end of the growing season was 5.8 feet with a groundline diameter of 0.6 inches. This represents 20% more growth than the preplant OUST + ROUNDUP treatment with no additional treatment. There was no difference between preplant OUST + ROUNDUP alone and SCEPTER + ROUNDUP alone ($p>0.178$).

CONCLUSION

SCEPTER provided excellent selectively when used on hybrid poplar at four timings including preplant, postplant prebudbreak, after first shoot development and midseason. All sequential applications of SCEPTER, following a preplant application of SCEPTER + ROUNDUP, improved weed control over the preplant treatment alone and increased hybrid poplar growth.

OUST phytotoxicity was evidenced by the fact that at the August 10 assessment, preplant OUST + ROUNDUP with no additional treatment resulted in trees about the same size as preplant SCEPTER + ROUNDUP with no additional treatment, despite the fact that weed control was substantially better for the OUST treatment. Although statistically not significant, all sequential SCEPTER applications following OUST reduced tree growth. Possible causes: (1) SCEPTER improved weed control resulting in less uptake of OUST by weeds and more available for uptake by the trees; (2) OUST and SCEPTER have the same mechanism of action and the combination may increase phytotoxicity in hybrid poplar.

SCEPTER + PENDULUM did not work as a stand-alone postplant treatment due to poor weed control. SCEPTER controls the broadest spectrum of weeds when applied preemergence to the weeds. Results indicate that preplant applications of SCEPTER + ROUNDUP are required if there is substantial weed development at the time of application. It is important to recognize that winter weed development on this sight was substantial and that control was made more difficult because weeds were grazed by geese during the winter, thereby reducing the above ground foliage through which herbicides could be absorbed.

The March 23 and April 28 applications of SCEPTER provided good control of cutleaf geranium, a species not currently on the SCEPTER label. Sequential applications on these dates resulted in close to 100% control of cutleaf geranium at all assessments. The June 18 treatment, however, did not improve cutleaf geranium control at the 120-day assessment. Visual observations indicated that SCEPTER was providing good burndown of emerged cutleaf geranium. By June 18, this species may have been too large for good control with SCEPTER, or time between the application and assessment (30 days) was insufficient to fully quantify the impact of the late sequential treatment.

REFERENCES

Quicke, H. and Hoien, E. 1997. Screening of four imidazolinones and pendimethalin for early-postemergence weed control in hybrid poplar: The 1997 Clatskanie, Oregon Study. BASF Forestry Research Report 97-07.

Table 1. Weed cover for main vegetation categories and weed-free area at 60, 90 and 120 days after the preplant treatments. Due to overlapping crowns, grass cover plus broadleaf cover plus weed-free area may add to more than 100%. Shaded areas indicate assessments made after a sequential SCEPTER Jtreatment.

	Grass and sedge cover			Broadleaf weed cover			Weed-free area		
Treatment	**60 DAI May 18**	**90 DAI Jun 18**	**120 DAI Jul 18**	**60 DAI May 18**	**90 DAI Jun 18**	**120 DAI Jul 18**	**60 DAI May 18**	**90 DAI Jun 18**	**120 DAI Jul 18**
Stand-alone treatments	..... %			..... %			..... %		
Preplant 0.1 lb ae imazapic	79	53	63	21	48	58	13	0	0
0.2 lb ae imazapic	43	38	39	23	50	68	33	13	4
0.2 lb ae imazapic + 4.8 qt PENDULUM 3.3 EC	8	20	8	20	45	78	72	32	15
0.4 lb ae imazapic	20	14	21	11	54	45	69	33	34
Prebud-break 0.1 lb ae imazapic	84	68	75	23	43	40	8	0	0
0.2 lb ae imazapic	65	58	56	15	43	54	20	3	0
0.2 lb ae imazapic + 4.8 qt PENDULUM 3.3 EC	39	49	43	16	38	56	48	14	4
0.4 lb ae imazapic	39	51	35	13	39	60	56	13	8
Prebud-break 5.6 oz SCEPTER 70 DG + 4.8 qt PENDULUM 3.3 EC	60	48	36	18	53	73	23	0	0
11.2 oz SCEPTER 70 DG + 4.8 qt PENDULUM 3.3 EC	46	41	24	16	54	80	38	8	3
Sequential treatments									
Preplant 0.75 oz OUST+ 2 qt ROUNDUP (Mar 13)									
No additional treatment	0	1	0	2	10	15	98	90	84
5.6 oz SCEPTER 70 DG prebud-break (Mar 23)	0	0	0	1	6	8	99	94	92
5.6 oz SCEPTER 70 DG first flush (Apr 28)	0	0	0	1	6	17	99	95	83
5.6 oz SCEPTER 70 DG midseason (Jun 18)	0	0	0	3	21	9	97	83	91
Preplant 5.6 oz SCEPTER 70 DG + 2 qt ROUNDUP (Mar 13)									
No additional treatment	3	3	4	8	38	67	89	58	33
5.6 oz SCEPTER 70 DG prebud-break (Mar 23)	0	1	1	3	17	35	97	82	64
5.6 oz SCEPTER 70 DG first flush (Apr 28)	0	0	0	2	11	26	98	89	74
5.6 oz SCEPTER 70 DG midseason (Jun 18)	4	2	3	8	36	23	89	63	75

DAI = Days after initial preplant application.

Table 2. Percent control with respect to unsprayed strips for the most common weed species on the study site. Shaded areas indicate assessments made after a sequential SCEPTER treatment.

	White clover			Fescue			Cutleaf geranium		
Treatment	**60 DAI May 18**	**90 DAI Jun 18**	**120 DAI Jul 18**	**60 DAI May 18**	**90 DAI Jun 18**	**120 DAI Jul 18**	**60 DAI May 18**	**90 DAI Jun 18**	**120 DAI Jul 18**
Preplant 0.75 oz OUST+ 2 qt ROUNDUP (Mar 13)									
No additional treatment	100	100	97	100	100	100	98	73	25
5.6 oz SCEPTER 70 DG prebud-break (Mar 23)	100	100	100	100	100	100	100	100	100
5.6 oz SCEPTER 70 DG first flush (Apr 28)	100	100	100	100	100	100	100	100	100
5.6 oz SCEPTER 70 DG midseason (Jun 18)	100	100	96	100	100	100	97	50	20
Preplant 5.6 oz SCEPTER 70 DG + 2 qt ROUNDUP (Mar 13)									
No additional treatment	97	83	80	97	100	98	80	17	0
5.6 oz SCEPTER 70 DG prebud-break (Mar 23)	100	89	84	100	100	100	100	100	98
5.6 oz SCEPTER 70 DG first flush (Apr 28)	100	94	93	100	100	100	93	100	100
5.6 oz SCEPTER 70 DG midseason (Jun 18)	96	53	93	98	75	100	93	0	0

DAI = Days after initial preplant application.

Table 3. Herbicide symptoms and mortality. All herbicide symptoms were characterized as leaf discoloration or leaf deformation. Mortality resulted from some or all of the following: failure of cutting to sprout, early heavy deer browsing, weed competition and herbicide phytotoxicity.

Treatment	Herbicide symptoms		Missing trees	
	Number*	Severity†	Jul 18	Sept 28
Stand-alone treatments	…%…		…%…	…%…
Preplant 0.1 lb ae imazapic	12	very light	29	38
0.2 lb ae imazapic	13	light	25	21
0.2 lb ae imazapic + 4.8 qt PENDULUM 3.3 EC	0	…	17	14
0.4 lb ae imazapic	21	very light	25	29
Prebud-break 0.1 lb ae imazapic	5	moderate	58	56
0.2 lb ae imazapic	42	light	19	23
0.2 lb ae imazapic + 4.8 qt PENDULUM 3.3 EC	54	light	27	27
0.4 lb ae imazapic	45	light	21	21
Prebud-break 5.6 oz SCEPTER 70 DG + 4.8 qt PENDULUM 3.3 EC	24	light	31	35
11.2 oz SCEPTER 70 DG + 4.8 qt PENDULUM 3.3 EC	2	light	15	23
Sequential treatments				
Preplant 0.75 oz OUST+ 2 qt ROUNDUP (Mar 13)				
No additional treatment	7	light	10	13
5.6 oz SCEPTER 70 DG prebud-break (Mar 23)	21	light	17	23
5.6 oz SCEPTER 70 DG first flush (Apr 28)	21	light	19	19
5.6 oz SCEPTER 70 DG midseason (Jun 18)	8	light	10	15
Preplant 5.6 oz SCEPTER 70 DG + 2 qt ROUNDUP (Mar 13)				
No additional treatment	7	light	14	17
5.6 oz SCEPTER 70 DG prebud-break (Mar 23)	13	light	15	15
5.6 oz SCEPTER 70 DG first flush (Apr 28)	5	light	10	10
5.6 oz SCEPTER 70 DG midseason (Jun 18)	0	…	8	8

* Number of trees showing herbicide induced symptoms expressed as a percentage of the total number of live trees.

† Severity: very light (symptoms on 1%-5% of the tree); light (symptoms on 6%-35% of the tree); moderate (symptoms on 36%-65% of the tree)

Table 4. Hybrid poplar groundline diameter and height. Size assessments were made on August 10 and September 28 at the end of the first growing season.

Treatment	Groundline diameter		Height	
	August 10	September 28	August 10	September 28
Stand-alone treatments	……inches……	……inches……	……feet……	……feet……
Preplant 0.1 lb ae imazapic	0.20	0.25	1.67	2.37
0.2 lb ae imazapic	0.17	0.21	1.39	1.90
0.2 lb ae imazapic + 4.8 qt PENDULUM 3.3 EC	0.20	0.28	1.64	2.64
0.4 lb ae imazapic	0.21	0.30	1.64	3.03
Prebud-break 0.1 lb ae imazapic	0.19	0.22	1.45	1.93
0.2 lb ae imazapic	0.18	0.24	1.52	2.28
0.2 lb ae imazapic + 4.8 qt PENDULUM 3.3 EC	0.19	0.29	1.58	2.78
0.4 lb ae imazapic	0.19	0.27	1.69	2.75
Prebud-break 5.6 oz SCEPTER 70 DG + 4.8 qt PENDULUM 3.3 EC	0.17	0.20	1.36	1.87
11.2 oz SCEPTER 70 DG + 4.8 qt PENDULUM 3.3 EC	0.22	0.31	1.90	2.90
Sequential treatments				
Preplant 0.75 oz OUST+ 2 qt ROUNDUP (Mar 13)				
No additional treatment	0.31	0.50	2.36	4.80
5.6 oz SCEPTER 70 DG prebud-break (Mar 23)	0.28	0.45	2.11	4.44
5.6 oz SCEPTER 70 DG first flush (Apr 28)	0.28	0.42	2.16	3.83
5.6 oz SCEPTER 70 DG midseason (Jun 18)	0.27	0.46	2.23	4.30
Preplant 5.6 oz SCEPTER 70 DG + 2 qt ROUNDUP (Mar 13)				
No additional treatment	0.29	0.43	2.43	4.37
5.6 oz SCEPTER 70 DG prebud-break (Mar 23)	0.34	0.54	2.93	5.38
5.6 oz SCEPTER 70 DG first flush (Apr 28)	0.39	0.60	3.20	5.75
5.6 oz SCEPTER 70 DG midseason (Jun 18)	0.36	0.59	3.10	5.93

Table 5. Statistical analysis for end-of-season groundline diameter and height assessments. Contrasts are generally considered statistically significant when p-values are less than 0.05.

Treatment numbers used to explain the contrasts below

Number	Treatment
	Preplant 0.75 oz OUST+ 2 qt ROUNDUP (Mar 13)
1	No additional treatment
2	5.6 oz SCEPTER70 DG prebud-break (Mar 23)
3	5.6 oz SCEPTER 70 DG first flush (Apr 28)
4	5.6 oz SCEPTER70 DG midseason (Jun 18)
	Preplant 5.6 oz SCEPTER 70 DG + 2 qt ROUNDUP(Mar 13)
5	No additional treatment
6	5.6 oz SCEPTER70 DG prebud-break (Mar 23)
7	5.6 oz SCEPTER 70 DG first flush (Apr 28)
8	5.6 oz SCEPTER 70 DG midseason (Jun 18)

Contrasts

	p-values	
Contrast	Diameter	Height
Does preplant treatment make a difference (1,2,3,4 vs. 5,6,7,8)?	0.042	0.027
Does sequential treatment make a difference (1,5 vs. 2,3,4,6,7,8)?	0.368	0.601
Is there an interaction between preplant treatment and sequential treatment?	0.011	0.022
Is there a difference between preplant OUST + ROUNDUPalone and preplant OUST + ROUNDUP followed by a sequential SCEPTER treatment (1 vs. 2,3,4)?	0.178	0.170
Is there a difference between preplant SCEPTER + ROUNDUP alone and preplant SCEPTER + ROUNDUP followed by a sequential SCEPTER treatment (5 vs. 6,7,8)?	0.016	0.046
Is there a difference between preplant OUST + ROUNDUPalone and SCEPTER+ ROUNDUPalone (1 vs. 5)?	0.178	0.337