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**Manning Diversified Forest Products
Research Trust Fund
MDFP 7/96
New Herbicides For Calamagrostis Control
Final Report 1996/97**

ENVIRONMENTAL PROTECTION

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New Herbicides For Calamagrostis Control
Final Report 1996/97**

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- Disclaimer -

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CONTROL OF CALAMAGROSTIS CANADENSIS

1996 FIELD RESEARCH SUMMARY

Deanna Koebernick

Introduction:

Calamagrostis canadensis (blue-joint reedgrass) is an invasive perennial rhizomatous grass that establishes rapidly in forest cut blocks and competes with tree seedlings, limiting growth potential and seedling survival. The only chemical control currently available is glyphosate, applied in the fall when spruce and pine seedlings are dormant. A herbicide screen was conducted in the greenhouse in the winter of 1995 to determine efficacy of five herbicides for the control of young explants. Herbicides tested included clethodim (Select), glyphosate (Vision), fluazifop (Venture), fenoxaprop (Puma) and sethoxydim (Poast), all of which are registered for control of grass weeds in agricultural crops. Rates used were those recommended for control of *Agropyron repens* (quackgrass) in agricultural crops and 2 and 4 times the label rate. All rates of Vision, Poast and Select gave greater than 90% control of *C. canadensis*; these herbicides were selected to be tested under field conditions.

Materials and Methods:

Two research trials were established on cut blocks approximately 60 km north west of Whitecourt, Alberta. Trial 96CAL1 was located on Block 84 which had been cleared in the winter of 1994/1995. Trial 96CAL2 was located on block 85 which was logged in the summer of 1995. Treatments included Select and Poast at 0.5, 1 and 2 times the label rate, Vision at the label rate and an untreated check (Table 1). The trial was designed as a randomized complete block with 4 replicates. Herbicide applications were made on July 30, using a back pack sprayer. In both trials the *C. canadensis* was headed out. Visual evaluations (0% is no effect and 100% is complete kill) were conducted at 14, 28 and 62 days after application.

Summary and Conclusions:

In both trials, Vision at 2136 g a.i./ha gave 100% control of *C. canadensis* 62 days after application (Table 1). Treatments of Post and Select gave less than 40% control of *C. canadensis*. In 96CAL1, control of *C. canadensis* was not more than 25% 62 days after application. In 96CAL2, Select at 180 g a.i./ha and Poast at 1000 g a.i./ha gave 38% control of *C. canadensis*. Select at 180 g a.i./ha gave significantly (SNK, 10%) better control of *C. canadensis* than Select at 45 g a.i./ha. There was no significant difference between any other of the Poast and Select treatments.

Future Research:

These trials will be evaluated in the spring and summer of 1997, to evaluate regrowth. Two additional trials will be established adjacent to these trials, with herbicide applications to take place in the early spring soon after growth of *C. canadensis* has began. This will give comparative data for an early spring application versus a late summer application. An attempt will be made to locate another site, cleared in the summer of 1996 or winter of 1996/1997. This will provide efficacy information from newly established grass on a recently cleared area.

TABLE 1: PER CENT CONTROL OF CALAMAGROSTIS CANADENSIS

96CAL1	RATE g a.i./ha	14 DAA 13-Aug-96	28 DAA 27-Aug-96	62 DAA 27-Sep-96
Poast	250	18 b	23 b	23 b
Poast	500	18 b	30 b	25 b
Poast	1000	20 b	28 b	23 b
Select	45	14 b	20 b	25 b
Select	90	13 b	20 b	23 b
Select	180	14 b	30 b	25 b
Vision	2136	85 a	95 a	100 a

96CAL2	RATE g a.i./ha	14 DAA 13-Aug-96	28 DAA 27-Aug-96	62 DAA 27-Sep-96
Poast	250	20 b	23 b	33 b
Poast	500	18 b	30 bcd	28 bc
Poast	1000	20 b	30 bcd	38 b
Select	45	18 b	25 cd	20 c
Select	90	20 b	35 b	28 bc
Select	180	18 b	33 bc	38 b
Vision	2136	68 a	94 a	100 a

Means followed by the same letter do not significantly differ ($P=0.10$, SNK)

Herbicide Screen for *Calamagrostis canadensis* Control

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INTRODUCTION

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Calamagrostis canadensis infestations can preclude successful white spruce seedling establishment in Northern Alberta (Con and Deck, 1991). *C. canadensis* occurs at low abundance in mature forest stands but this invasive perennial rhizomatous grass establishes rapidly in areas after a disturbance such as logging. It competes with *Picea glauca*, *Pinus contorta* and *Populus tremuloides* seedlings for limited resources. *C. canadensis* thatch can delay the thawing of soil in the spring by up to one month (Hogg and Lieffers, 1991), reducing productivity of tree species. Thatch under snow load may also form a physical barrier, detrimental to seedling survival. Because of its competitive nature, *C. canadensis* should be controlled before or soon after disturbance, before *C. canadensis* establishment and thatching. However, many hectares of previously disturbed or logged areas currently remain under or unstocked because of this grass.

To date, control strategies have focused on non selective herbicides (Con and Deck, 1991), and cultural, biological or mechanical control methods (Lieffers *et al*, 1993). Herbicide strategies include glyphosate applied as Vision® in the autumn when some crop trees are dormant. While glyphosate is effective in autumn, it is not an optimal time for control as the annual effects of competition and thatching have already occurred.

There are many selective grass herbicides currently registered for agricultural use on food crops. They are members of two chemical groups, the aryloxyphenoxypropionate (AOPP) and cyclohexanediones (CHD). Herbicides in these two chemical families affect the same target site, the enzyme ACCase (E.C. 6.4.1.2). This is a key enzyme in the biosynthetic pathway of fatty acids. Grasses have an ACCase enzyme which is sensitive,

while most broadleaves have an enzyme insensitive to these herbicides. Because of differences at the target site, these compounds have no effect on most broadleaves. These effective grass herbicides are foliar applied but have no residual control. Perennial weed control, therefore, depends on translocation of the herbicide and movement to distal roots and rhizomes. Additionally, the AOPP and CHD herbicides are not readily leached in soil, are broken down readily by soil microbes, are active in low doses and are not harmful to mammals.

Successful weed control integrates chemical, cultural, mechanical and biological control methods. Integrated weed management combines several control methods in a strategic approach designed to prevent weeds from becoming competitive with crop plants. It depends on prevention, rather than rescue; small scale intervention at appropriate times, rather than large scale, intrusive reactions.

The purpose of this experiment was to determine the usefulness of the AOPP and CHD herbicides as a possible component of an integrated weed management program. Selective grass herbicides are a potential tool for forest managers which could reduce *C. canadensis* infestations, leaving crop species and non target species like shrubs and forbs. During the winter of 1959/96 a greenhouse screen was conducted to identify AOPP and CHD herbicides effective on *C. canadensis* but non-toxic to crop tree species *P. glauca*, *P. contorta* and *P. tremuloides*.

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MATERIALS AND METHODS:

Plant Materials. *Calamagrostis canadensis* rhizomes were obtained from the Whitecourt area of Alberta, washed and cut into sections, each containing a bud. Rhizome sections were planted into pots (four per pot) filled with Metro-mix and maintained in a greenhouse with temperatures of 21/18 °C day/night and 18/6 hours of light/dark period, respectively. Natural light was supplemented with 16 hours of HID lamps. Plants were watered as required and fertilized biweekly with 20-20-20 Complete. Pots of *C. canadensis* were sorted so that each treatment contained a total of sixteen plants. *P.*

tremuloides, *P. glauca* and *P. contorta* seedlings were obtained from Millar Western Industries and placed into storage at -3°C. After 52 days, seedlings were planted into pots (two seedlings per pot) filled with Metro-mix and maintained in a greenhouse under the conditions previously stated. *P. tremuloides* seedlings were allowed to leaf out (65 days), then were sorted into replicates by size. The treatments were replicated three times with the exception of *P. tremuloides* which was only replicated twice due to a shortage of seedlings. The pots were sorted so that each treatment consisted of a total of eight seedlings.

Herbicide Application. Herbicide applications were made to *C. canadensis* when a majority of the plants had reached 20 cm in height. Crop trees were sprayed during a time when they were expected to be most sensitive to herbicide damage, after bud break, during rapid growth. Applications were made to *P. glauca* and *P. contorta* when seedlings were 10-40 cm tall. *P. tremuloides* were sprayed when the seedlings were 15-40 cm tall. Herbicide applications were conducted in an automated spray chamber equipped with a 8001 EVS nozzle at 300 kPa at 2.10 km hr⁻¹ delivering 100 L ha⁻¹ of spray solution. The herbicides evaluated were quizalofop-ethyl at 142.8, 284.16 and 568.32 g a.i./ha⁻¹, sethoxydim at 494.96, 989.92 and 1979.84 g a.i./ha⁻¹, fenoxaprop-p-ethyl at 92, 184 and 368 g a.i./ha⁻¹, clethodim at 91.2, 182.4 and 364.8 g a.i./ha⁻¹, fluazifop-p-butyl at 172.9, 345.8 and 2766.4 g a.i./ha⁻¹ and glyphosate at 2136 g a.i./ha⁻¹ (Table 1). Rates were chosen based on the recommended rate for control of *Agropyron repens*, plus two and four times this rate. Adjuvants were used according to the recommended rate. Plants were evaluated at 1, 2, 4 and 6 weeks after treatment. Visual percent control and percent injury ratings were conducted by comparing the treated plants to the untreated control and Canplus 411 alone; where 0% indicates no visible effects and 100% indicates complete control. Following the 6 week rating, above ground biomass of *C. canadensis* plants were harvested, dried in ovens for 48 hours at 60°C, then weighed to determine total dry matter. Fenoxaprop-p-ethyl gave poor control of *C. canadensis* and was consequently eliminated from the tolerance screen.

Statistical Design. The experimental design was a randomized complete block. Means were separated by Duncan's Multiple Range Test at the 0.05 probability level.

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RESULTS AND DISCUSSION:

Sethoxydim and clethodim provided greater than 90% control of *C. canadensis* six weeks after application at the lowest rate and were comparable to glyphosate (Table 2, Figure 1). Quizalofop-ethyl control of *C. canadensis* increased with herbicide rate, from 63, 75 and 92 % respectively. Fluazifop-p-ethyl was less effective, with only 72% control at the highest rate. Fenoxaprop was not effective at controlling *C. canadensis* and was dropped from subsequent experiments. Plants treated with Canplus 411 alone did not differ from the untreated controls. All of the herbicides decreased above ground dry weight accumulations, as compared to controls, however the six week interval between spraying and harvesting did not allow sufficient re-growth to differentiate between herbicide treatments (Figure 2).

Quizalofop-ethyl, sethoxydim, clethodim and fluazifop-p-butyl showed less than 5% damage at the highest rates compared to the control plants. *P. glauca* seedlings were sensitive to glyphosate, with 30% damage (Figure 3). *P. contorta* showed 37% damage from glyphosate, and less than 10% damage from all other herbicide treatments (Figure 4).

Injury by the AOPP and CHD herbicides generally increased with herbicide rate (Figure 5). Clethodim was most injurious, with 35, 45 and 45% damage at the 1, 2 and 4 times rate, respectively. Sethoxydim caused 5, 15 and 25% injury, respectively. Tolerance information on *P. tremuloides* is less complete than for *P. glauca* and *P. contorta* because of the loss of a replicate. Glyphosate was very injurious to *P. tremuloides* seedlings with 100% injury.

The herbicides sethoxydim, clethodim and quizalofop-ethyl show promise as selective herbicides for *C. canadensis* control. All are non-injurious to *P. glauca* and *P. contorta*. Quizalofop shows the least injury to *P. tremuloides*, sethoxydim is more injurious and clethodim most injurious to *P. tremuloides* under greenhouse conditions.

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While this greenhouse screen has identified candidate herbicides which control *C. canadensis*, results must be confirmed by trials performed in the field. Several factors, including herbicide rate for effective *C. canadensis* control in the first and second year after application, crop tree injury during various times of the year, and the response of crop trees to removal of *C. canadensis* will need to be established under field conditions.

The optimum time during the forest renewal cycle for herbicide intervention also needs to be determined. *C. canadensis* establishment and invasion occurs within a larger cycle of forest renewal. The forest renewal cycle and silviculture practices pre-harvest, post-harvest, site preparation and seedling establishment dramatically affect presence of *C. canadensis* seeds and rhizomes for inoculum and their successful establishment. When *C. canadensis* establishment biology is combined with understanding of the renewal cycle and control measures, more effective intervention may be possible

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Table 2: Control of *Calamagrostis canadensis* and Tolerance of *Populus tremuloides*, *Picea glauca* and *Pinus contorta* 6 Weeks After Treatment

HERBICIDE COMMON	HERBICIDE ACTIVE	RATE g a.i. ha ⁻¹	RATE L ha ⁻¹	RATE g ha ⁻¹	ADJUVANT	RATE % v/v	AVERAGE		AVERAGE DRY WEIGHT g	AVERAGE		AVERAGE		AVERAGE	
							% CONTROL	<i>C. canadensis</i>		% INJURY	<i>P. glauca</i>	% INJURY	<i>P. contorta</i>	% INJURY	<i>P. tremuloides</i>
Control							0g*		15.67ab	0b		0b		0f	
Canplus 411						0.5	0g		15.28ab	0b		0b		0f	
Assure	quizalofop-ethyl	142.08	1.48		Canplus 411	0.5	63.3cd		7.5d	0b		0b		5ef	
Assure	quizalofop-ethyl	284.16	2.96		Canplus 411	0.5	75b		7.43d	0b		0b		0f	
Assure	quizalofop-ethyl	568.32	5.92		Canplus 411	0.5	91.7a		10.85cd	3.33b		0b		15def	
Poast	sethoxydim	494.96	2.69		Merge	1	95a		11.07cd	0b		3.33b		5ef	
Poast	sethoxydim	989.92	5.38		Merge	1	96.7a		10.83cd	0b		0b		15def	
Poast	sethoxydim	1979.84	10.76		Merge	1	98.3a		10.92cd	1.67b		6.67b		25cd	
Puma	fenoxaprop-p-ethyl	92	1				20f		13.04abc						
Puma	fenoxaprop-p-ethyl	184	2				30f		12.03bc						
Puma	fenoxaprop-p-ethyl	368	4				43.3e		11.25cd						
Select	clethodim	91.2	0.38		Amigo	1	91.7a		11.13cd	0b		0b		35bc	
Select	clethodim	182.4	0.76		Amigo	1	96.7a		11.23 cd	0b		0b		45b	
Select	clethodim	364.8	1.52		Amigo	1	96.7a		11.14cd	3.33b		0b		45b	
Venture	fluzifop-p-butyl	172.9	691.6		Charge	1	56.7d		11.09cd	1.67b		6.67b		10def	
Venture	fluzifop-p-butyl	345.8	1383		Charge	1	70bc		11.15cd	0b		0		10def	
Venture	fluzifop-p-butyl	691.6	2766		Charge	1	71.7bc		10.87cd	0b		3.33b		20cde	
Vision	glyphosate	2136	6				100a		10.75cd	30a		36.67a		100a	

* Duncan's Multiple Range at the 0.05 probability level

Table 1: Herbicide Treatments

HERBICIDE	COMMON	ACTIVE	g a.i. ha ⁻¹	L ha ⁻¹	g ha ⁻¹	% v/v
HERBICIDE	ADJUVANT	RATE	RATE	ADJUVANT	RATE	ADJUVANT

Control
Canplus 411 0.5

Assure quizalofop-ethyl 142.08 1.48 Canplus 411 0.5
Assure quizalofop-ethyl 284.16 2.96 Canplus 411 0.5
Assure quizalofop-ethyl 568.32 5.92 Canplus 411 0.5

Poast sethoxydim 494.96 2.69 Merge 1
Poast sethoxydim 989.92 5.38 Merge 1
Poast sethoxydim 1979.84 10.76 Merge 1

Puma fenoxaprop-p-ethyl 92 1
Puma fenoxaprop-p-ethyl 184 2
Puma fenoxaprop-p-ethyl 368 4

Select clethodim 91.2 0.38 Amigo 1
Select clethodim 182.4 0.76 Amigo 1
Select clethodim 364.8 1.52 Amigo 1

Venture fluazifop-p-butyl 172.9 691.6 Charge 1
Venture fluazifop-p-butyl 345.8 1383.2 Charge 1
Venture fluazifop-p-butyl 691.6 2766.4 Charge 1

Vision glyphosate 2136 6

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C. canadensis

C. canadensis

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P. glauca

P. contorta

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P. tremuloides

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