Expert Committee on Weeds
Comité d’experts en malherbologie

Proceedings of the 2001 National Meeting

November 25 - 28, 2001
Hôtel Lews Le Concorde
Québec City, Québec, Canada

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Expert Committee on Weeds
Comité d'experts en malherbologie
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Introduction

Expert Committee on Weeds
Comité d'experts en malherbologie
2001 National Meeting
Réunion nationale 2001
Québec City, Québec

The 2001 annual meeting was held in Québec City, Québec, from November 25 to November 28 and was attended by over 250 persons. The plenary session theme was "Tools available to increase weeds management / Les outils disponibles pour améliorer la gestion des mauvaises herbes and Anne Légère (Agriculture and Agri-Food Canada, Ste-Foy, Québec) acted as moderator. There was a special Forestry Workshop titled "Vegetation management in boreal mixedwoods" chaired by Bob Campbell (Canadian Forestry Service, Sault Ste. Marie, Ontario). Over 60 persons registered for this workshop.

There were 9 graduate students oral presentations and 32 posters were displayed during the meeting. The Bayer Inc. Best Student Presentation Award was awarded to Robert Gulden, University of Saskatchewan, for his presentation titled "Evidence of cyclical dormancy behaviour in spring *B. napus*" by R.H. Gulden, S.J. Shirtliffe, and A.G. Thomas. The poster titled "Effect of endemic *Colletotrichum gloeosporioides* f. sp. *malvae* on round-leaved mallow (*Malva pusilla*) in Nova Scotia.", by Cheryl Konoff, Klaus Jensen and Paul Hildebrand won first place. The poster titled "Is barley competitiveness against wild oat linked to its mycorrhizal dependency?" by Lisette J.C. Xavier, Susan M. Boyetchko, and Douglas A. Derksen won second place. The poster titled "Development of a Canadian spray drift model for determination of buffer zone distances." by Tom Wolf, Eric Johnson, and Brian Caldwell won the third place.

Several awards and scholarships were awarded at the Québec meeting. The Monsanto Canada Scholarships were awarded to Orla Nazarko (M.Sc.), University of Manitoba and to Robert Gulden (Ph.D.) from the University of Saskatchewan. The Dow AgroSciences Canada Travel Awards were awarded to Peter Burgess (M.Sc.), Nova Scotia Agricultural College and to Jason Cathcart (Ph.D.), University of Guelph. The Syngenta Canada Travel Awards were awarded to Valérie Chabot (M.Sc.), université Laval and to Nathan Boyd (Ph.D.), University of Manitoba. The Excellence in Weed Science Award, Sponsored by Dow AgroSciences was awarded to Dr. James R. Moyer, Agriculture and Agri-Food Canada, Lethbridge, Alberta. Denise Maurice, Western Co-operative Fertilizers Limited, Calgary, Alberta, received The Outstanding Industry Member Award.

The committee members and their responsibilities were:

Présidente du Comité d'organisation local / Chair of the Local Arrangement Committee
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Forestry Session – Session en foresterie
Vegetation Management in Boreal Mixedwoods

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Agenda
2001 Meeting

Expert Committee on Weeds
Comité d'experts en malherbologie
2001 National Meeting
Réunion nationale 2001
Hôtel Loews Le Concorde Hotel
Québec City, Québec

Agenda

Sunday November 25 / Dimanche, 25 novembre

09:00 – 17:00	Board Meeting / Comité directeur
16:00 – 20:00	Registration / Inscription
18:00 – 21:00	Poster / Commercial display set-up Montage des affiches et kiosques commerciaux

Monday November 26 / Lundi, 26 novembre

Tools available to increase weeds management /
Les outils disponibles pour améliorer la gestion des mauvaises herbes
Animatrice / Moderator : Anne Légère, *Agriculture et Agroalimentaire Canada, Ste-Foy, QC*

07:30 – 08:30	Registration / Inscription
08:30 – 08:45	ECW Welcome / Mot de bienvenue *Robert Blackshaw, président CEM / ECW Chair*
08:45 – 09:15	Present and Future in weed science / Le présent et le futur de la malherbologie *Dr. Claudel Lemieux, Agriculture et Agro-alimentaire Canada, Ste-Foy, Québec*

09:15 – 10:00	Modelization in weeds management / La modélisation et la gestion des mauvaises herbes *Dr. John Lindquist, Dept.of agronomy, University of Nebraska, Lincoln NE, USA*
10:00 – 10:30	Break / Pause
10:30 – 11:15	Diagnostic tools / Outils de diagnostic *Claude J. Bouchard Ms.Sc. et Romain Néron Bacc. Sc., Direction des services technologiques, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec*
11:15 – 12:00	Precision agriculture / Agriculture de précision *Dr. François Tardif, Dept. of Crop science, University of Guelph, Ontario*
12:00 – 13:30	Lunch / Dîner
13:30 - 14:30	Poster viewing and commercials displays / Visite des affiches et kiosques commerciaux
14:30 – 15:15	The Web / Le web *Henry C. de Gooijer, P.Ag., Saskatchewan Land Resource Center, University of Saskatchewan, Canada*
15:15 – 15:30	Break / Pause
15:30 – 16:00	The Québec experiment / L'expérience québécoise *Simon Marmen, agr. Coordonnateur Clubs-conseils en agroenvironnement*
16:00 – 17:00	Scouting / Dépistage *Jocelyn Magnan, agr. Club-conseil*
17:00 – 18:30	Poster viewing and commercials displays / Visite des affiches et kiosques commerciaux
18:30 – …….	CropLife Canada Reception / Réception CropLife Canada

Tuesday November 27 / Mardi 27 novembre

Graduate students papers presentation, working group, forestry workshop / Exposé des étudiants gradués, groupes de travail, conférences en foresterie

08:00 – 08:30	Poster viewing and commercials displays / Visite des affiches et kiosques commerciaux
08:30 – 10:10	Graduate students paper presentations / Exposé des étudiants gradués (Animateur / moderator Bruno Maltais, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec)
10:10 – 10:30	Break / Pause
10:30 – 12:00	Graduate students paper presentations / Exposé des étudiants gradués (Animateur / moderator Bruno Maltais, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec)
12:00 – 14:00	Awards banquet / Banquet d'honneur
	Forestry workshop registration / Inscription atelier de foresterie

Concurrent Working Groups meetings /
Sessions concomitantes des groupes de travail

14:00 – 15:30	New pesticide products and herbicide characteriszation
	Site specific
	Extension and teaching
	Forestry workshop / Conférences en foresterie
15:30 – 16:00	Break / Pause

16:00 – 18:00	Integrated weed management
	Noxious weeds
	Biological control
	Forestry workshop / Conférences en foresterie
18:00 – 19:00	Taking off posters and commercial displays / Démontage des affiches et kiosques

Wednesday November 28 / Mercredi 28 novembre

Business meeting and concurrent working groups /
Réunion d'affaire et sessions concomitantes des groupes de travail

07:30 – 10:30	Business breakfast / Déjeuner d'affaires
10:30 – 12:00	Application technology
	Herbicide resistance
	Physical weed control
12:00 – 15:30	Board Meeting / Comité directeur

Forestry workshop / Conférences en foresterie

09:00 – 10:20	Workshop / Conférences
10:20 – 10:50	Break / Pause
10:50 – 12:00	Workshop / Conférences
12:00 – 13:30	Lunch / Dîner
13:30 – 14:10	Workshop / Conférences
14:10 – 16:30	Sessions / Ateliers 1- Managing spruce – aspen mixture – past experiences, promising options, decision making tools 2- Intensive *vs* extensive management of mixedwoods – what are the objectives, what are the implications of these approaches 3- *Calamagostis* challenge in boreal mixedwoods
16 :30 – 18 :00	Summaries – Concluding remarks Résumé - Conclusions

Tools available to increase weeds management

Les outils disponibles pour améliorer la gestion des mauvaises herbes

These presentations were originally in Microsoft Powerpoint.
They have been converted in Adobe Acrobat and are available separately.

Present and Future in weed science
Le présent et le futur de la malherbologie

Dr. Claudel Lemieux, Agriculture et Agro-alimentaire Canada, Ste-Foy, Québec

Modelization in weeds management
La modélisation et la gestion des mauvaises herbes

Dr. John Lindquist, Dept.of agronomy, University of Nebraska, Lincoln NE, USA

Diagnostic tools
Outils de diagnostic

Claude J. Bouchard Ms.Sc. et Romain Néron Bacc. Sc., Direction des services technologiques, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec

Precision agriculture
Agriculture de précision

Dr. François Tardif, Dept. of Crop science, University of Guelph, Ontario

The Québec experiment
L'expérience québécoise

Simon Marmen, agr. Coordonnateur Clubs-conseils en agroenvironnement

Scouting
Dépistage

Jocelyn Magnan, agr. Club-conseil

Graduate Students Papers

The influence of wheat-canola-pea multiple cropping systems on weed and crop biomass

Szumigalski, A.R.*, Van Acker, R.C. and M.H. Entz, Dept. of Plant Science,
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Introduction

Intercropping (or multiple cropping) is defined as growing two or more crops simultaneously on the same field, which is the opposite of sole cropping: growing one crop variety alone in pure stand at normal density (Francis 1986).

The biological and agronomic advantages for intercropping versus sole cropping are reviewed by Willey (1979a). These benefits include higher yields in a given season without an increase in inputs. A major cause of these yield advantages has been attributed to better use of growth resources. Yield benefits of intercropping may also result from enhanced control of weeds, pests and diseases (Willey 1979a). For example, Carr et al. (1995) found that wheat/lentil intercrops tended to suppress weed biomass more compared to sole crops.

Despite their excellent potential to increase yields and control weeds, there has been very little research investigating the use of multiple cropping systems in the Canadian Prairies. More research is definitely needed on crop combinations and competition for limiting resources. The underlying mechanisms (e.g., effects of nutrients and water) related to the function of intercropping systems are also not well understood and need further study (Willey 1979b).

Objectives

The primary objective of this research is to study the effect of intercropping systems on crop biomass, yields and weed biomass. A second objective is to investigate resource use (light, water and nitrogen) of crops and weeds in different cropping systems. A field experiment investigating different wheat-canola-pea cropping systems, including the three species mix, all pair combinations of the three crops and sole crops will be carried out in 2001, 2002 and 2003. The effects of the different crop combinations on crop biomass and yields, land equivalent ratios (LER), grain quality and weed biomass will be studied. After each year of the experiment the plots will be sown to oats or flax as a 'test' crop to study the residual effects (e.g. N-levels, pest populations, diseases, etc.) of the different cropping systems. To determine the environmental effects and possible mechanisms of resource use, various environmental parameters will be measured at the sites throughout the growing season. These will include temperature (air and soil), precipitation, soil water content, photosynthetically active radiation (PAR) at the soil surface, and soil N levels.

This presentation will be limited to some preliminary results (crop and weed biomass) from the first field season (2001).

Hypothesis

We hypothesize that the most diverse cropping system (i.e., the three-crop intercrop) will have the greatest crop biomass and lowest weed biomass because of more efficient resource use and greater overall competitiveness.

Experimental Design

The experiments are being conducted at two field sites in Manitoba. These are the JRI-Kelburn Research Farm (south of Winnipeg) and the University of Manitoba Carman Research Station near Carman, Manitoba.

The experimental design is a randomized-complete block/split plot design with 6 replicates at each site. Plot size is 6m x 6m. The main treatment is crop and includes: wheat sole crop (W), canola sole crop (C), pea sole crop (P), wheat and canola intercrop (WC), wheat and peas intercrop (WP), canola and peas intercrop (CP), and wheat, canola and peas intercrop (WCP). The sub-treatment includes sprayed and unsprayed, therefore, one-half of each plot was treated with the herbicide 'Odyssey' at recommended rates. The wheat and canola are 'Clearfield' varieties (BASF), to allow the use of a single herbicide for weed control in all three crops. All treatments were sown at the same density (144 seeds/m2) and all crops were planted in equal proportions within each treatment.

Preliminary Results

Preliminary results from the Carman site indicate that the pea sole crop may be the most competitive cropping system by having the greatest crop biomass, lowest weed biomass and greatest canopy interception of light. However, all four intercrops tended to have higher total biomasses compared to the wheat and canola monocultures. The wheat-canola intercrop had the greatest increase in biomass (~20%) compared to the average of its component crops, followed by the wheat-canola-peas intercrop (~10%). The canola-peas and wheat-peas intercrops had biomasses that were similar to the means of their component crops. Weed biomass data suggest that the spraying of Odyssey was effective in reducing weed biomass in all cropping systems except in the wheat-canola intercrop, where spraying had no apparent effect. These are only preliminary results and until a more complete analysis of the data is made, it is difficult to make any strong conclusions.

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Pesticide Free Production: A participatory research case study

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Introduction

Pesticide-Free Production (PFP) is a flexible, alternative crop production system that eliminates all synthetic pesticide use during the growth phase of crops. PFP crops are bred with conventional techniques and are not grown where residual pesticides are active; however, conventional fertilizer use is permitted. Pre-emergent applications of non-residual herbicides such as glyphosate are permitted. Specific rules for PFP crops can be found at **www.pfpcanada.com**.

Certification for PFP crops is on a yearly basis, so these crops can fit into a conventional crop rotation without requiring a long-term commitment to PFP. If pest levels exceed thresholds, farmers can abort PFP attempts without losing the potential for certification the following year. While Integrated Weed Management (IWM) has not been widely adopted by mainstream crop producers (Manitoba Agriculture and Food 1996; Czapar et. al. 1997), PFP provides simple guidelines as a way to implement IWM principles. Advantages of PFP include reduced production costs, reduced risk of herbicide resistance, and reduced pesticide load in the environment. In addition to these advantages, consumer demand for food produced with reduced pesticides is growing, creating an opportunity for new markets for PFP crops. Because of its flexibility and the possibility of market premiums, PFP has the potential to be widely adopted by farmers and have a significant impact in reducing pesticide use.

Research Objectives:

The PFP participatory research case study involves on-farm research with Manitoba farmers attempting to produce PFP crops. Objectives are to determine 1) what agronomic factors allow farmers to successfully produce PFP crops and 2) the demographics of farmers interested in PFP. This information will allow us to discover the means by which farmers achieve PFP, and place those who practice PFP in the context of the broader farm population.

Materials and Methods

The on-farm research project was conducted during the 2000 and 2001 growing seasons. Farmers were encouraged to participate in the project through promotion by Ag Reps, as well as newspaper and radio advertisements. Farmers were selected as participants if they intended to produce a PFP crop that year. Fields involved in the project were characterized in terms of their weed, insect, and disease pressure, and farmers completed a questionnaire regarding their management practices, demographic information, and adherence to alternative vs. conventional agriculture paradigms. Farmers were asked to provide grain samples from PFP-certified fields for grading and dockage analysis by the Canadian Grain Commission. They were also asked to report yields. In 2000, all crops volunteered for the project were included. Due to participant interest, only wheat, oats, flax and barley were included in the project in 2001. Data was separated on the basis of whether or not fields had successfully met PFP criteria (certifiable or non-certifiable fields), and where possible, values for these two groups were compared using t-tests or Chi-square comparison methods. Demographic information and agronomic management practices are not yet available for 2001 participants.

Preliminary Results:

Over the two years of the project, 50% of the farmers expressing interest in PFP actually attempted to implement it. The most common PFP crops attempted were spring and winter cereals, as well as flax and canola. Sixty-eight percent of the 37 farmers participating in the project in 2000 were able to produce a certifiable PFP crop. Spring cereals and fall rye were the most successful crops. Non-certifiable cereal fields were primarily sprayed for weed control. Exceptions to this were canola crops, which were not certifiable due to the use of seed treatments; and winter wheat crops, which were ineligible due to the application of fungicide for leaf diseases. Seventy-eight percent of the 40 participants in 2001 were able to produce a PFP crop. In 2001, all non-certifiable fields were sprayed for weed control. Over 2300 ha were certified as PFP in Manitoba during the two years of the project.

In both years, average weed densities in certifiable fields were higher than Manitoba averages; however, yield reductions (2000 data only) were minimal. Weed densities in non-certifiable fields were higher than in certifiable fields (Table 1), indicating that it was fields with the highest weed pressure that opted out of PFP. Average weed densities in certifiable fields in 2000 were 1.81 times a post-weed control average (Manitoba provincial weed survey of 1997; Thomas *et. al.* 1998), and 1.61 times this standard in 2001. However, comparisons with an estimate of pre-weed control densities in Manitoba (Friesen and Shebeski, 1960) showed certifiable fields to have only 0.63 times this average in 2000, and 0.59 times in 2001. Overall, yields for all certifiable crops in 2000 were 96% of 5-year average yields for Manitoba (Table 2). Yields in 2000 were well above organic production averages (Entz *et. al.* 2001) for the province. Dockage levels for 2000 PFP crops were considered to be typical, with the exception of spring wheat, where dockage levels were considered higher than normal (8.9% vs. 1%). In terms of grain quality, most downgrading factors for PFP-certified crops were not directly related to non-use of pesticides.

Table 1. Average weed density in certified and non-certified PFP fields (2000 and 2001).

Crop	Certified PFP fields	Non-certified PFP fields	p-value
		Density (plants/m^2)	
Barley	145.0	237.1	0.29
Oats	118.0	177.4	0.35
Spring wheat	103.6	169.6	0.16
All crops	110.4	157.8	0.11

Table 2. Relative crop yields for 2000 in certified and non-certified PFP fields as a percent of 5-year provincial average or as a percent of long-term organic average.

Crop	Certified PFP fields	Non-certified PFP fields	p-value
	---Percent of 5-year provincial average---		
Barley	96	96	0.97
Oats	90	113	0.41
Wheat	82	101	0.47
All crops	96	108	0.20
	---Percent of long-term organic average---		
Barley	146	138	0.70
Oats	140	171	0.48
Spring wheat	117	156	0.21
All crops	134	163	0.08

In 2000, farmers were using or planned to use a wide range of techniques to accomplish PFP. Dominant practices included the use of crop rotation, particularly the use of forages like alfalfa in the rotation. Other practices designed to improve crop competitiveness, such as increasing seeding rates and choosing competitive crops were also mentioned. These techniques showed initiative on the part of some participants to actively plan for future PFP crops. Other participants were more likely to attempt PFP without advance planning, in the “hope” that pest pressure would be low enough to avoid pesticide application. Preliminary results suggest that this lack of advance planning is a less successful approach to PFP.

Demographic characteristics of participants in 2000 were fairly typical of the range that exists among Manitoba farmers. Average size of farms with certifiable PFP crops (576 ha) was larger than the 1996 provincial average of 317 ha (Manitoba Agriculture and Food 2000), indicating that PFP can be successfully practiced on large farms. Farmers with certifiable PFP fields in 2000 were more likely to have tried PFP in the past than those without certifiable fields

(66% vs. 33%). About one-third of participants were in transition to organic certification, while about one-quarter were zero-till producers.

The primary reason for interest in PFP in 2000 was to reduce input costs; however, those without certifiable fields were more interested in marketing opportunities (p = 0.02) than those with certifiable fields. This indicates that farmers without certifiable fields were perhaps less likely to leave fields unsprayed without guaranteed market premiums. Farmers with certifiable fields were more concerned about the environment than those without (p = 0.12), suggesting that farmers with certifiable fields have an interest in PFP beyond markets. All participants in 2000 stated they were financially better off by producing a PFP crop and the majority would try PFP again.

Conclusions:

This participatory research project demonstrates that PFP crops such as wheat, oats, and barley can be grown in Manitoba without major yield reductions, and that farmers attempting to implement PFP are interested in continuing to investigate its potential. Farmers are using diverse methods to achieve PFP, demonstrating that this concept can be applied within the context of various farm operations. Almost half the participants had never attempted PFP before, indicating that PFP has the potential to act as an incentive for farmers to implement IWM principles.

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Characterisation of a green pigweed (*Amaranthus powellii)* biotype resistant to linuron

Mélanie Dumont and François J. Tardif.
Department of Plant Agriculture, University of Guelph

Introduction

Herbicides are the principal tool used to manage weeds within many cropping systems. In the past 50 years, starting with the introduction of 2,4-D in 1946, agrochemical companies have successfully discovered and brought to the market a wide array of herbicides. As early as the 1950's, there were predictions that herbicide resistance would eventually develop in weeds (Blackman, 1950). Since the discovery of triazine-resistant *Senecio vulgaris* (common groundsel) in 1968 (Ryan, 1970), the development of various biotypes of weed species that are resistant to herbicides is an acute problem that farmers over the world have to face.

Linuron is a substituted urea herbicide used to control annual and perennial broadleaf and grass weeds on crops such as soybeans, cotton, potato, corn, beans, peas, winter wheat, asparagus, carrots, and fruit crop. It can be applied in pre and post-emergence and it works by inhibiting photosystem II in target weed plants. Linuron is one of the only herbicide able to provide efficient control of dicot weeds, such as *Amaranthus sp*, in carrots.

In 1977, Tisher and Stromann reported that the diverse chemicals that act as PS II inhibitors such as the triazines, phenylureas, pyridazinones and biscarbamates, compete for a common binding site on thylakoid membranes. Later, photoaffinity labelling studies conducted with [^{14}C]azido derivative of atrazine (Pfister et al., 1981), monuron, and a triazinone demonstrated that this common binding site was the D1 protein.

In November 1999, failure of linuron to control green pigweed (*Amaranthus powellii*) in a carrot field situated near Keswick, Ontario, was reported to us. The aim of this research was to confirm and characterize resistance to linuron in this population. We also wanted to determine whether it showed cross resistance to other photosynthesis inhibitors. Finally, we wanted to determine if the basis for resistance was an alteration in the *psbA* gene.

Materials and methods

Dose Response

A seed sample of the surviving plants was obtained. A biotype from the same locality collected from an area where linuron has never been sprayed was used as the susceptible reference. Seeds were reproduced in growth room where the resistant and the susceptible biotypes where kept apart. Seeds were placed on petri dishes containing 0.6% agar and were allowed to germinate for 2 or 3 days before transplantation in pots. Five seedlings for each seed sample were transplanted in 15cm x 15cm pots filled with Sunshine LA4 MIX Agregate Plus (55-65% peat moss, perlite, dolomitic limestone, gypsum, wetting agent). At the 4 leaf stage, the plants were sprayed with the following herbicides: linuron from 0 to 3000 g ai ha^{-1}, monolinuron from 0 to 2000 g ai ha^{-1}, diuron from 0 to 2500 g ai ha^{-1}, atrazine from 0 to 1000 g ai ha^{-1}, prometryn from 0 to 1000 g ai ha^{-1}, metribuzine from 0 to 1000 g ai ha^{-1}, bentazon from 0 to 1200 g ai ha^{-1}, bromoxynil from 0 to 350 g ai ha^{-1}, and bromacil from 0 to 1000 g ai ha^{-1}. Herbicide applications were made in a moving nozzle spray chamber calibrated to deliver 210 L ha^{-1} of spray solution at 276 kPa using compressed air and a Teejet SS8002E spray tip. Ten days after treatment, dead plants were identified by termination of growth and counted. The surviving plants were harvested at soil level and dried at 80°C for 24-h to a constant weight. The dry weight biomass was converted to % of mean control and analyzed using a log-logistic statistical model. The resistance factors for each biotype were then calculated by dividing the dose required to reduce growth by 50% (GR_{50}) of the resistant biotype by the GR_{50} of the susceptible biotype.

Sequencing of psbA Gene

DNA was extracted from 3 susceptible plants and 3 resistant plants, and polymerase chain reaction (PCR) was used to amplify the psbA gene. The PCR cycle used followed that of Foes *et al*. (1998). After amplification, the PCR products were cleaned up using a Microcon® PCR Kit, which removes all small fragments (mainly primers) under 300 bp in size. The samples were then sequenced to determine the nucleotide sequence of the gene.

Results

Dose Response

Dose response analysis confirmed resistance to linuron in the biotype from Keswick. The GR_{50} value of the resistant population was 112.59 g ha^{-1} of linuron compared to 9.67 g ha^{-1} for the susceptible reference population which indicates a resistance factor of 11.64. Dose response analysis also shows resistance to diuron and monolinuron. The resistance factors were 6.43 and 3.09 for diuron and monolinuron, respectively

The resistant biotype also had cross-resistance to triazine herbicides. Determination of GR_{50} values indicated that cross-resistance existed to the triazine herbicides atrazine, metribuzin, and prometryn. The GR_{50} values of the resistant biotype where significantly higher compared to the susceptible reference biotype. The level of resistance to the triazines was, however, not as high as what was observed with the substituted ureas with resistance factors of 1.81, 2.6 and 1.42 for atrazine, metribuzin and prometryn, respectively.

Cross-resistance to the herbicides bentazone and bromoxynil was also observed. There was a significant difference in GR_{50} values for bentazon which were 26.50 and 37.61 for the susceptible and resistant biotypes, respectively. The resistance factor was 1.41. The susceptible biotype had a significantly lower GR_{50} value than the resistant biotype when treated with bromoxynil. The GR_{50} of the susceptible reference had a value of 48.69 while it was of 106.55 for the resistant biotype, resulting in a resistance factor of 2.19

Table 1. GR_{50} values resistance factors for the susceptible and resistant *A. powellii* biotypes after treatment with PSII inhibitors.

Herbicides	GR_{50}		Resistance factors
	Sus	Res	
	g ai ha^{-1}		
Linuron	9.67	112.59	11.64 *
Diuron	24.47	157.39	6.43 *
Monolinuron	62.47	192.95	3.09 *
Atrazine	20.94	37.87	1.81 *
Metribuzin	26.08	67.78	2.60 *
Prometryn	26.44	37.49	1.42 *
Bromoxynil	48.69	106.55	2.19 *
Bentazon	26.50	37.61	1.41 *

*indicates that the resistance factor is from a population with a significantly higher GR_{50} value than that of the susceptible reference.

DNA Sequence Analysis

The susceptible reference sequence was compared to a known *A. h*ybridus sequence (GenBank accession number K01200.1 GI:33605). The susceptible reference sequence exactly matched the published nucleotide *A. hybridus* sequence. Comparison of the sequences of the susceptible and the resistant *A. powellii* sequences infdicates the presence of one mutation causing an amino acid substitution. The D1 protein from the resistant biotype has an isoleucine at position 219 as opposed to a valine in the susceptible. There was no other changes in the deduced amino acid sequence. We therefore assume that this substitution at position 219 is the most likely cause of resistance in this population.

Conclusions

Dose response analysis confirmed that the *A. powellii* biotype that was not controlled by linuron was resistant to that herbicide and cross-resistant to other PS-II inhibitors. Analysis of the psbA gene indicated that cross resistance to PS-II inhibitors is most likely due to a mutation at residue 219 where valine is substituted for isoleucine. This finding is the first case of a $Val_{219}Ile$ substitution in the *psb*A gene that confers cross-resistance to PS-II inhibitors in a dicot species.

There are few cases of PSII inhibitor resistance that have been selected by phenylureas compared to triazine. Our results indicate though that given the right conditions, this type of resistance can be selected for in weed populations. This reinforces the fact that herbicide choice, rotation, and mixtures are very important, especially in crops like carrot where the herbicide choice is limited. There is a continued need for grower education in order to try and prevent resistant weeds from being selected for. The fight against herbicide resistant weeds should start with the people that are trying to manage them.

Acknowledgements

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Site-specific weed control reduces herbicide applications in field crops.

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Abstract

Site-specific spraying presents an interesting potential for the reduction of chemical inputs used in agriculture. The availability of geographic information systems allows to generate site-specific application maps in order to apply herbicides only in those portions of a field in which weeds are present. The intensity of scouting influences the accuracy and precision of weed patches characterization. Field crops were sampled in 2000 and 2001 in four fields of 100 x 500 m. Each field was scouted according to a systematic grid of 10 x 10 m. Weed percent ground cover data were used to produce distribution maps. The latter were compared to predetermined thresholds to produce site-specific spraying maps. Distribution and spraying maps were generated from three sampling grids (10 x 10 m, 20 x 20 m and 30 x 30 m) in order to evaluate the influence of the number of points scouted on the amount of herbicides applied. The results demonstrate that the use of site-specific technology for weed control can theoretically reduce herbicide applications. Compared to a broadcast application, the amount of postemergence herbicides applied to control grass weeds would be reduced by 24 to 82 % in corn, by 51 % in soybean and by 83 to 100 % in a small grain cereal. Likewise, the amount of postemergence herbicides applied to control broadleaf weeds would be reduced by 0 to 9 % in corn, by 97 % in soybean and by 38 to 89 % in a small grain cereal. It was found that the amount of glyphosate applied in fall to control quackgrass (*Elytrigia repens*) would be reduced by 19 %.

Le désherbage localisé réduit les quantités d'herbicides utilisées dans les grandes cultures.

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Résumé

L'application localisée des herbicides représente une perspective intéressante pour la réduction des intrants chimiques utilisés en agriculture. Contrôler les mauvaises herbes seulement aux endroits les plus infestés nécessite des informations géoréférencées qui permettent de générer des cartes d'applications localisées. L'intensité à laquelle l'échantillonnage est effectué influence l'exactitude et la précision de la caractérisation des îlots de mauvaises herbes. En 2000 et 2001, quatre champs de grandes cultures de 100 x 500 m ont été parcourus selon une grille systématique de 10 x 10 m. À l'aide de seuils d'intervention donnés, les cartes de distribution ont permis de générer des cartes d'application localisée des herbicides. Trois grilles d'échantillonnage (10 x 10 m, 20 x 20 m et 30 x 30 m) ont été comparées afin de constater l'influence du nombre de points échantillonnés sur les quantités d'herbicides appliqués. D'après le protocole utilisé, les applications localisées permettraient théoriquement de réduire les applications d'herbicides. Par rapport à une application en pleine couverture, les quantités d'herbicides appliqués pour détruire les graminées seraient réduites de 24 à 82 % dans le maïs, de 51 % dans le soya et de 83 à 100 % dans une culture de céréales. Les quantités d'herbicides appliqués pour détruire les dicotylédones seraient réduites de 0 à 9 % dans le maïs, de 97 % dans le soya et de 38 à 89 % dans une culture de céréales. La quantité de glyphosate appliqué à l'automne pour combattre le chiendent (*Elytrigia repens*) serait réduite de 19 %.

Competition between green foxtail and corn as influenced by differing nitrogen rates

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Current scientific research in crop agriculture has been in the direction of economic and environmental sustainability through the use of reduced, but efficient, agronomic inputs to the cropping system. Nitrogen represents a major input cost to non-legume crops grown in Ontario, and as such, is potentially the most likely nutrient to give economic and environmental benefits from reduced rates of application. Evidence suggests, however, that as N application rates are reduced, there is an increase in the relative competitiveness of weeds (Tollenaar et al., 1994, Bosnic and Swanton, 1997). The specific objective that will be dealt with in this presentation is whether an increase in the weed competitiveness of green foxtail (*Setaria viridis* L.), associated with decreasing N rates, lowers the acceptable weed density threshold in corn (*Zea mays* L.). If this is the case, any savings made from reducing N application rates may be offset by an increase in herbicide dose and/or in herbicide application frequency, all resulting in potential increases in the cost of weed control.

To address this objective, the specific hypotheses being examined are:
Hypothesis 1:
The economic threshold of green foxtail in corn is influenced by variable N rates.
Hypothesis 2:
A reduction in nitrogen fertilizer will result in the need for greater weed management, potentially through increased herbicide use.

Materials and Methods

Research was conducted at the University of Guelph's Cambridge Research Station. The experimental design was a randomized complete block (RCBD), replicated four times, with green foxtail densities of 0-300 plants m^{-2} and under five levels of N fertilization (0-200 kg N ha^{-1}). Ammonium nitrate fertilizer and green foxtail seed was broadcast applied to the soil surface using a calibrated Hege 33 Fertilizer distributor and then was hand-raked into the top 5 cm of the plot. Soil nitrate levels (to 30 cm depth) were followed throughout the growing season. Broadleaf weeds were chemically controlled, and all weed escapes were removed by hand

Each plot measured 3 m x 15.5 m and consisted of four rows spaced 76 cm apart. Four sections (three measuring 1.5 m in length, and one measuring 4 m in length, all by 1.25 m in width and separated by a 1 m buffer) of the centre two rows were hand harvested at approximately 3 weeks prior to silking, at silking, three weeks after silking, and at corn maturity. Weed density, biomass, and tissue N; and corn leaf area, biomass and tissue N was measured at each sampling date. Corn grain yield and harvest index of each treatment was measured from the 4 m harvest area. Actual plot weed density was determined by averaging the weed densities measured at each sampling date.

Field Results: 1999 through 2000

Considering first soil N fertility, a similar trend was observed in both the 1999 and 2000 field seasons. Initial soil test values were approximately 6.7 and 4.6 ppm (1999 and 2000, respectively), and increased significantly with the addition of ammonium nitrate. Soil nitrate levels (within the top 30 cm) subsequently declined to pre-fertilized levels (or lower, depending on N rate) within approximately 6-8 weeks of N application.

Corn yields in 2000 were lower than those of 1999, due to increased precipitation and subsequent leaching of applied N. Cooler 2000 temperatures, may have also reduced N mineralization, thus further reducing crop yields.

Nitrogen rate has been attributed to a significant difference in crop yield regardless of whether the plots contained green foxtail or not. In 1999, this response was found to be quadratic in nature, and resulted in the ability to predict the most economic rate of N (MERN). Weed free plots (N=20) yielded within a range of 4.9 to 7.7 t ha^{-1} (with N rates of 0 to 200 kg N ha^{-1}), with a MERN of 125 kg N ha^{-1}. In comparison, the presence of green foxtail (N=80) reduced corn grain yield to 3.2 to 6.8 t ha^{-1}, and increased the MERN value to 161 kg N ha^{-1} (Figure 1, left). In 2000, weed-free plots (N=20) yielded within a range of 4.2 to 7.3 t ha^{-1}, although this response was linear thus preventing the calculation of a 2000 weed-free MERN value. The presence of green foxtail (N=100) reduced yields to 2.3 to 6.1 t ha^{-1} (with N rates of 0 to 200 kg N ha^{-1}), at a MERN value of 168 kg N ha^{-1} (Figure 1, right).

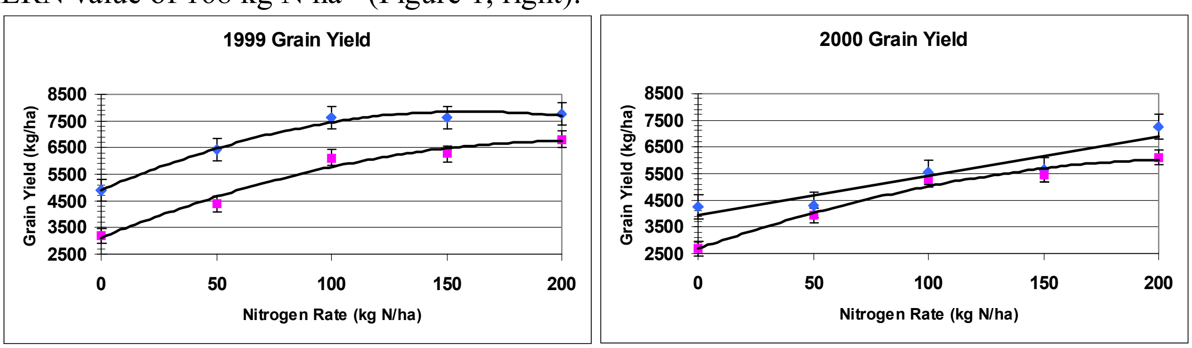

Figure 1. Corn grain yield (1999 & 2000) as influenced by N rate in the absence of weeds (upper curves) and in the presence of weeds (lower curves). Weed-free 1999: Yield = 4897 + 37N -0.12N^2 (R^2=0.72); 2000: Yield = 3945 + 15N (R^2=0.53). Weedy 1999: Yield = 3115 + 34N - 0.08N^2 (R^2=0.55); 2000: Yield = 2675 + 29N - 0.07N^2 (R^2=0.44).

When the influence of both N rate and weed density on 1999 and 2000 corn grain yield were considered, both N rate and weed density were found to significantly influence crop yield, although their interaction did not. Response surface analysis (Figure 2) indicated that a saddle response was obtained in 1999, and that the maximum ridge estimate for a crop yield of 7.5 t ha^{-1}

occurred when the N rate was approximately 135 kg N ha^{-1} and when weed density was low, at approximately 10 plants m^{-2} ground area. A saddle response was again observed in 2000, with a maximum ridge estimate of 6.0 t ha^{-1} at an N rate of approximately 160 kg N ha^{-1}, and a weed density of 21 plants m^{-2}. Further examination of the response surface indicates that with any reduction in N fertilizer a subsequent reduction in weed density is needed in order to maintain crop yield.

Impact of this Research

This research will provide corn producers and researchers alike with knowledge on:

- the green foxtail economic threshold in corn
- how weed thresholds change under different N levels
- how nitrogen use efficiency is affected by competition in the field
- the nitrogen use efficiency of a common Ontario weed species - green foxtail
- how to manage both fertilizer and herbicide applications to be both environmentally and economically efficient and responsible
- how the adoption of site specific nutrient management may influence the cropping system dynamic.

Hopefully this research will promote public awareness of corn as a renewable and environmentally friendly resource. For Ontario corn producers, this research will identify the potential for reducing corn production costs, if an economic balance between crop inputs can be identified.

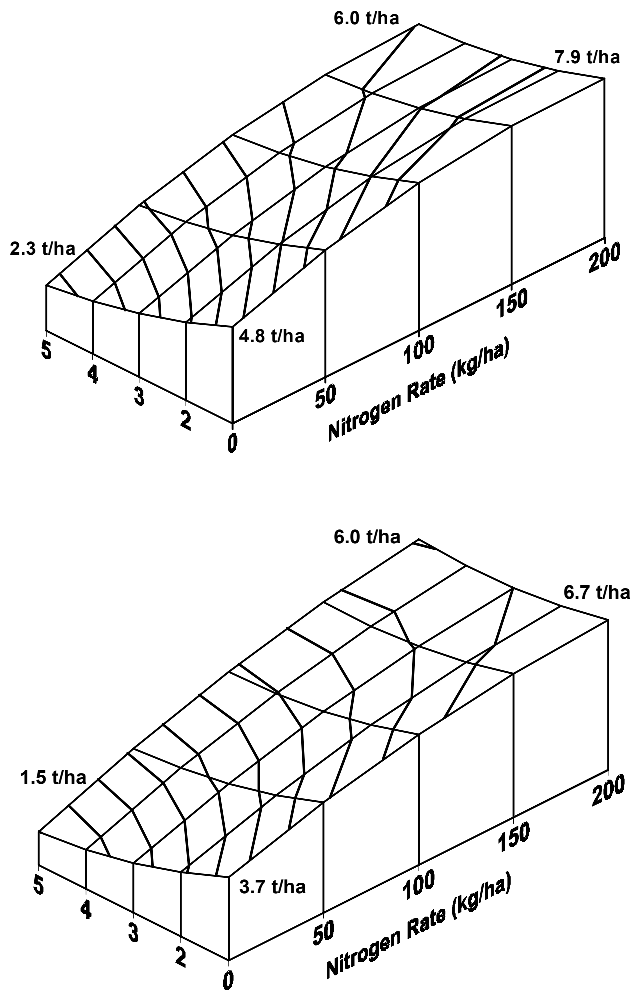

Figure 2. Corn grain yield as affected by the level of N fertilization and classed weed density (e.g. Class 2 = 1-51 weeds m^{-2}, Class 5 = 151-200 weeds m^{-2}) for the 1999 (top) and 2000 (bottom) growing seasons. Isobars represent levels of equal yield with respect to N and weed density.

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The relative importance of seed and microsite limitation on annual and perennial weed populations

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Introduction

The presence of seeds within the soil profile is often not a good indicator of the weed population that will emerge the following spring. Successful germination of seeds and subsequent seedling establishment at the soil surface is determined both by the number of seeds in the soil profile and by environmental conditions directly surrounding the seed. Seedling germination occurs when conditions directly surrounding the non dormant seed match the germination requirements of that particular species.

Tillage practice may affect soil moisture levels, soil temperature, surface residue and seed position within the soil profile (Buhler 1995; Cousens and Moss 1990; Malhi and O'Sullivan 1990; Teasdale and Mohler 1993). The type and timing of tillage may also affect soil aggregation, bulk density and porosity. The change in soil structure may in turn affect moisture retention and light penetration (Benvenuti 1995). The extent of the impact of aggregate size and bulk density on weed emergence will depend on the weed species. Large seeded species, such as wheat and *Galium aparine,* have been reported to be less affected by clod size than smaller seeded species (Cussans et al. 1996). Variation in soil texture and structure may also impact weed population dynamics by influencing the depth of light penetration, affecting the gaseous environment directly surrounding the seed, or the energy required for the seedling to penetrate through the soil.

The position of seed within the soil profile and soil moisture are affected by tillage and may impact weed germination and emergence. Some species, e.g. *Rumex crispus,* are extremely specific, emerging only on or near the surface, with even burial at 1 cm significantly reducing emergence (Weaver and Cavers 1979). Other species, e.g. *Asclepias syriaca,* have negligible germination on the surface or below 7 cm (Yenish et al. 1996), while *Avena fatua,* can emerge from depths ranging from near the surface to 20 cm (Sharma and Vandenborn 1978). Despite the wide variation in depths from which weeds can emerge, most weeds in the field emerge from depths in the range of 1-4 cm below the soil surface (du Croix Sissons et al. 2000). The impact of soil moisture on germination and emergence is highly variable between weed species and moisture conditions within a field may vary horizontally and vertical. Although climatic variables such as rainfall and temperature play key roles in determining soil moisture, these vary seasonally as well as spatially. Within agricultural fields, soil moisture may be altered by many variables including litter cover and tillage.

The objectives of these experiments were to determine the impact of depth, fluctuating moisture levels and soil aggregates size on the percentage emergence of a variety of annual and perennial weed species commonly found in agricultural fields in Western Canada.

Materials and methods

Seeds from fifteen weed species were collected from various locations in Manitoba, Canada. The number of plants emerging were counted and recorded three times per week until emergence ceased. The percentage of maximum emergence was determined by dividing the number of seedlings of each species in each pot by the maximum number of seedlings that emerged of the same species in this experiment. This method was used to eliminate any variation between species due to different dormancy levels. All pots were kept in a greenhouse during the summer months where temperature fluctuated throughout the day. Minimum and maximum temperatures averaged 14 and 32 ^{o}C, respectively.

Soil depth experiment. This experiment consisted of a Randomized Block Design replicated 4 times with 4 seeding depths. The experiment was seeded in 15.5 by 14 cm pots in a potting mixture consisting of 1/3 sand, clay loam topsoil, and peat moss. Fifteen seeds were placed on the surface or at 1-2 cm, 3-4 cm, or 6-7 cm below the surface in each pot. The pots were watered daily to keep the soil moist at all times.

Soil depth x moisture experiment. The experiment was a Factorial Design with 3 seeding depths 2 moisture levels and 4 replicates. Fifteen seeds were placed in pots on the surface, at 1-2 cm or 3-4 cm below the surface at each moisture level. The experiment was seeded in 15.5 by 14 cm pots in a potting mixture consisting of 1/3 sand, clay loam topsoil, and peat moss. In the first moisture treatment, soil moisture was allowed to fluctuated between field capacity and 1/3 field capacity. The second moisture treatment fluctuated between field capacity and 1/6 field capacity.

Soil aggregate size x depth experiment. A clay loam soil was sieved into three aggregate size classes; small aggregates less than 2.0 mm, medium sized aggregates ranging between 2.0 mm to 12.7 mm, and large aggregates, larger than 12.7 mm. The sieved soil was placed on top of the weed seeds to depths of 1-2 cm, 3-4 cm and 6-7 cm. All pots were watered every second day to keep the soil moist at all times.

Results and discussion

Soil depth experiment. Seedling emergence of *Malva pusilla, Avena fatua, Echinochloa crus-galli* and *Brassica napus* were unaffected by seeding depth. *Setaria viridis* had significantly lower emergence of surface placed seed than seeds placed at all other depths while *Galium aparine* had lower emergence at the surface and 6-7 cm than all other depths. Conversely, *Thlaspi arvense*, *Brassica kaber Rumex crispus, Sonchus arvensis* and *Taraxacum officinale* all had significantly higher percentage emergence from surface placed seeds. *Elytrigia repens* was the only perennial species for which depth of seed placement did not affect the number of seedlings emerging.

Soil depth x moisture experiment. *B. napus, T. aestivum, S. viridis* and *M. pusilla* emergence was largely unaffected by seeding depth or moisture fluctuation. Under either moisture regime *A. fatua* emergence was significantly lower when seeds were on the surface than at 1-2 and 3-4 cm. Both *G. aparine* and *E. crus-galli* had lower percentage emergence with surface placed seeds versus seeds placed at 1-2 and 3-4 cm when the moisture levels fluctuated between FC and 1/3 FC. When seeds of these same two species were exposed to fluctuating moisture levels between FC and 1/6 FC emergence was lower but depth no longer had an impact on percentage emergence. Percentage emergence of four of the six perennial species studied was largely unaffected by depth when moisture levels fluctuated between FC and 1/3 FC or FC and 1/6 FC.

Soil aggregate size x depth experiment. Soil aggregate size and depth did not influence light interception. Overall weed emergence increased when soil aggregate size was greater than 12.7 mm while weed emergence decreased as seeding depth increased. For six of the species studied emergence increased with aggregate size, six species were unaffected by aggregate size and for one species emergence decreased with large aggregate sizes. Percentage emergence decreased with increasing depth for 10 of the 13 species. Emergence of *Avena fatua*, *Echinochloa crus-galli* and wheat was not affected by seeding depth.

Throughout the three experiments emergence of two of the species, *Avena fatua* and *Setaria viridis*, was generally unaffected by seeding depth, moisture fluctuations or soil aggregate size. For other species, such as *Galium aparine* and *Brassica kaber*, emergence was affected by depth, moisture, and soil aggregate size. We suggest that *Avena fatua* and *Setaria viridis* may be classed as germination generalist, able to emerge under a wide range of conditions while *Galium aparine* and *Brassica kaber* may be classed as germination specialist, only emerging under very specific conditions. Given these classifications, one would hypothesize that generalist would be largely seed limited within agricultural fields with a short seed bank duration while specialist would be microsite limited with a long seed bank duration.

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Vegetation management in lowbush blueberries: the influences of sub-lethal doses of herbicides on *Danthonia spicata* L. Beauv. used as a living mulch.

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Abstract

In order to maintain sustainable production of wild blueberry it is important to manage competing vegetation. Using native grasses as living mulches to maintain vegetative cover in areas with no crop cover, is one solution. This two year study used selected herbicides applied at varying rates to determine an optimal application strategy to suppress a native grass (Poverty oat grass, *Danthonia spicata* L. Beauv.) but maintain a viable vegetative cover. The two sprouting year applied trials revealed that fluazifop-p-butyl could suppress *D. spicata* without eliminating it. The plots with fluazifop-p-butyl suppressed grass also had a significantly higher soil moisture compared to treatments where the grass was killed. This along with the a low phytotoxic rating of blueberry to fluazifop-p-butyl, permitted the exploration of a crop year application of this herbicide. The crop year trial, used rates of 2L/Ha and 4L/Ha at three different application timings from early to full bloom. Both rates at all timings suppressed the grass effectively with no detrimental effects to the blueberry plant or yield. In fact, the later application timing (near full bloom) showed a significantly higher berry number per plant at harvest than the early application. Though not yet registered for use in the cropping year, fluazifop-p-butyl shows great potential as a living mulch management tool.

Introduction

The wild lowbush blueberry (*Vaccinium angustifolium* Ait.) is an indigenous plant that has been developed into the most important horticultural crop in Nova Scotia (Wild Blueberry Producers Association of Nova Scotia, 1997). Although commercially managed, wild blueberry fields originate when competing vegetation is removed from native plant stands found in cleared woodland or abandoned farmland (Hanchar *et al.*, 1985). The blueberry plant spreads vegetatively by rhizomes, and nutrient uptake is dependent upon native mycorrhizae (Korcak, 1988). The wild lowbush blueberry grows on nutritionally marginal and poorly structured soil which is often unsuitable for conventional agriculture (Sanderson and Cutcliffe, 1991). Optimum growth occurs at a soil pH between 4.5 and 5.5 (Korcak, 1988).

Fields are commercially managed on a two-year production cycle, with shoots being pruned in alternative years to maximize vegetative growth, floral bud initiation, fruit set, yield and ease of mechanical harvest (McCully *et al.*, 1991). Pruning occurs either in the fall after harvest or in the following spring by either burning or mechanical mowing of above ground plant structures. Regrowth occurs the following year during which most plant resources are put towards vegetative growth and floral bud formation. Selective pre-emergent herbicides, like hexazinone (Velpar®), are generally applied in the spring of this year to control most competing weeds.

During the second year of the production cycle, the cropping year, pollination, fruit set, berry development and harvesting occurs. Blossoms develop in late May and early June with both native pollinators and domesticated honey bees used for pollination. The berries are harvested mechanically or by hand, with 99% of these berries directed to processors for domestic and export markets (Wild Blueberry Producers Association of Nova Scotia, 1997).

Wild lowbush blueberries, in commercial production, have a relatively low rate of biomass production and vegetative expansion. Wild blueberry fields are thus, very susceptible to invasion by weeds; one of the major limiting factors in production (M^cCully *et al.*, 1991). As a result, chemical weed control can be a useful method to limit competition. In the early 1980's, the development of hexazinone helped eliminate many prominent weeds that were previously uncontrolled, and thus helped create a boom in both yields and ease of harvest (Yarborough and Ismail, 1985, Hanchar *et al.*, 1985). With the elimination of competing vegetation, there became a high susceptibility to soil erosion with the exposure and destabilisation of the top soil.

Living mulches are being used to stabilize the soil in bare areas and minimize soil erosion in many cropping situations. The use of mulches has drastically reduced erosion problems in many horticultural crops (Bruce *et al.* 1995 and Abdual *et al.* 1996). Mulches in general reduce frost heaving, provide winter protection, moderate soil temperatures, benefit soil fertility and increase soil moisture (Sanderson and Cutcliffe 1991). Living mulches can also increase harvest efficiency in wild blueberry by supporting the crop, resulting in a lower rate of unharvested and damaged crop.

Materials and Methods

Three commercial wild blueberry fields were selected, in the Oxford, Nova Scotia area, that contained a dense infestation of poverty oat grass(*Danthonia spicata* L. Beauv.). Two of the sites had five different herbicides (nicosulfuron/rimsulfuron, primisulfuron, clethodim, sethoxydim and fluazifop-p-butyl) applied at four different rates (0X, 1/3X, 2/3X and full recommended rates) in a split-plot design. The herbicides were applied in the spring of the sprouting or non-cropping year. One site was initiated in the spring of 2000 while the second site was a repeated experiment initiated in the spring of 2001. The third experimental site involved the application of one herbicide (fluazifop-p-butyl) at three rates (0X, 1X, and 2X) over three application timings (early, mid and full bloom) in the cropping year. This sites was initiated in the spring of 2001. Visual and quantitative ratings for phytotoxicity were taken throughout the summer months on both *D. spicata* and wild blueberry. Wild blueberry stem lengths and floral and vegetative bud numbers were measured in the fall of the sprouting and early summer of the cropping years. *Danthonia spicata* heights and densities were measured periodically as well as soil moisture. Yield, berry weights and harvest efficiency measurements were taken on the first sprout year applied site and the crop year applied site.

Objectives

The objectives of the proposed research were to (1) compare and contrast the effects of sub-lethal doses of several herbicides on *D. spicata* and wild blueberry; (2) determine how well selected herbicides suppress *D. spicata*; (3) analyse the effects of the herbicides on the competitive ability of D.spicata**;** (4) analyse the effect of suppressed *D. spicata* on soil moisture: and (5) determine the effect of utilizing suppressed D. spicata in a vegetation management strategy for wild blueberry.

Preliminary Results

In the sprout year applied sites fluazifop-p-butyl showed it had a significantly greater suppression effect on D. spicata, than all other treatments. It also showed no significant phytotoxic effect on wild blueberry compared to the weedy check. Soil moisture measurements in the first sprouting year site indicated that nicosulfuron/rimsulfuron, which left the grass less healthy, maintained a lower soil moisture than fluazifop-p-butyl applied treatments. Due to fluazifop-p-butyl's performance in the sprouting year trials, it was selected to look at in a cropping year application trial.

In the cropping year applied trial, fluazifop-p-butyl showed effective suppression at all rates and all timings. However, initial results show a trend for an increase in crop yield with a higher rater (2X) application. There was also a factor interaction between rate and timing with regard to berry number per stem. At the 1X or 2L/Ha rate, berry number per plant increased with a later application timing. At the 2X or 4 L/Ha rate, berry number per plant decreased with a later application timing.

Conclusions

Fluazifop-p-butyl may minimize significant poverty oat grass competition pressures in lowbush blueberry, while maintaining a living and adequate ground cover to control erosion in bare areas. Nicosulfuron/rimsulfuron showed good poverty oat grass control, in the sprouting year applied trials, but it did not maintain an effective vegetative cover. In the cropping year applied trial it was shown that application timing of fluazifop-p-butyl may increase berry numbers per plant and also limit *D. spicata* competition and harvesting interference. Although not currently registered for crop year applications this treatment may prove to be a valuable tool for some producers, as part of their overall vegetation management program.

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The identification of critical spray coverage at low carrier volumes using pulse width modulation technology

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Introduction:

The application of herbicides for weed control is common practice throughout Western Canada. One of the largest concerns about spraying is the threat of particle drift (Wolf et al., 1993). The movement of herbicide containing droplets to sensitive areas poses a risk of environmental and economic damage.

One way of reducing drift is through the introduction of low-drift nozzles (Grover *et al.*, 1997). As low-drift nozzles gain popularity, it is necessary to determine the effects of larger droplet sizes on herbicide performance, particularly when low water volumes are being used.

Objective:

The objective of the study was to characterize the droplet size / carrier volume interaction and to try and identify a critical droplet size as a function of water volume. The study evaluated glyphosate, as an example of a product with a systemic mode of action, and glufosinate, as an example of a contact mode of action.

Methods:

The study evaluated three water volumes (45, 85 and 125 L/ha) in conjunction with five droplet sizes (Table 1). Nozzles were chosen or developed so that droplet sizes of approximately 200, 300, 400, 500 and 600 µm volume median diameter (VMD) could be evaluated. Pulse width modulation technology was used in the application of the treatments so that water volume could be altered independent of droplet size. A Capstan Syncro system was used on a plot sprayer at 25, 65 and 100 percent duty cycle to produce the water volumes required.

Table 1. Treatment List

Carrier Volume (L/ha)	Nozzle	Spray Quality (ASAE)	Product	Product Rate
45	XR11003	Fine-Medium	Roundup Transorb	0.5 L/acre
85	DG11003	Medium		0.25 L/acre
125	RF 03	Medium-Coarse		
	RF 03/04	Coarse	Liberty	0.35 L/acre
	RF 03/05	Very Coarse		0.675 L/acre

Applications were made to three different simulated weed types, oriental mustard, tame oats and tame buckwheat. These three plant types were chosen to represent a range of plant architectures, wettabilities and susceptibilities to herbicides.

Results and Discussion:

For brevity, only the glyphosate results will be discussed in this report.

Results from the first year of the study indicate that effective control of all three plant species was obtained at the 85 L/ha and 125 L/ha water volume at all five droplet sizes. When the water volume was reduced to 45 L/ha, a reduction in efficacy began to appear.

On easy to kill broadleaf weeds such as mustard, droplet sizes from 200-400 µm VMD maintained an adequate level of control with 45 L/ha water volume. When droplet sizes of 500-600 µm VMD were applied, mustard control dropped below 80%.

For grassy weed species such as oats, which have lower droplet retention values than broadleaf weeds, the critical droplet size for maintaining efficacy throughout the growing season was 200 µm VMD. Suppression of oats was maintained up to 400 µm VMD. Droplet sizes of 500 and 600 µm VMD had very little effect on the oats (Figure 1).

The results for buckwheat, a difficult to control weed, indicated that the 45 L/ha water volume should not be used with droplet sizes of 200µm VMD or greater. Larger droplet sizes were efficacious at the higher water volumes.

Weed control at 45 L/ha was lower than control at the higher water volumes. These results appear to be contrary to previous studies that indicated higher efficacy with glyphosate at lower water volumes (Knoche, 1994). A possible basis for these results is the size of the droplets at 45 L/ha. Other studies have used finer sprays at lower volumes, whereas the pulse width modulation technology allowed us to use fairly coarse sprays. It is possible that as droplet size increases, glyphosate performance begins to drop with decreasing water volume. Alternatively, the reduction in ratings could be a result of the severe drought conditions that were faced throughout the growing season around Saskatoon, or as a result of using a different formulation of glyphosate than was used in earlier published studies. Additional work will be evaluated in the lab and field to determine if the results were unusual due to external factors, or if they are in fact a result of droplet size.

Conclusions:

Information on the interaction of nozzle droplet size and water volume could be used by applicators to determine how coarse a spray they could use given a certain water volume and target weed species. The ability to maximize drift reduction while optimizing efficiencies through appropriate choices of water volume will be of value to herbicide applicators throughout Canada.

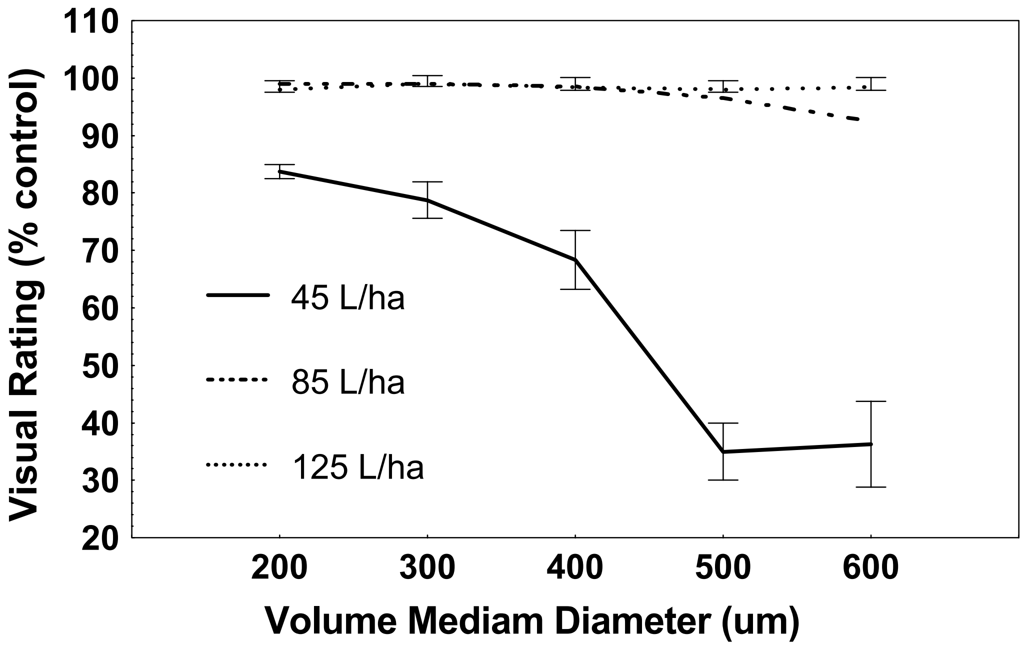

Figure 2. Visual Evaluation of Glyphosate at the full rate on oats 5 WAT.

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Evidence of cyclical dormancy behaviour in spring *B. napus*

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Introduction

In western Canada, survey and small plot research has shown that volunteer canola persists for at least four years in rotation (Derksen at al. 1999; Thomas et al. 1999). Presently, very little is known about the seedbank ecology of this species in western Canada. Research in Europe has shown that *B. napus* can be readily induced into secondary dormancy by a combination of darkness and moisture stress (Pekrun, 1994). Nevertheless, field studies have revealed that only a small proportion of seeds persist via secondary dormancy in Europe (Pekrun et al. 1998).

Canadian *B. napus* genotypes differ in their potential for induction into secondary dormancy using a laboratory assay. High temperatures are perhaps the most important contributing factor to the induction of secondary dormancy (Gulden et al. 2000), while low temperatures rapidly remove secondary dormancy. These observations suggest the seedbank ecology of a typical summer-annual weed where germination is limited to spring.

Field emergence in a volunteer canola persistence experiment under two contrasting tillage systems seemingly agree with these laboratory observations, as no emergence of volunteer canola was observed beyond mid-June. In contrast, volunteer canola may germinate throughout the entire growing season in Europe (Pekrun et al. 1998). Nevertheless, it is was not clear from our field observations whether the lack of summer emergence of volunteer canola was the result of loss of viability or induction into secondary dormancy. The objectives of this experiment are to determine the fate of the *B. napus* seedbank over the growing season as influenced by genotype, location, burial depth and tillage system.

Materials and methods

B. napus cultivars, LG 3295 and Option 501, with the most divergent potential for the development of secondary dormancy were chosen for this field experiment. A series of eight 14 x 14 cm plastic pots with modified bottoms to facilitate drainage were buried level to the soil surface in each treatment, in four zero tillage and four conventional tillage plots, at two locations (Kernen and Dundurn) near Saskatoon, Sk. As the pots were filled with soil, two hundred *B. napus* seeds (app. 10,200 seeds m^{-2}) were sprinkled on the soil surface at depths of 1 and 10 cm, prior to completely filling each pot with soil. The pots were buried in October of 2000. In the zero tillage treatment, pots were buried between two adjacent rows of stubble. The soil was placed in the pots in the same order as it was removed from the field to maintain the soil moisture gradients as they occurred in the field. Effort was taken not to disturb the stubble in the zero tillage system to maintain maximum snow trapping ability.

At various times throughout the year, one pot per repetition was exhumed from each treatment. The pots were placed into a growth cabinet at a constant temperature of 15C and irrigated. Germination of canola was monitored for two weeks. Immediately following germination, the remaining seeds were washed from the soil, placed in petri dishes containing moistened filter paper and stratified in a refrigerator (app. 3C) for 7 days. After stratification, the petri dishes were placed in a 15C cabinet and germinated for a further 2 weeks. Percent dormancy was calculated from the post-stratification germinated seeds in relation to the original seedbank additions. Field emergence, soil temperatures as well as gravimetric soil moisture contents were measured at each location throughout the year.

Results and Discussion

At both locations, little secondary dormancy was observed at the shallow (1 cm) burial depth (Fig.1b, d) in both genotypes. Total visible emergence decreased to zero at both locations and in both genotypes by the mid September exhumation date (data not shown), indicating that no non-dormant viable seeds remained in the seedbank by September. Thus, the persistence of the volunteer canola seedbank is minimal at shallow burial depths, irrespective of genetic potential for induction into secondary dormancy. These results are similar to those in winter canola in Europe where shallow burial decreases persistence (Pekrun et al. 1998).

At the 10 cm burial depth, an interaction between genotype and location in the induction into secondary dormancy was observed within exhumation dates. This interaction began in June and continued for the remainder of the year (Fig. 1a, c). The genotype with high potential for the development of secondary dormancy (LG 3295) exhibited significantly higher levels of secondary dormancy in a clay soil (Kernen) than in a sandy soil (Dundurn). Little secondary dormancy was detected at both locations in Option 501, suggesting low potential for persistence. During the germination phase following exhumation, few seedlings emerged from the 10 cm burial depth at any time of the year. Thus, the quantity of non-dormant viable seeds at the 10 cm burial depth cannot be determined accurately.

The observed increase in secondary dormancy in LG 3295 over time at the 10 cm burial depth at Kernen (Fig. 1a) corresponds well to our laboratory findings where secondary dormancy was greater for equal thermal induction periods at temperatures above 15C than below 10C (Gulden et al. 2000). The mean soil temperatures for 30 days prior to each exhumation date under conventional tillage at Kernen were -0.03C (+/- 1.02 C), 7.92C (+/- 4.33C), 14.86C (+/- 1.79C), and 19.54C (+/- 1.71C) for mid-April, -May, -June, and -September, respectively. These observations were similar to those reported by Baskin and Baskin (1988) in other species and resemble the seed ecology of a summer-annual with a temperature dependent annual dormancy cycle.

The field emergence pattern of volunteer canola was seasonal in nature in this experiment, as field emergence was observed prior to mid-May only (data not shown). A general lack of precipitation may have been one of the contributing factors that limited emergence as well as differences among tillage systems. Nevertheless, our data indicate that the lack of summer emergence of volunteer canola appears to be the result of both, a loss in seed viability at shallow burial depths as well as induction into secondary dormancy at deeper burial depths (Fig. 1). The experiment is still ongoing and further exhumations will be required to verify the occurrence of an annual dormancy cycle in *B. napus*.

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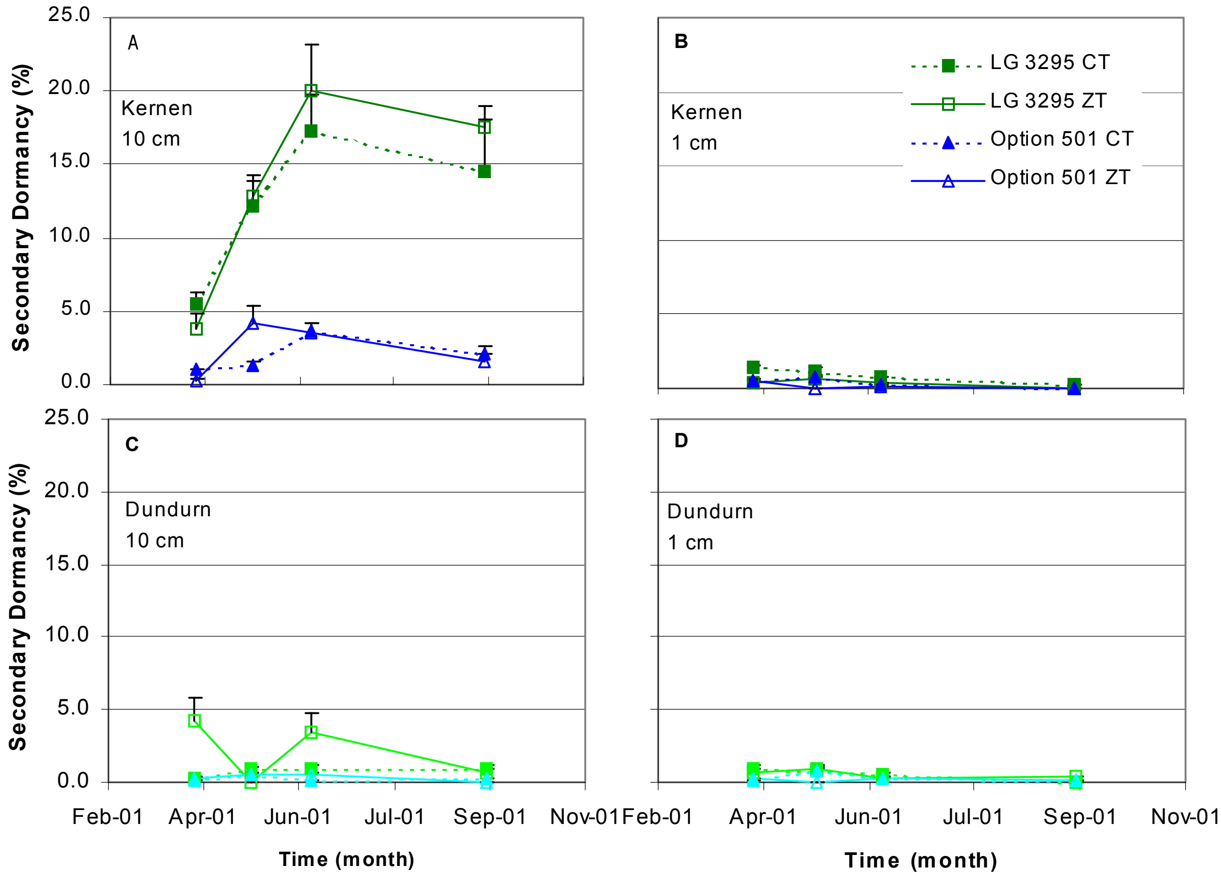

Figure 1. Secondary dormancy in two *B. napus* cultivars over time as affected by soil type and burial depth in conventional (CT) and zero-tillage (ZT). Standard errors of the mean are indicated.

Poster Abstracts

Establisment of competitive vegetation cover to reduce common ragweed (*Ambrosia artemesiifolia* L.) along roadsides. Massicotte R.[1], DiTommaso A.[1], Beaumont J.P.[3], Bédard Y.[3], Watson A.K.[2] [1]Dep. Of Crop Science , Cornell University, Ithaca, USA [2]Dep. Of Plant Science of Mc Gill University, Sainte-Anne-de-Bellevue, Québec; [3]Ministère des Transports du Québec

Field trials were performed in 1998 and 1999 to evaluate the potential of establishing an effective competitive vegetation cover for suppression of common ragweed along roadsides of three major Québec highways in Pointe-Claire (autoroute Félix Leclerc), Mascouche (autoroute 25), and Québec City (autoroute Henri IV) regions. Along these roadsides, common ragweed was found at densities as high as 2000plants m ^{2} within the first 2 meters from the paved highway shoulder. This relatively homogenous region was characterized by highly compacted, coarse, alkaline soils having relatively elevated salinity levels (300 µg/ g soil) and low organic matter content (< 1,5%). Based on the edaphic conditions and preliminary seeding trials in 1997 in each of three seeding mixtures comprising various proportions of total of five legume and grass species were selected for further testing. The selected species included *Trifolium repens*, *Medicago lupulina*, *Puccinellia distans*, *Festuca rubra* and *Lolium perenne*. A number of criteria was used for selecting the given species including the ability for rapid growth and production of a dense canopy so as to provide an effective means of competing for available light with emerging common ragweed plants. Following mechanical tillage of 3 m x 20 m roadside experimental plots to a depth of 4 to 6 cm, the three mixtures were seeded in May 1998 using a manual seeder. First summer, in two of three sites, white clover (*Trifolium repens*) was most successful at establishing. In the Pointe-Claire site, saltmarsh grass (*Puccinellia distans*) was the dominant species within treatment plots. Regardless of the dominant species within the established vegetation, findings from this single growing season demonstrated that common ragweed densities could be reduced by as much as 95% in treated plots compared with initial common ragweed densities in these same plots or tilled (but not seeded) control plots. In 1999, the cover of *Trifolium repens* was reduced but the Festuca rubra density was higher thal last year. In two sites (Pointe-Claire and Mascouche) the mixture didn't well resisted at the winther. The result at Québec site was much better. We obtained again a reducing cover and number of ragweed plants at this site. The principal reason of this success at this site was the well edaphic conditions.

La table québécoise sur l'herbe à poux partager l'expertise pour mieux influencer. Gauvin D. (1), Masson E. (2), Poulin C. (2), Goulet A.-M. (2), Hamel-Fortin S. (3), Christin C. (4) [1]Direction de la santé publique de Québec; [2] Direction de la santé publique de la Montérégie; [3]Direction de la santé publique de Lanaudière; [4]Direction de la santé publique de Montréal-Centre.

La Table québécoise sur l'herbe à poux (TQHP) a été créée sous l'impulsion des Directions de la santé publique (DSP) afin de faciliter l'arrimage entre les principaux acteurs dans le but d'améliorer l'efficacité des interventions. Les partenaires proviennent de divers horizons : Association de lutte contre l'Ambrosia A.L.C.A. Québec, Canadien National, Directions de santé publique de Lanaudière, de la Montérégie, de Montréal-Centre et de Québec, Hydro-Québec, Fédération québécoise des municipalités, ministères des Affaires municipales et de la Métropole,

de l'Agriculture, des Pêcheries et de l'Alimentation, de l'Environnement et des Transports, Union des municipalités du Québec, Union des producteurs agricoles.

La concertation des partenaires publics et privés permet de décupler l'expertise et de travailler conjointement sur un ensemble de facteurs déterminants. L'image projetée en est une de responsabilités partagées et autorise également une plus grande notoriété des efforts investis par des organisations autres que les DSP. Le consensus reste fragile entre des intervenants qui peuvent parfois avoir des intérêts divergents. Les DSP constituent un liant très important en coordonnant les activités de la table sous l'angle des risques à la santé.

Bien que créé récemment, la TQHP compte déjà à son actif de nombreuses réalisations dont, entre autres, la publication du bulletin d'information *Le Flash herbe à poux* diffusé à fréquence régulière à toutes les municipalités concernées, la réalisation d'une enquête provinciale sur l'implication municipale dans le contrôle de l'herbe à poux, la parution de plusieurs articles de fond dans les revues spécialisées et rejoignant les clientèles cibles, etc. Cette année, le point d'orgue de la TQHP sera le lancement d'une trousse d'aide destinée aux responsables d'entretien des terrains, des services d'inspection ou des gestionnaires de l'environnement. Cet outil, qui se veut simple et efficace, couvre tous les aspects d'un plan d'intervention. Son efficacité sera en lien direct avec l'adhésion des élus et l'engagement des décideurs. Ainsi, le partenariat, largement inspiré par les DSP, sera un facteur déterminant d'influence dans la stratégie de communication et de diffusion.

Remote sensing for crop/weed discrimination? Anne M. Smith and Robert E. Blackshaw. Agriculture and Agri-Food Canada, Research Centre, 5403 1st Avenue South, Lethbridge, Alberta, T1J 4B1

The technique of spectral mixture analysis provides the ability to obtain information from a remote sensing image at sub-pixel scales and may offer a method for mapping weed infestations in a crop. However, the success of spectral mixture analysis is dependent upon the spectral separability of the weed and crop species. An experiment was conducted to determine the reflectance characteristics of five weed and two crop species of economic importance on the Canadian prairies. The weeds included green foxtail (*Setaria viridis*), wild oat (*Avena fatua*), lamb's-quarters (*Chenopodium album*), redroot pigweed (*Amaranthus retroflexus*) and wild mustard (*Sinapis arvensis*) and the crops included wheat (*Triticum aestivum*) and canola (*Brassica napus*). A field spectroradiometer and integrating sphere were used to collect reflectance (350-2500 nm) from the uppermost fully expanded leaf of field grown plants. The data were subjected to discriminant function and canonical analyses to assess the wavelengths of greatest importance in separating the various species, and the spectral separability of the seven plant species. Results indicate that the broadleaf weeds are separable from the grassy crop (wheat) and that the grassy weeds are separable from the broadleaf crop (canola). Within the broadleaf species, lamb's-quarters is separable from canola, redroot pigweed and wild mustard. Within the grasses, green foxtail is separable from wheat and wild oats. The potential for hyperspectral remote sensing to map weed infestations in a crop merits further study.

Evaluation of a model for estimating barley yield loss due to wild oat. J. T O'Donovan, Agriculture and Agri-Food Canada, Beaverlodge, Alberta; K. N Harker and G.W Clayton, Agriculture and Agri-Food Canada, Lacombe, Alberta; R. E Blackshaw, Agriculture and Agri-Food Canada, Lethbridge, Alberta; D. Robinson, Alberta Research Council, Vegreville; D. Maurice, Westco, Calgary, Alberta.

A regression model based on wild oat (*Avena fatua* L.) and barley (*Hordeum vulgare* L.) plant density, and relative time of emergence is being used in western Canada to advise farmers on the economics of wild oat control with herbicides. Experiments were conducted in farmers' fields sown to barley in 1997, 1998 and 1999 to evaluate the reliability of the model in estimating barley losses due to wild oat. Nine fields were assessed over the three-year period. Correlation between actual and predicted barley yield loss was high. With few exceptions, the model accurately predicted whether or not a herbicide application resulted in a net profit or loss. Under certain cost and price assumptions, herbicide application was rarely economical. Thus, decision-makers using the model can advise on the need for wild oat control in barley with increased confidence. Seed production by unsprayed wild oat was determined from a second regression model derived from data collected in five of the fields. Wild oat seed production was influenced by barley plant density, and decreased considerably as barley density increased. Seeding barley at relatively high rates will minimize wild oat seed production and possibly the long-term risk associated with not spraying.

Sulfonylurea resistant spiny annual sow thistle can be managed with alternative herbicides. Abdur Rashid[1], Jeff Newman[1], John O'Donovan[2], Darren Robinson[3] and Denise Maurice[4]; [1]Crop & Plant Management, Alberta Research Council, Vegreville, Alberta ; [2]AAFC Research Station, Beaverlodge, Alberta; [3]Agronomy Department, University of Guelph, Ridgetown, Ontario; [4]Agronomy, Westco Fertilizers Ltd., Calgary, AlbertaWe investigated the response of two sulfonylurea (SU) resistant (R) and two susceptible (S) spiny annual sow thistle (*Sonchus asper*) populations to three SU and a number of alternative herbicides *viz.* Ally® (*metsulfuron-methyl*), Refine Extra® (*thifensulfuron-methyl + tribenuron-methyl*), and Telar® (*chlorsulfuron*), Crossfire® (*tribenuron-methyl + metribuzin*) + MCPA, 2,4-D, Roundup® (*glyphosate*), Attain® (*fluroxypyr + 2,4-D*), Buctril M® (*bromoxynil + MCPA*), Curtail M® (*clopyralid + MCPA*), DyVel DS® (*2,4-D + mecoprop + dicamba*), Target® (*MCPA + mecoprop + dicamba*), and Liberty® (*glufosinate ammonium*). Visual injury data recorded 20 days after herbicide treatment (DAT) indicate that both R populations were highly resistant to all SU herbicides, but were adequately controlled by herbicides with alternate modes of action. The S populations were controlled by all herbicides tested. Data on shoot biomass production, determined 25 DAT indicate that the resistance ratios, generated from the equation, $G_{50}R/GR_{50}S$ (GR_{50} = the herbicide rate required to reduce the shoot biomass by 50%), ranged from 33 to >9k for SU herbicides, and only 0.4 to 1.3 for the alternative herbicides tested. *In vitro* acetolactate synthase (ALS) activity determined in the presence of *metsulfuron methyl* indicates that the resistant ALS was 440 times more resistant than susceptible ALS ($I_{50}R/I_{50}S$ = 440; I_{50} = the concentration of the herbicide required to inhibit ALS activity by 50%). Replacement series experiments conducted and RelativeCrowding Coefficients calculated indicate that R populations produced more shoot biomass and leaf area compared to S populations. We conclude that (i) R populations were selected through the application of SU herbicides in the fields, (ii) R populations are more competitive than S populations, (iii) resistance is related to ALS modification i.e. target-site based, and (iv) R populations can be managed by herbicides with alternate modes of action.

Climatic factors affecting herbicide performance. Abdur Rashid[1], Sandi Checkel[1] and John O'Donovan[2]. [1]Crop & Plant Management, Alberta Research Council, Bag 4000, Vegreville, Alberta T9C 1T4. [2]AAFC Research Station, Beaverlodge, Alberta T0H 0C0

We investigated, under controlled environmental conditions, the impacts of cold temperature (CT) and soil moisture stress (SMS), on the performance of Achieve® (*tralkoxydim*) Achieve Extra Gold® (AEG®, (*tralkoxydim* + *bromoxynil* + *MCPA*), Horizon® (*clodinafop-propargyl*) and Accord®(*quinclorac*) with regard to crop tolerance and weed control. Major findings include: (a) at the recommended rate (RR), AEG® caused significant biomass reduction in both wheat and barley, when determined 4 weeks after application, even under a constant temperature (T1) regime; (b) at the RR and/or twice the RR, Achieve® and AEG® caused biomass reduction both in wheat and barley, but this effect was observed under all of the three temperature regimes tested *viz.* T1, T2 (CT before spraying), and T3 (CT after spraying). This suggests that CT did not significantly affect the tolerance of wheat or barley to Achieve® or AEG®; (c) at the RR or even twice the RR, Horizon® or Accord® did not cause significant biomass reduction in wheat under any of the three temperature regimes; (d) The efficacy of Achieve® and AEG® on wild oat control was reduced when the plants were subjected to the T3 regime; the loss of efficacy was higher with Achieve® than with AEG®; (e) the efficacy of Horizon® or Accord® on the control of wild oat or green foxtail appeared to be not significantly affected by CT, particularly at their RR; (f) based on loss of efficacy due to CT, these herbicides can be graded as Achieve® >> AEG® > Accord® ~ Horizon®; (g) despite considerable variations in the response of crops to the herbicides when subjected to SMS either before spraying (M2) or after spraying (M3), the overall crop tolerance was not significantly affected by moderate or even by elevated SMS; (h) herbicide efficacy on weed control was slightly reduced when the plants were subjected to moderate SMS (SMC~15%) but were significantly reduced when subjected to elevated SMS (SMC~10%); (i) in the majority of cases, loss of efficacy of the herbicides on weed control was higher when the plants were subjected to M3 regime compared to M2 and M1 (no moisture stress) regimes. Based on the loss of efficacy due to SMS, the herbicides can be ranked as: Achieve® >>Accord®> AEG®~ Horizon®; (j) while there were some non-specific interactions of two stresses on crop tolerance to the herbicides, and their rates, the overall tolerance of the crops to the herbicides appeared to be not noticeably affected when the plants were subjected to the combined action of the two stresses; (k) the combined interaction of two stresses on the efficacy of the herbicides on weed control was either more antagonistic (particularly at 0.5x rate) or similar to that caused by one of the two stresses. Based on the degree of antagonism, the herbicides can be ranked as: Achieve® >> Accord® > AEG® ~ Horizon®.

Recent weed population shifts in alberta. A. Gordon Thomas[1], Julia Y. Leeson[1], Linda M. Hall[2], John Huffman[2], Trevor Kloeck[2], Russel Horvey[2] and Rob Dunn[2]. [1]Agriculture and Agri-Food Canada, Saskatoon, SK; [2]Alberta Agriculture, Food and Rural Development

The comparison of the relative abundance of weeds in Alberta in 2001 with results from the 1997, 1987-1989 and 1973-1977 provincial surveys enables the identification of recent shifts in selected weed populations. In 2001, 1153 fields of spring wheat, durum, barley, oat, canola and field pea were surveyed in Alberta. These fields were selected using a stratified random sampling procedure based on ecodistricts. In each field, weeds were counted in 20 quadrats (50 by 50 cm) in late summer. Weed data are summarized using a relative abundance index based on frequency, field uniformity and density. Wild buckwheat was the most abundant weed in 2001, wild oats ranked second, and chickweed ranked third. The list of the twenty most abundant species included five perennials (Canada thistle, dandelion, field horsetail, quack grass and perennial sow-thistle). The results from the 2001 survey are compared to results from surveys of 685 fields in 1997, 1113 fields in 1987-1989 and 3109 fields in 1973-1977. Weed community composition has been similar since the 1970's; however, shifts have occurred in relative abundance of the top twenty species. Twelve species have been ranked amongst the top twenty most abundant species in each survey. These species are the thirteen most abundant species in 2001 with the exception of cleavers. Seven species ranked in the top twenty species in the 1970's and/or 1980's have since declined (Tartary buckwheat, wild mustard, corn spurry, redroot pigweed, clover species, Russian thistle, bluebur). Six species have appeared in top twenty most abundant species in the 1997 and/or 2001 (cleavers, annual sow-thistle, volunteer wheat, pineappleweed, quack grass, narrow-leaved hawk's-beard).

Susceptibility of sweet corn (*Zea mays*) to the rotary hoe. Maryse L. Leblanc [1] and Daniel Cloutier [2]. [1] Researcher, Institut de Recherche et de Développement en Agroenvironnement, P.O. Box 480, Saint-Hyacinthe, Québec, Canada J2S 7B8; [2] Researcher, Institut de malherbologie, P.O. Box 222, Sainte-Anne-de-Bellevue, Québec, Canada H9X 3R9

Mechanical weeding of corn usually requires two weeders, one to weed at the beginning of the season and a second to weed between crop rows later in the season when the crop is more developed. Inter-row weeding is generally well established. However, weeding at the beginning of the growing season is more problematic. Weeds that become established during this period can cause considerable loss and therefore, must be removed as early as possible both on and between rows. One of the rare weeders currently available that can perform this task is the rotary hoe. The rotary hoe can cultivate 2 to 4 times faster than a regular inter-row weeder and so save time and money. It is most effective when it is used on germinating weeds prior to emergence or at the cotyledonary stage. However, there is the possibility of damage to the crop since the rotary hoe cultivates on the row. Sweet corn can tolerate some cultivation by the hoe. However, a systematic study to identify the susceptible growth stages has never been performed. This information is essential to develop mechanical weed control programs that will aid producers in the management of their crops. The objective of this project was to determine the susceptibility to cultivation of various growth stages of three varieties of sweet corn: early, mid-season and late-season and at two seeding date (only mid-season and late-season varieties were seeded at the second date). Five experiments were seeded both in 1999 and 2000. In order to prevent confounding by weed interference, this study was conducted in a weed-free environment by first treating the field with selective herbicides. According to the results observed in this experiment, sweet corn can be cultivated with the rotary hoe at any growth stage, from pre-emergence to 6th leaf. The pre-emergence to 2 leaf stage appears slightly more susceptible to cultivation damage than the other growth stages studied in this project but yield was not affected. Sweet corn yield was not significantly decreased by up to four cultivations in six of the nine experiments in this project. One, two or three cultivations with the rotary hoe were beneficial to the crop and, in the absence of weeds, this is probably due to breaking the soil crust and/or decreasing insect damage. Late-season corn suffered slightly more damage by cultivation and had more insect damage than the other types of corn in this project. The type and condition of soil plays an important role in the susceptibility of corn to cultivations with the rotary hoe. Risks of crop damage increase in dry light soils.

Effect of endemic *Colletotrichum gloeosporioides* f. sp. *malvae* on round-leaved mallow (*Malva pusilla*) in Nova Scotia. Cheryl Konoff*, Klaus Jensen and Paul Hildebrand. Atlantic Food and Horticulture Research Centre, Agriculture and Agri-Food Canada, Kentville, Nova Scotia B4N 1J5. * Current address: Pacific Forestry Centre, Canadian Forest Service, Victoria, BC.

The fungal pathogen, *Colletotrichum gloeosporioides* f. sp. *malvae* (*Cg-malvae*), is widely distributed in Nova Scotia and was found on 85% of surveyed round-leaf mallow (rlm) sites. Naturally occurring *Cg-malvae* provided good control of the weed by late summer in three rlm-infested orchards studied. Here disease reduced RLM topgrowth by >98% and seed production by about 60% compared to that of disease-free, nursery-grown plants. Seedling mortality due to infected seed (0.2% of emerging seedlings) or contact with diseased rlm litter on the soil surface (1%) was low. However, spread of primary inoculum from infected seedlings within a site by physical means (rainsplash, machinery, livestock) can induce epidemics resulting in significant rlm control under favorable conditions. At former 'classical' release sites in orchards and barnyards, *Cg-malvae* has persisted and provided control for 5 years. *Cg-malvae* has been extensively studied as a mycoherbicide, namely BioMal, but the pathogen can also persist in certain non-arable agricultural habitats and provide control under favorable conditions.

Occurrence and management of hexazinone tolerant native grasses in lowbush blueberry. Klaus Jensen and Glen Sampson*, Atlantic Food and Horticulture Research Centre, Agriculture and Agri-Food Canada, Kentville, Nova Scotia B4N 1J5. * Environmental Sciences, Nova Scotia Agricultural College, Truro, Nova Scotia B2N 5E3.

Initially hexazinone controlled most woody and herbaceous weeds, including grasses, when introduced into lowbush blueberry culture in 1981. Continuous use of hexazinone has resulted in soil degradation problems and changes in weed populations, including the recent selection of hexazinone tolerant populations of native grasses. Among these are: *Agrostis hyemalis*, *A. stolonifera, Danthonia spicata, Festuca capillata, F. ovina, Muhlenbergia mexicana, Panicum* *uliganosum* and the annual weed *P. capillare, Poa compressa, P. palustris, P. pratense* and possibly several others. Growth response experiments typically indicate a 3- to 4-fold increase in tolerance over 'wild' non-exposed populations which permits their survival and spread in hexazinone-treated fields. The presence of native grasses may be beneficial because they stabilize eroding soils, encourage expansion of the blueberry clones, and suppress other weeds. Some hexazinone tolerant grasses (e.g. *A. hyemalis, D. spicata, or P. compressa*) appear to be useful ground covers in this crop because they can be managed (suppressed) with selective graminicides, e.g. fluazifop-P, particularly in the fruiting year when they impede mechanical harvesting.

The elusive nature of weed seed bank-aboveground flora relationships in cereal-forage cropping systems. F. Craig Stevenson, Saskatoon, SK; Anne Légère, AAFC Sainte-Foy; Diane Lyse Benoit, AAFC Saint-Jean; Nathalie Samson, Lac Beauport, QC.

This study examines the relationship between the seed bank and aboveground population density of selected weed species, as affected by cropping practices in cereal-forage systems. A cropping systems study, initiated in the fall of 1987 at La Pocatière, QC, included crop rotation, tillage, and weed management treatments. The density of the aboveground (mid-summer, after postemergence weed control) and seed bank (prior to fall primary tillage) flora were assessed from 1989 to 1992. Field pennycress (*Thlaspi arvense*) seed bank density was four times greater, and aboveground density was 16 times greater, when minimum weed management was compared with more intensive weed management treatments across all years. Shepherd's-purse (*Capsella bursa-pastoris*) aboveground density response to weed management was similar to that for field pennycress. However, shepherd's-purse seed bank density did not differ among weed management treatments. Dandelion (*Taraxacum officinale*) aboveground density was much greater in reduced tillage (chisel plow and no-till) treatments than in the moldboard plow treatments, especially in the barley-red clover rotation compared with the barley monoculture. Similar treatment differences occurred for the seed bank. However, average dandelion seed bank density among the treatments did not exceed 4 propagules m^{-2}. Preliminary results indicate that the effect of cropping practices on the relationship between the seed bank and aboveground density is variable and species dependent.

5-keto Clomazone inhibits 1-Deoxy-D-Xylulose 5-Phosphate Synthase of non-mevalonate pathway in isoprenoid biosynthesis. Y. Ferhatoglu, M. Barrett, and J. Chappell. Department of Agronomy, University of Kentucky, Lexington, KY 40546

Clomazone or an active clomazone metabolite(s) is thought to inhibit chlorophyll and carotenoid biosynthesis through inhibition of a step(s) of the isoprenoid pathway. Historically, isoprenoid biosynthesis was thought to proceed from mevalonate. However, recently a second isoprenoid pathway localized in the chloroplast and proceeding from pyruvate and glyceraldehyde-3-phosphate was identified. The new chloroplast isoprenoid pathway is responsible for chlorophyll and carotenoid biosynthesis. We developed an assay using isotonic sorbitol for isopentenyl pyrophosphate (IPP) incorporation and slightly isotonic sorbitol solution for pyruvate incorporation into carotenoids to test the effect of clomazone and clomazone metabolites on the chloroplastic isoprenoid pathway. Clomazone and clomazone metabolites did not inhibit formation of products from IPP in the studies using intact spinach chloroplast. However, a clomazone metabolite 5-keto clomazone and the 1-Deoxy-D-Xylulose 5-Phosphate (DOXP) reductoisomerase inhibitor fosmidomycin inhibited the formation of a non-polar product cochromatographed with xanthopyll when pyruvate was used as a precursor. DOXP reductoisomerase is the 2^{nd} step in the chloroplastic isoprenoid pathway. Although 5-OH clomazone, 5-keto clomazone, and clomazone (parent) all showed herbicidal activity on *Catharanthus roseus* seedlings, in an in vitro assay only 5-keto clomazone inhibited DOXP synthase. DOXP synthase catalyzes the 1^{st} committed step in the chloroplastic isoprenoid pathway. Our present hypothesis is that clomazone (inactive) is converted to 5-OH clomazone (inactive) which is, in turn, converted to 5-keto clomazone (active). The activity of keto clomazone against DOXP synthase was also recently demonstrated by Mueller et al. (2000).

Competition dynamics and competition management in young spruce-aspen mixtures. Phil Comeau. Center for Enhanced Forest Management, Department of Renewable Resources, University of Alberta

Competition from aspen can reduce growth and survival of white spruce. Treatments that reduce competition can provide substantial increases in growth of white spruce. However, the presence of aspen in a stand can contribute to stand health, amelioration of frost and other problems, biodiversity, productivity, and long-term sustainability. In addition, aspen is a potential fibre source and is heavily utilized in many areas. This poster briefly describes a series of studies that are being initiated to advance our understanding of both temporal and spatial aspects of competition and to provide a basis for development and refinement of prescriptions for managing boreal spruce-aspen mixtures. Major study components are examining: 1) Spatial influences of aspen on microclimate and growth of spruce seedlings along the interface between young aspen stands and young spruce plantations; 2) Effects of environment on interactions between aspen and white spruce; 3) Temporal dynamics of interactions between aspen and white spruce; 4) Effects of timing of aspen density reductions on subsequent growth of white spruce; and, 5) Effects of radius of removal of young aspen on light and on spruce growth.

Is barley competitiveness against wild oat linked to its mycorrhizal dependency? Lisette J.C. Xavier[1], Susan M. Boyetchko[1] and Douglas A. Derksen[2]. [1]Agriculture and Agri-Food Canada, 107, Science Place, Saskatoon, SK, S7N 0X2; [2]Agriculture and Agri-Food Canada, Box 1000A, R.R. #3, Brandon, Manitoba

Arbuscular mycorrhizal fungi (AMF) are soil fungi that intimately associate with most crops and influence their productivity. This study determined (i) the mycorrhizal dependency of eight barley cultivars and (ii) whether barley competitiveness against wild oat was linked to its mycorrhizal dependency. Of the eight cultivars tested, Virden was the most dependent on AMF whereas CDC Earl was the least dependent, and Earl and Virden were therefore evaluated for competitiveness against wild oat at weed density ratios of 1:0.5, 1;1, 1:2 and 1:4 with or without

AMF. Regardless of the AMF treatment, the total shoot dry weight of both barley cultivars decreased with increasing crop: weed ratio, Earl derived 32% less benefit than Virden at a crop:weed ratio of 1: 0.5, and at a crop:weed ratio of 1:1, the total shoot dry weight of wild oat competing against Virden was significantly lower than that of wild oat competing against Earl. Regardless of the crop:weed ratio, (i) both barley cultivars responded positively to the AMF mixture, (ii) the total shoot dry weight of AMF-inoculated Virden was 13% higher than that of AMF-inoculated Earl, and (iii) the shoot dry matter ratio of barley:wild oat was greater for AMF-inoculated Virden than Earl. At crop:weed ratios of up to 1:1, AMF-inoculated Virden plants had significantly more total shoot biomass than uninoculated Virden, whereas this was not the case with Earl. In general, wild oat competing against AMF-inoculated Virden had the least shoot dry matter at all the crop:weed ratios compared to all other treatments. These results suggest that the highly mycorrhizal Virden appeared to be more competitive than Earl and indicates that barley competitiveness may be partially linked to its mycorrhizal dependency.

Effect of landscape position on herbicide persistence and injury to following crops. Dr. Jim Moyer - AAFC, Lethbridge, Rob Dunn - AFRD, Lethbridge, Dr. Gerry Coen, AAFC, Lethbridge, Dr. Anne Smith - AAFC, Lethbridge

Residues from imidazolinone and sulfonylurea herbicides can injure following crops in western Canada. Soil organic matter and pH are the two most important properties, affecting both herbicide persistence and the toxicity of residues to following crops. These properties tend to vary depending on field history and landscape position within the field. A field site was identified close to Lethbridge, Alberta with gently rolling topography. The site includes a conventionally tilled field that has large eroded hilltops with low organic matter (OM) and high calcium carbonate ($CaCO_3$) levels near the soil surface. The hilltop has a pH and OM content of 7.8 and 1.4%, respectively. The lower slope position has a pH of 5.9 and 2.1% OM. In contrast, the adjacent field with the same topography has been under zero-tillage since about 1980 and minimum tillage was practiced for decades prior to 1980. In this field the upper slope pH and OM were 7.0 and 2.1% while the lower slope pH and OM were 5.2 and 2.6%, respectively. Metsulfuron, imazamox/imazethapyr and atrazine were applied at recommended and 2x recommended rates at both slope positions in both fields in 2000. In 2001 lentils, wheat and canola were seeded where metsulfuron, atrazine and imazamox/imazethapyr were applied in 2000, respectively. Severe injury due to atrazine and metsulfuron occurred on the eroded hilltops under conventional tillage but there was little injury at the lower slope positions. In contrast, imazamox/imazethapyr severally injured canola at the lower slope position under zero-tillage and little injury occurred at the other locations.

Effects of temperature during maturation on Scotch thistle: structural characteristics and germination patterns. Qaderi, M. M., Cavers, P. B., and Bernards, M. A., Department of Plant Sciences, The University of Western Ontario, London, Ontario N6A 5B7

Weeds such as Scotch thistle (Onopordum acanthium) produce seeds that have different degrees of dormancy and germinate intermittently over time create problems in agricultural systems.

Since environmental conditions such as temperature can affect the structural and physiological characteristics of both plants and seeds, we examined its effects on the growth and cypsela (seed) maturation of Scotch thistle. In April 2000, thirty rosettes that had been grown from cypselas and over-wintered in the field were placed in each of two greenhouse rooms maintained at a 5 to 12oC difference in temperature. At various developmental stages, structural (plant height, leaf area) and physiological (time to first flowering and cypsela ripening) characteristics were monitored. From each room, two cypsela collections (early and late) were made. Shortly after each collection cypselas were placed to germinate on moist filter paper in an incubator. Cypselas from each temperature regime for surface and transverse structural characteristics were examined by stereo and/or scanning electron microscopy. We found that plants from the cooler regime had taller and thicker shoots, larger leaves, larger capitula that appeared sooner, and more and larger cypselas with smoother surfaces and thicker coats than those from the warmer regime. However, the germination percentages of cypselas matured under lower temperatures were much lower (40 and 12%; early and late collection, respectively) than those matured under higher temperatures (86.8 and 36.2%; early and late collection, respectively). These findings plus chemical data from the cypselas will help us to predict the intermittency of weed seeds and to design an appropriate control method.

Determining ease of desiccation of the potato (*Solanum tuberosum* l.) cultivar russet burbank using vine components. G.McMillan[1], I. Affleck[1], J. Ivany[2] and G. Sampson[1]. [1]Nova Scotia Agricultural College, Truro, Nova Scotia; [2] Agriculture and Agri-Food Canada, Research Centre, Charlottetown, Prince Edward Island

In recent years, there has been interest in potato producers of P.E.I. harvesting a crop at an earlier point in the season. This is due in part to produce demand and seed quality issues. Conventional practices involve top killing the crop with a chemical desiccant anywhere from the first of September to the middle of October, depending on the crop's intended use. During this period of growth, the potato is in the later stages of its development and is quite easily top killed. An early top killing date necessitates that the potato foliage be completely dead by the middle of August. At this time, the plants are still actively growing and difficult to desiccate. When a desiccant is applied, leaf material readily dies while the vine persists for a considerable period of time. Objectives of this experiment were to determine if there is any relationship between various essential elements found within the vine to desiccation rates. If so, then it is important to determine at what period of plant growth would a desiccant application be most effective. Preliminary results show correlation between the desiccation rate of the vine with vine components such as *N., P., K., Zn.* and others, found in the upper and lower 25 cm of the plant. Results also suggest that these relationships are influenced by the choice of product used for desiccation (diquat and glufosinate ammonium). Results also indicate that glufosinate ammonium will not provide adequate top kill when applied early in the season. Further analysis is being performed to help determine where further studies should be directed.

Control of wild radish (*Raphanus raphanistrum* l.) in seed canola production fields in Atlantic Canada. K. Patterson, T. Dixon and G. Sampson. Department of Environmental Sciences, Nova Scotia Agricultural College, PO Box 550, Truro, N.S. B2N 5E3

Wild Radish (*Raphanus raphanistrum*) is a primary noxious weed prohibited in hybrid seed canola seedlots. Any plants occurring in a seed field must be removed by hand before field inspection, greatly increasing production costs. Two seasons of research have been conducted on the use of standard industry practices and alternatives to those practices for control of wild radish. Current recommendations for herbicide selection and timing do not adequately control wild radish even when applied at target weed growth stages. Ethametsulfuron-methyl applied at rates up to 4 times the recommended rate did not control wild radish and does not represent an option for control of this weed problem. It will remain an important component of a production system for seed canola for weeds that it does control. The effect of pre-plant and pre-emergent herbicide selection and time of seeding (stale seed bed) was examined over two seasons. The products used were glyphosate/glufosinate ammonium, paraquat and glufosinate ammonium applied as pre-plant and pre-emergent treatments. The glyphosate/glufosinate ammonium treatments, particularly the pre-emergent treatment performed very well in both trials and provided the best control of wild radish observed in any of the conventional tillage trials. The effect of pre-plant and pre-emergent herbicide selection under no-till production was examined over the season of 2001. Seed canola produced under no-till cropping systems had significantly less wild radish in the weed population composition than in canola grown under conventional tillage systems. Two, 5-year crop rotation studies including seed canola, soybeans, forages, cereal grains and corn were initiated to assess crop rotation and tillage systems as tools in weed management. Standard post-emergent weed control treatments were applied to the specified crops under both conventional and no-till cropping systems. Further research will be directed at identifying species shift under no-till systems and post-emergent control of these weeds. Additional studies aimed at reducing the time from tillage to seeding operations using a stale seed bed technique are planned.

Crop tolerance of cranberry (*Vaccinium macrocarpon* ait.) to post-emergent weed control products. K. Patterson, S. Savoy and G. Sampson. Department of Environmental Sciences, Nova Scotia Agricultural College, PO Box 550, Truro, N.S. B2N 5E3

Two seasons of greenhouse and field trials to evaluate weed control products for use as post-emergent foliar applications in cranberries have been completed. Trials were conducted at five sites, two in New Brunswick and three in Nova Scotia. Visual ratings on crop tolerance and weed control were taken at intervals throughout the summer. Yield data were collected from three sites which were producing uniformly. In 2000, products which exhibited favourable tolerance for crop tolerance, weed control and yield include: chlorimuron-ethyl, nicosulfuron/rimsulfuron, terbacil and triasulfuron. Some crop injury was caused by triasulfuron initially but the cranberry crop recovered from the symptoms. Products which exhibited fair tolerance include: nicosulfuron, propyzamide, prosulfuron and rimsulfuron. Products which exhibited poor tolerance include: imazathapyr, flumetsulam/clopyralid, napropamide, thifensulfuron-methyl/tribenuron-methyl and tribenuron-methyl. Imazathapyr caused unacceptable crop injury from which the plants did not recover. In 2001, imazathapyr, flumetsulam/clopyralid and napropamide were dropped as post-emergent treatments and quinclorac added. Two products, napropamide and dichlobenil, currently registered for cranberries as early spring prebloom applications were also added as standard treatments. Products which performed favourably for a second season included: chlorimuron-ethyl, triasulfuron and nicosulfuron/rimsulfuron. Also performing well were: rimsulfuron, nicosulfuron, propyzamide and quinclorac. Tolerance improved over the 2000 season while quinclorac was evaluated in 2001 only. Results for terbacil in 2001 were not as favourable as those of 2000 and crop yields were significantly lower in 2001. Products which produced unacceptable results in 2001 were: prosulfuron, tribenuron-methyl and thifensulfuron-methyl/tribenuron-methyl.

Response of a quinclorac-resistant false cleaver (*Galium spurium*) biotype to several auxinic herbicides. Laura L. Van Eerd, Gerald R. Stephenson, and J. Christopher Hall. Department of Environmental Biology, University of Guelph, Guelph, ON N1G 2W1

Due to lack of control following treatment with an ALS herbicide, G. spurium seeds were collected from an Alberta, Canada field. ALS resistance was due to target-site insensitivity resulting from a point mutation in the ALS gene. This ALS-resistant biotype was also resistant to quinclorac. We are interested in characterizing quinclorac resistance in this G. spurium biotype, particularly the pattern of response compared to other auxinic herbicides. Plants were treated at the 3- to 4-whorl stage of development with 1/4, 1, and 4 times the field dose of the following auxinic herbicides: quinclorac, triclopyr, dicamba, fluroxypyr, picloram, clopyralid, and 2,4-D. Plants were harvested 14 DAT. Symptoms varied with the different herbicides and ranged from leaf hyponasty/epinasty to whole plant wilting and death. Differences in phytotoxic response of both biotypes suggest that each auxinic herbicide tested cause slightly different physiological responses in G. spurium. LD50 values for quinclorac-resistant (R) and susceptible (S) biotypes were >1500 and 47 g a.i./ha, respectively. Based on calculated LD50 values, the resistant biotype was moderately resistant to triclopyr but not resistant to the other auxinic herbicides tested.

The effect of competition on the expression of seed size effects in *Thlaspi arvense* L. (Brassicaceae). David J. Susko and Paul B. Cavers. Department of Plant Sciences, University of Western Ontario, London, ON, N6A 5B7

We examined the effects of seed size on plant size and competitive ability of plants from different maternal families of *Thlaspi arvense* (stinkweed) grown with and without competition. For solitary plants from each of four maternal families, seed mass had significant effects on total seedling biomass for the first 30 days of growth, with plants that developed from small seeds being significantly smaller than plants from large seeds. For two families plant-size differences persisted for 120 days of growth, but these size differences disappeared after 60 days for the other two families. This suggests that genotypic differences may play a role in the establishment of size hierarchies in natural populations. Subsequently, small and large seeds (c. 2-fold greater than small seeds) of a single maternal family were sown in monocultures or mixtures (S:L;

100:0%, 75:25%; 50:50%; 25:75%; 0:100%) at each of three densities (4, 8, or 16 seeds pot^{-1}) to assess the influence of competition on the expression of seed-size effects to reproductive maturity. In mixtures, plants from large seeds grew significantly larger and had significantly greater reproductive output than did plants from small seeds. In addition, plants from small seeds were about the same size in both monocultures and mixtures, whereas plants from large seeds in mixtures grew significantly larger than did plants from large seeds grown in monoculture. These size inequalities were amplified as density increased. The duration and extent of differences in plant size arising from seeds of contrasting size depends on both maternal genetic differences and the intensity of intraspecific competition.

Clipping weeds above crop canopy reduces subsequent seedling recruitment. E.N. Johnson[1] and G. Hultgreen[2]. [1] AAFC, Scott, SK., [2]PAMI, Humboldt, SK.

Weed control is a challenge for organic growers. Organic producers rely on crop rotation, cultural practices, and mechanical weed control to control weeds. Some organic producers have experimented with clipping weeds above the canopy of short stature crops such as lentil or flax. A study was initiated in 1999 to develop or modify equipment for weed clipping and to evaluate whether the practice improved crop yield and/or reduced weed seedling recruitment the following growing season. At Scott, a field experiment was conducted over three years (1999-2001) where clipping at various stages of weed development was evaluated. The clipping was done above a lentil crop canopy with a gas-powered hedge trimmer. The Prairie Agriculture Machinery Institute at Humboldt modified the cutting component of a self-propelled swather and carried out field trials on four farmer's fields. At Scott, weed clipping did not result in a detectable lentil yield increase in either year. Although variable, clipping generally reduced subsequent weed seedling emergence. Clipping in 1999 reduced wild oat emergence by 64% in the spring of 2000 if clipping was done after wild oat heading. There was a trend towards lower wild mustard recruitment if clipping was done at the podding stage, however the differences were not detectable. In 2000, wild oat populations were low and clipping had no detectable effect on 2001 recruitment. Clipping at any weed stage past flowering in 2000 resulted in a 95% and 85% decline in wild mustard and common lambsquarters recruitment, respectively in 2001. The PAMI field trials resulted in an average of 80% reduction in wild oat recruitment the year following clipping. While the results are preliminary, weed clipping may have potential as an integrated weed management practice for organic producers. Further study is warranted to improve consistency of results.

Competitive ability of hybrid and open-pollinated canola (*Brassica napus*) with wild oat (*Avena fatua*). Eskandar Zand[1], Hugh J. Beckie[2]. [1]Plant Pest and Diseases Research Institute, Tehran, Iran. [2]Saskatoon Research Centre, Agriculture and Agri-Food Canada, Saskatoon, SK

The competitiveness of three hybrid and three open-pollinated canola cultivars against two wild oat populations was determined under controlled environment conditions at two plant densities (12 and 20 plants per 15-cm diameter pot) and five canola:wild oat ratios (100:0, 75:25, 50:50, 25:75, 0:100). Analysis of replacement series and derivation of relative crowding coefficients

(RCC), based on shoot dry weight or leaf area, indicated that hybrid canola cultivars were more competitive than open-pollinated cultivars when weed interference was relatively high (i.e., high plant density and vigorous wild oat growth). Little difference in competitiveness among cultivars was apparent when weed interference was lower. The results of this study suggest that hybrid canola cultivars may be best suited for use in an integrated weed management program, particularly for growers of organic or low input cropping systems.

Characteristics and biology of wild parsnip. Nancy P. Cain, Cain Vegetation Inc., 5 Kingham Road, Acton, ON L7J 1S3

Wild parsnip is a naturalized, weedy form of the cultivated parsnip. It is found in areas that have undergone disturbance at some time, such as road rights-of-way, fence rows, waste places and edges of agricultural fields, as well as along riverbanks and other drainage courses. The characteristics and life cycle of wild parsnip is presented. Contact with the plant in hot, humid weather results in a characteristic photodermatitis. This is due to exposure of the skin to chemicals in the plant juices called furanocoumarins or psoralens and subsequent sun exposure. Prevention of skin irritation involves preventing exposure to wild parsnip by wearing protective clothing when working around the plant, washing affected skin right after exposure and avoiding sun exposure of exposed skin to prevent the phototoxic reaction. Integrated control programs for wild parsnip involve establishment of perennial vegetation cover to prevent re-infestation of the site by wild parsnip seedlings. Several herbicides have been found to be effective against wild parsnip, especially when used with plant competition to displace the wild parsnip. Chemical and cultural control methods for wild parsnip are reviewed.

How weedy can canola be? The case of overwintering volunteers in no-till. Marie-Josée Simard, Anne Légère. AAFC, Ste-Foy, QC.

In Québec, volunteer canola (Brassica napus) can be very abundant one year after cropping, and volunteers can still be present five years after production. In a no-till situation three types of volunteer canola can be found one year after cropping. Type-1 consists of plants that overwinter as dormant unharvested seeds and germinate in the spring. Type-2 consists of pants that overwinter as rosettes and are issued from unharvested seeds that germinated in the fall, after seed shed. Type-3 consists of crop plants that grow new leaves after harvest, prior to the onset of winter, and overwinter as rosettes. The latter two types are larger and flower earlier than spring-germinated volunteers. This experiment was undertaken to study flowering and seed production by volunteer canola in a no-till cropping system. Flowering and seed production of Types-2 and -3 canola volunteers was monitored during the 2001 growing season. Sixteen canola plots (1.25 m2) grown in year 2000 were left un-tilled after harvest. In spring 2001, seven plants of over-wintered volunteer canola issued from those plots were observed and tagged. Of those, six were of Type-2 and one was of Type-3. The number of flowers per plant was assessed weekly. Biomass and seed production were recorded at maturity. Flowering patterns varied extensively from plant to plant. In general flowering started early June and ended in July. Two volunteer canola plants produced over 3000 seeds. It is therefore concluded that, in Québec, overwintering volunteer canola plants present in a no-till cropping system have the capacity to replenish the seed bank if not controlled.

Development of a Canadian spray drift model for determination of buffer zone distances. Thomas M. Wolf and Brian C. Caldwell. Agriculture & Agri-Food Canada, Saskatoon Research Centre, 107 Science Place, Saskatoon, SK S7N 0X2

As part of its risk assessment for pesticides, the Pest Management Regulatory Agency (PMRA) estimates the off-target concentration of products resulting from spray drift using various mathematical models. Depending on the application method, these models were developed in Europe of the US, and most do not reflect Canadian conditions or current technologies. To effectively assess risk, the PMRA needs to know pesticide dosages at distances up to 100 m downwind for a range of wind speeds and sprayer configuration conditions. A high-clearance self-propelled sprayer with a boom height of 90 cm above ground, travelling 23 km/h and emitting 100 L/ha was compared to a pull-type sprayer with a boom height of 60 cm above ground and travelling 13 km/h. Each sprayer was equipped with conventional and air-induced low-drift tips. Off-target drift was measured using rotorods (initial airborne drift) and horizontal petri plates or vertical drinking straws (downwind fallout to 120 m) at five wind speeds (10 to 30 km/h). With conventional tips (TT11005 for high clearance, XR8003 for pull-type, both at 275 kPa), initial airborne spray drift was equivalent for both sprayers. Use of air-induced tips (TeeJet AI11004 and AI110025 at 415 kPa for high clearance and pull-type, respectively) reduced airborne drift by 43% for the high clearance sprayer, and 77% for the pull-type sprayer. Airborne drift increased with wind speed at a lower rate for the coarser sprays. Downwind fallout was less sensitive to wind speed, nozzle or sprayer choice than initial airborne drift. Drift fallout for a pull-type sprayer with conventional nozzles had the following relationship: log deposit (% of applied) = 0.679 - 1.159 * log distance (m) (r^2=0.97). For the air-induced nozzles, the relationship was: deposit (% of applied) = 0.44 - 1.174 * log distance (m) (r^2=0.96). This information can be used in PMRA risk assessments to more accurately calculate buffer zone distances and to better anticipate the impact of lower-drift application methods.

Allelopathic potential of *Cynoglossum officinale* and *Centaurea maculosa* leaf leachates. S. Li, Q. Dai, B. Adomas, and M.K. Upadhyaya, Faculty of Agricultural Sciences, University of British Columbia, Vancouver, B.C.

Effects of hound's-tongue (*Cynoglossum officinale* L.) and spotted knapweed (*Centaurea maculosa* Lam.) leaf leachates on seed germination and seedling growth of crested wheatgrass (*Agropyron cristatum* (L.) Gaertn.) were studied. Weed leaves collected from natural populations in the Interior British Columbia were dried at room temperature, ground, and the aqueous extracts prepared by incubating leaf biomass (1, 2, 3, and 4% w/v) in 50 ml deionized, distilled water in a rotary shaker (25 °C, 80 rpm) for 4 hours. The extracts were cleared by centrifugation. The effect of leaf extracts on crested wheatgrass seed germination was studies by placing seeds on two Whatman No. 1 filter discs wetted with either 5 ml water or 1, 2, 3, or 4% leaf extract in

9 cm petri dishes (25 seeds per dish, 4 replicates per extract). Seed germination was monitored. Extracts (2% or stronger) of both species inhibited crested wheatgrass seed germination significantly. Seed germination was inhibited by 35 and 58% by 2 and 4% hound's-tongue extracts and 40 and 62% by spotted knapweed leaf extracts, respectively. In a separate study, effects of the weed leaf extracts on crested wheatgrass root and shoot growth were investigated by incubating pre-germinated seeds in water or 0.5, 1, 2, and 3% extracts as described above. Root and shoot elongation and mass were significantly inhibited by the extracts of both weeds. Root elongation was more sensitive than the shoot elongation. Even the 0.5% extract of either weed inhibited crested wheatgrass root elongation significantly. The inhibitions of root elongation and the reductions of root mass by 3% extract were 82% and 76% for hound's-tongue and 82% and 81% for spotted knapweed. These results show possible allelopathic potentials of these weeds.

Boreal Mixedwood natural developmental process and silvicultural implications. Roman Popadiouk and Han Y. H. Chen. Boreal Mixedwood Silvicultural Guide Project Forester Northeast Science & Technology. Ontario Ministry of Natural Resources Hwy 101 East, P.O. Bag 3020, South Porcupine, Ontario P0N 1H0

Boreal mixedwoods (BMW) are most productive and diverse forest ecosystems in the boreal climate. Like other forest ecosystems, BMWs undergo several structural and compositional stages after stand replacing disturbances. The objectives of this paper were to 1) define stand developmental stage by key processes, 2) examine the factors that affect those processes, and 3) discuss silvicultural opportunities involved at each stage of BMW development under a paradigm of emulating natural disturbances and processes.

Analysis of recent publications allows us to define four functionally distinctive stand development stages that occur in BMW: 1) stand initiation, 2) stem exclusion, 3) canopy transition, and 4) gap dynamics. These stages are defined by a key process, and associated with distinctive structural characteristics. For example, invasion of trees of new cohort is the leading process, and availability of receptive seedbeds (or unlimited growth space) is the structural characteristic. Both are key features for the stand initiation stage.

Stand development is affected by disturbance and site factors in such way that the same disturbance (fire) initiates the same process (new cohort establishment), but results in different species compositions and structures on different sites. Multiple pathways of BMW development are also modified by non-stand replacement disturbances of abiotic and biotic nature. Depending on the type and severity of non-stand replacing disturbance, they may accelerate or decelerate stand development process. Each stand development stage presents a unique set of silvicultural opportunities to achieve diverse management objectives.

Weed control using micro-rates of herbicide in sugarbeets. A.S. Hamill, P.H. Sikkema and D. Robinson. Agriculture & Agri-food Canada, Greenhouse and Processing Crops Research Centre; University of Guelph, Ridgetown Campus; University of Guelph, Ridgetown Campus, respectively.

As weed size increases the effectiveness of conventional postemergence herbicides falls rapidly. Sugarbeet growers who do not apply herbicides in a timely fashion have few options for rescue treatments. Currently in the mid-western United States a considerable percentage of acres are treated at micro-rates at short term intervals. Use of micro-rates has the following advantage: 1) herbicide costs are reduced, 2) weeds are more effectively controlled if weeds are very small, and 3) crop tolerance is improved. The initial results from the U.S. studies indicate that methylated seed oil adjuvants are equal or superior to other tested adjuvant types. The prime objective of the 2001 research was to assess the crop tolerance and weed control of conventional sugarbeet herbicides applied at micro-rates with various adjuvants at multiple timings. Preliminary results indicated that waiting for seven days after sugarbeet emergence for initial herbicide applications was too late for success with the lowest dose used. In general, methylated seed oil (MSO) as an adjuvant was better than Merge but either could be acceptable. Using Crop Heat Units (CHUs) as an indicator for spray application timing has potential. With the herbicide combinations currently available for use in sugarbeets, lambs-quarters will be the more difficult species to manage if not controlled early.

Seasonal variation of herbicide and nutrient concentrations in prairie farm dugouts (ponds). Cessna, A.J.*, Elliott, J.A., National Water Research Institute, Saskatoon, SK, Canada.

More than 100,000 farm dugouts (ponds) have been constructed on the Canadian prairies. With holding capacities generally ranging from 2 to 5 ML, they provide a valuable and often sole source of water for on-farm activities including potable and household use, livestock watering, and irrigation. Situated on or adjacent to tilled farmland, the majority typically receive water from surface (snow melt and rainfall) runoff which provides a mechanism of entry for pesticides and plant nutrients into these water bodies. Previous studies have confirmed the presence of several herbicides commonly used in prairie crop production in farm dugouts. Utilizing three farm dugouts, the present study was designed to investigate possible seasonal variation in herbicide and nutrient concentrations during the 1995 to 1997 growing seasons. The dugouts were sampled from May to October each year. Farmers were surveyed to determine herbicide and fertilizer use within each watershed so that herbicide and nutrient contents could be related to crop production practices. Water samples were analyzed for herbicide content using gas chromatography interfaced with a mass selective detector (GC-MSD).

The maximum number of herbicides detected in a water sample was seven. Herbicides detected in dugout water tended to reflect their long-term use rather than applications made during the previous or current growing season, and to be associated with spring snow melt runoff and dugout rollover in the fall. Application drift deposition did not result in detectable concentrations of herbicides in the dugout water. Bottom sediments acted as a source of herbicides to the water column, especially during fall rollover. Drinking water and livestock watering guidelines were not exceeded but aquatic life and irrigation guidelines were exceeded for some herbicides. Maximum nutrient concentrations were measured during early snow melt and did not exceed drinking water guidelines.

Airborne and field hyperspectral remote sensing to detect nitrogen deficiency and weed infestation in corn. P. K. Goel, Shiv. O. Prasher, A.A. Viau, R. Bonnell, J.Miller. Université McGill - Campus Macdonald Sainte-Anne-De-Bellevue (Québec) H9X 3V9.

A Compact Airborne Spectographic Imager (CASI) was used to obtain images over a field that had been set up to study the effects of various nitrogen application rates and weed control on corn (*Zea mays*). The objective was to determine to what extent the reflectances obtained in the 72 visible and near infrared (NIR) wavebands (from 409 nm to 947 nm) might be related to differences associated with combinations of weed control (none, full, grasses only, broadleafs only) and nitrogen application rate (60, 120 or 250 kg/ha). Plots were arranged in a split plot experiment in completely randomized design at the McGill University Research Farm on Macdonald Campus, Ste-Anne-de-Bellevue, Quebec, Canada. Weeding treatments were assigned to the main plot units and nitrogen rates to the sub-plot units. Three flights were made during the growing season. Hyperspectral measurements were also made from a field spectroradiometer on the day of first and second flights for comparing two remote sensing data acquisition platform. Data were analyzed for each flight and each band separately, then regrouped into series of neighboring bands yielding identical analyses with respect to the significance of main effects and interactions on reflectance. The results indicate that the reflectance of corn is significantly influenced (α=0.05) in certain wavebands by the presence of weeds, the nitrogen rate and their interaction. The influence of weeds was most easily observed in the aerial and field spectroradiometer data from the second flight (August 5, 2000), about nine weeks after planting. The nitrogen effect was detectable in all the three flights. Differences in response due to nitrogen stress were most evident at 498 nm and in band 671 nm in the aerial data set. In these bands, differences due to nitrogen levels were observed at all growth stages, and weed had no interaction effect. Differences in other regions, whether related to nitrogen, weeds or the interactions, appeared to be dependent on the growth stage. Much better results for distinguishing different weed and nitrogen treatments were obtained from aerial spectral

Exploitation de capteurs hyperspectraux pour la caractérisation des cultures et la détection des mauvaises herbes. Caroline Guénette, Alain A. Viau, Pierre Tremblay, Léon-Étienne Parent. Laboratoire de géomatique agricole et d'agriculture de précision, Université Laval, Sainte-Foy, Québec. G1K 7P4

L'application de la télédétection embarquée en agriculture de précision est très prometteur pour le développement d'indicateurs spatiaux aidant à la prise de décision afin d'assurer la gestion de la production végétale et la lutte contre les mauvaises herbes. Ainsi, en considérant les propriétés spectrales et thermiques des surfaces et des cultures combinées aux informations au champ; l'exploitation de capteurs embarqués (hyperspectral, infrarouge et thermique) permet de produire des informations détaillées sur la variabilité et les conditions au niveau des champs en regard à l'état des cultures, la présence de mauvaises herbes et à la qualité du milieu. L'utilisation d'indicateurs spectraux et thermiques géoréférencées sur l'état des cultures, produits à l'aide des capteurs optiques embarqués est un moyen simple, précis, économique et efficace de support à la prise de décision en matière de contrôle des mauvaises herbes.

L'objectif de cette affiche est de présenter les différentes techniques et approches par télédétection embarquée qui sont préconisées pour : 1) suivre les variations spatiales des conditions des champs, du début à la fin de la saison de cultures, 2) la caractérisation des cultures en fonction des stades phénologiques, 3) la détection de stress comme les mauvaises herbes.

Working Groups
Session Summaries

Working Group Report - Application Technology

Submitted by Helmut Spieser

Ontario Ministry of Agriculture, Food and Rural Affairs, Ridgetown, Ontario

The Application Technology working group discussed five spray application problems and possible solutions. These problems may involve application technology but definitely result in reduced weed control. After a brief outline of the problem, the participants in attendance discussed possible causes and solutions.

Application Technology Problems

1. **Weed escapes in the wheel tracks when soys are sprayed under dry conditions** with products like Basagran. These weed escapes in the wheel tracks are evident with trail sprayers, self-propelled sprayers with rear booms and self-propelled sprayers with front-mounted booms. The problem? The solutions?

- weed control problems in wheel tracks is also evident with other herbicides, Group 1 products like; Assure, Poast, Select, Venture, Excel Super
- one suggested cause for these weed escapes is that the very fine dust created by the traffic across the field is settling behind the sprayer and deactivating the product
- Are the aerodynamics behind the sprayer such that a higher proportion of spray droplets is held aloft and not reaching the target?
- wheel traffic may crush plant cells and reduce translocation or uptake of lethal doses of product
- as the plants are bent over by wheels, the spray droplets are wicked off the leaf surfaces or come into contact with soil particles
- wheel traffic may be firming the soil providing conditions to allow further weed seed germination in these strips
- observations by farmers finds the weeds growing only in the sprayer wheel tracks and not in the wheel tracks of the tractor, which are usually wider tires than the sprayer wheels
- as a result of the wheel traffic, plants may be more stressed and thereby harder to control
- some producers have increased the size of nozzles directly behind the wheels by one size and in some cases gone to a nozzle twice as big – getting some success
- concerns with this practice in that an increased nozzle size might cause carryover problems with some products
- this is likely not a large problem since overlaps by boom ends during normal spraying operations does not generally cause carryover concerns to succeeding crops

2. **Injury symptoms in wheat when spraying Folicur**. It appears that herbicide residues in the boom lines are coming out in a distinct pattern resulting in damaged wheat. The self-propelled sprayer used has 6" to 8" dead ends that extend beyond the nozzle bodies. Problems with other designs? Solutions?

- this problem is only a concern on sprayers with wet booms
- wheat showed injury symptoms for the first 200 metres of the first pass, when a new tankful of spray is started
- the symptoms clear up first wherever the boom feed line enters the boom sections
- eventually the whole boom section is clear of injury, right to the boom section ends
- the injury happened when applying Folicur, but the product suspected of causing the injury was used a number of jobs prior
- each time a new load of spray was started, injury was apparent for some distance
- the boom sections have threaded caps on each end
- a thorough flush of each boom section with end caps removed might be required to ensure product cleanout from the dead ends of boom sections
- this may not be the desired solution by the operator as there are 22 end caps on these 11 boom feed sections
- one suggestion was to install a small vent line into each end cap and connect it back into the boom line, 2 or 3 nozzles from each end
- this way there would always be some spray solution being drained from the end of the boom section and would prevent stagnation of spray solution
- this situation is likely happening with other machines and other products in other crops, just not showing symptoms
- the machine manufacturer has been made aware of the problem and is trying to find a solution which may involve plumbing changes

3. **Efficacy of contact herbicides is less than expected when applied with air-induction nozzle technology**. Products like Pardner in corn, Blazer in soys and Basagran in soys are not working to some producers' satisfaction. Ontario research?

- Air-induction nozzles have demonstrated exceptional drift reduction capabilities
- Air-induction nozzles have increased the spray window available to producers
- this fact may have allowed sprayer operators to stretch the spray envelope even further
- the product groups where performance concerns are occurring, were identified a number of years ago
- unsure if water volumes are being maintained according to product labels and if nozzle manufacturer’s recommended spray pressures are being followed when applying contact herbicides using air-induction or venturi nozzles
- nozzles may be a handy scapegoat

- chemical companies are concerned about the performance of products from Group 1, 6, 10, 14 and 22 when applied with air-induction nozzles
- research project is being planned by Peter Sikemma at Ridgetown College – University of Guelph to get good Ontario data in this area
- chemical companies are interested in this research and are assisting with funding for this 3 year project

4. **Roundup drift**. Plug plants grown in a greenhouse are not hardened off and consequently are ultra-sensitive to Glyphosate drift. Better neighbour education? Technology transfer? A big stick?

- herbicides seem to be drifting further than before, in some cases 1000's of metres
- spraying is occurring under more adverse conditions
- Western insurance companies have increased deductibles for spray drift from $5000 to $20000, demonstrating that there is basically zero tolerance of spray drift
- Product chemistry has not changed significantly to account for this problem
- As we still have problems with off-target spray drift, we must continue our education efforts in the area of mechanisms causing spray drift and drift management techniques

5. **Tank clean out surprises**. With the advent of Roundup Ready crops, farmers are seeing tank residues causing crop injury. Roundup is a good tank cleaner and loosens residues in the tank. The problem? Solutions?

- no good information exists on tank cleanout protocol for tank mixes
- which cleanout routine should be used – product A or product B, which do you use first if they are different
- farmers have to show good environmental stewardship regarding the fate of tank rinsate
- concerns were expressed that as some of these cleanout procedures require a lot of time and water, shortcuts will be taken by producers
- companies with new products and formulations need to be able to determine cleanout requirements quickly and accurately, unfortunately this is not always possible

Working Group Report – Biological Control

Submitted by Will Hintz
University of Victoria, British Columbia

One of the tasks of the Biocontrol group was to develop a working paper on the definition of our field. Susan Boyetcho, Agriculture and Agri-Food Canada, Saskatoon. Saskatchewan, took the lead in this initiative and gave a survey paper on the history of terms and opened the discussion on the limits of what is meant by "Biocontrol". Appended below are extracts from her thought-provoking presentation.

Among the suggestions for a strict definition were:

"the deliberate use of natural enemies to suppress or reduce the population of a pest until it no longer represent a problem" Watson 1991

"the planned use of living organisms to reduce the vigour, reproductive capacity, or effect of ....(weeds)" Quimby & Birdsall 1995

"the use of parasitoids, predators, pathogens, antagonists, or competitive populations to suppress a pest population making it less abundant and thus less damaging than it would otherwise be" van Driesche & Bellows 1996

"the use of biological agents which, directly or indirectly, are able to control pests or weeds" Smith 1911

"the utilization of living organisms (natural enemies) to depress the population of a specific organism which is a pest to society" Rees et al.
1995

All of these definitions included the management of pest populations and lacked the expectation of eradication of the pest. Excluded from these more strict definitions were biopesticides which can be described as:

"products containing living or dead organisms or parts of organisms....." (and added a caveat that a biopesticide "must be used as a pesticide") Smith 1994

"a living organism which is grown in bulk and used on a seasonal basis as a crop protection agent "Rodgers 1993 "preparations or formulations manufactured to be used in the control or eradication of pests.....where the active ingredient or principle is based on a living microorganism or is derived from one without significant purification or modification" Lisansky 1989

Thus Biopesticides can be interpreted as plant-derived substances (or in a broader definition of all organic substances) having a protective effect on plants. Biopesticides can be found in nature or chemically synthesized.

The boundaries become a little fuzzy when one considers that when pest control is achieved by microbial metabolites produced in situ, the approach is considered to be a biopesticide.

"microbially derived chemicals applied in pure form or in preponderance over the live propagules....fall under chemical (pesti)cide technology despite the possibility that some of these microbial chemicals...(are) biorational pesticides"
Charudattan 1991

Recent developments are forcing us to re-examine again what is meant by Biocontrol. At issue are processes and approaches such as gene modification, modification of genetic processes and the development of genetically modified organisms (GMOs), which must be considered in any broad-based discussion.

The issues that we would encourage our membership to consider include such questions as:

What are the expectations of biological control? Do we anticipate eradication of the target weed or is suppression the desired goal? Is it reasonable to expect a level of pest control similar to that achieved by chemical controls? How clear are we, the ECW Biocontrol working group, on our definitions? There seems to be a continuum of biological vs. chemical vs. plant breeding vs. agronomic practices. Should GMOs be considered for development as biocontrols? There is a need for a clear definition for Biological Control as the use of ambiguous terminology leads to confusion.

This confusion can impact on communication between practitioners, public acceptance of biological control as a viable alternative to the use of chemicals, support from funding agencies, and support from important end-user groups such as the Organic food growers. The use of correct terminology is encouraged to help promote the field of biological control.

At our last meeting we proposed a working definition of:

Biological Control as the deliberate use of living organisms to directly or indirectly reduce the vigour, reproductive capacity, or effect of weed populations.

We put these questions to the membership of the ECW to seek input and active debate.

Working Group Report – Extension and Teaching

Submitted by Carol Bubar
Olds College, Olds, Alberta

The focus of the meeting this year was on minor use registration in both the U.S. and Canada. Our first speaker was Marija Arsenovic, who is the Associate Coordinator/Weed Science for the IR-4 Project based out of Rutgers University in New Jersey. Dr. Arsenovic gave an overview of the IR-4 Project which was established in 1963 to provide pest management solutions to growers of fruits, vegetables and other minor crops. IR-4 develops data for submission to the EPA to support regulatory clearance of new crop protection chemicals and also assists in the maintenance of existing product registrations. Since 1996 the focus has been on "reduced-risk" pesticides and in 2001 over 300 herbicide petitions alone were submitted. Over the past five years nearly 40 field trials have been conducted, including some in Canada. Data packages developed for U.S. registrations have been provided to the PMRA in support of MRLs that allow use in Canada.

Michel Letendre, the Provincial Minor Use Coordinator for Quebec explained the background and current status of minor use registration in Canada. He noted that in 1995 the responsibility for minor use was shifted from Agriculture Canada to Health Canada (PMRA). In so doing the focus also moved from pest management to the protection of human health. There are currently two categories of minor use registration: URMULE and URMUR. URMULE is for products already registered in Canada and in 2001, 56 submissions were approved. URMUR is for products registered in the U.S. and other OECD countries and has had only 12 new registrations since 1997. One possible reason for the low numbers of approvals is that the sponsor for a submission must now be a user group instead of an individual researcher or extension agent. Another hurdle seems to be the amount of efficacy, crop tolerance and residue data that is required. A meeting to explore some of these issues was to be held in Ottawa in early December 2001 and hopefully some progress was made!

Working Group Report – Herbicide Resistance

Submitted by François Tardif (East, University of Guelph, Ontario)
and Todd Andrews (West, Manitoba Agriculture and Food)

An update of herbicide resistant weeds documentation and research in Eastern Canada was provided by Francois Tardif.

This was followed by a Teams Debate with the following Hypothesis:
"**That the problem of herbicide resistant weeds has been overstated in Western Canada**"

Affirmative Team: Todd Andrews, Lyle Friesen, Denise Maurice.
Negative Team: Neil Harker, Clark Brenzil, Linda Hall.

A series of colourful, entertaining and thought provoking points were made by both sides although most of the audience agreed that the affirmative team had scored a narrow but convincing victory.

Working Group Report – Integrated Weed Management

Submitted by Anne Légère
Agriculture and Agri-Food Canada, Ste-Foy, Québec

Current chair (2001): Anne Légère
Incoming chair (2002): Steve Shirtliffe
Vice-chair (2004): Rene Van Acker

This report is a summary of the discussion held at the Integrated Weed Management Working group session. This was an informal session with much participation from the audience. The theme for this session was: "Weed seedling recruitment". A panel of experts provided their critical views on the topic. The experts were:

Diane Benoit, AAFC St-Jean-sur-Richelieu, QC
Maryse Leblanc, IRDA, St-Hyacinthe, QC
Steve Shirtliffe, University of Saskatchewan, Saskatoon, SK
Gordon Thomas, AAFC Saskatoon, SK
Rene Van Acker, University of Manitoba, Winnipeg, MB

Prior to the meeting, they had been asked to consider the following questions: What was the goal of your experiment(s)? The hypotheses? How did you do it? What did you measure? What were the major hurdles? What would you do differently, given the chance? What were the statistical challenges? Did you get the answers you were looking for? If not? Why not? What research needs to done with regard to this topic? How should it be organized? Should there be a national effort of some kind?

My sincere appreciation to the experts for their dynamic and challenging contributions. Also, my most sincere thanks to Linda Hall for taking notes during the whole session. Without her efforts, I would not have been able to write this summary.

Summary of contributions:

Steve Shirtliffe
Discussed safe sites: whether sites limited recruitment; the relationship between safe sites and successful emergence; showed graphs relating % recruitment with density; the use of percentages was challenged - could be deceptive; discussed variability problems due to seeds from seed bank, quality of seeds from storage, changes in patterns due to time at which emergence is monitored. Rene mentions that cleavers will be affected by timing and method of seeding.

Diane Benoit
Discussed data from *Ambrosia artemisiifolia* emergence in muck soils; contamination (from pathogens?): does one use sterilized seeds? The nature of cohorts: how do you define a cohort? When does it begin? When does it end? Should we consider emergence as a continuum. Is a few seedlings emerging sometime late in the summer a cohort? Is there a minimal number or percentage of individuals in a cohort; different patterns according to tillage events; changes to microsites by removing, cutting or tagging seedlings; photographs could be a solution when density is low but not when it is crowded.

Maryse Leblanc
Presented her lambsquarters emergence model based on GDDs; questioned whether you can get good density or pattern information from monitoring quadrats with or without the presence of a crop (in this instance, corn) - answer: no crop influence on emergence patterns but the crop does affect emergence density; GDDs more limiting than soil moisture in Québec; there would be more than one base temperature for a given species; individuals with different base temperature in a population would emerge at different GDDs; each cohort would have a different GDD requirement; for lambsquarters, base temps range between 3.0 and 8 C; discussed the value of GDD calculations according to soil vs air temperature.

Rene Van Acker
Discussed functional types and recruitment; observations on depth of recruitment from 88 fields with various tillage systems, pre and post seeding; recruitment zone would be in first 5 cm vs. top inch in Forcella's model;

Gordon Thomas
Mentioned that there is data out there: Chepil (1930's) monitored emergence over time for approximately 50 species (included simulated tillage effects); presented material from a 3-yr experiment including tillage ???; emergence and mortality was monitored; seedlings tagged with paperclips; rainfall, moisture, temperature, N, P were monitored; some plots were watered to control moisture effects - this approach was not successful

Others
Knowledge of emergence patterns may help make spraying/cultivation decisions.
Could help decide on or avoid a re-spraying operation.

Diane Benoit, once more
Diane proposed to collate all available recent and historic information on weed emergence in a database that could be coupled with weather data.
She called on all willing to contribute to this project to contact her: benoitdl@em.agr.ca

Working Group Report
New Pesticide Products and Herbicide Characterization

Submitted by Marvin Faber
GlobalTox International Consultants, Guelph, Ontario

First of all I would like to thank Laura VanEerd, Mark Kidnie, and Linda Hall for their help over the last three years; your presentation ideas and assistance were very valuable. I would also like to welcome Mark Kidnie as the new chairperson of this working group. Mark is an extremely capable individual and I am sure he will provide exceptional leadership to this working group over the next three years. If you have any suggestions for this session or are interested in presenting new product information at the 2002 meeting please contact Mark at; Tel: (780) 430-1793 or email: mark.j.kidnie@monsanto.com.

This year no new product information was available to present. This slow down in new herbicides was the catalyst for the presentation by Dr. Francois Tardif (co-written by Dr. Gerry Stephenson) on the future of herbicides in Canada. Francois gave a good description of the development of herbicides from the early 1900's up to the present followed by potential future directions of the herbicide industry. Some of these directions included: natural compounds, combinatorial synthesis, and functional genomics. One of the challenges will be for industry to maintain or increase the screening capacity for new herbicides in the face of industry consolidation. There will be a need to go from chance discovery to rational design to meet specific weed control needs. Francois's presentation is included below if you would like additional information.

The regulatory process was also discussed as it can have a large impact on the future of herbicides in Canada. This process will need to be streamlined to ensure the continuing availability of new herbicide tools for growers. One way to accomplish this, is the joint registration of new herbicides in the US, Canada, and Mexico. This will avoid redundancies in the review process, potentially reduce the workload for the PMRA, and will ensure that products are brought to the market at the same time across North America which will help create a level playing for growers. Please see the attached presentation for an overview of the Canadian regulatory system and a more in-depth discussion of this topic.

One of the items that I hoped we would have more time to get into in more detail in the session was to have a group discussion on some key issues concerning the future of herbicides. Here is a list of questions for you to ponder on this subject.

- Are new products needed?
- Are herbicide tolerant crops improving weed science?

- Should we continue to develop herbicide tolerant crops?
- Are our current weed control strategies sustainable?
- What can ECW do to ensure grower needs are met?

We would really like to get your feedback on these questions so please send your comments to Mark Kidnie (sorry Mark this my last act of delegation as chairperson!!). This information will be valuable for discussions next year and will hopefully lead to a list of action items that we can accomplish as members of the Canadian Weed Science Society.

The presentations below were originally in Microsoft Powerpoint.
They have been converted in Adobe Acrobat and are available separately.

The future of herbicides
by François Tardif and Gerry Stephenson, University of Guelph

Herbicide registration in Canada
by Marvin Faber, DuPont Canada

Working Group Report – Noxious Weeds

Submitted by Roy Cranston
British Columbia Ministry of Agriculture, Food and Fisheries, Abbotsford

Chair: Roy Cranston
Present: Danielle Bernier, Stephen Darbyshire, Carol Bubar, Charles Smith, Nancy Cain, Marcel Dawson, Claire Wilson, Kevin McCully, Keith Baras, David Susko, Claude Bouchard, Barry Reisner, Kim Bedard, Clark Brenzil, Kim Brown, Leslie Huffman, Victoria Brookes, Richard Massicotte, Paul Cavers, Shaffeek Ali, Don Hare, Roy Cranston

Group Discussion - National Invasive Plant Policy

The Noxious Weeds Working Group (NWWG) initiated discussion regarding the need for a national policy to address weed and invasive plant quarantine and control at the 1999 Annual Meeting in Ottawa. An ECW Resolution and subsequent correspondence with the Minister of Agriculture requested establishment of a Noxious Weed Task Group and that this Task Group be charged with the responsibility for formulating a Federal Noxious Weed Policy Strategic Plan, with set timelines. The ECW offered the collective expertise of its members in assisting such a Task Group.

The response from Minister Lyle Vanclief acknowledged responsibility for this issue, stated that a comprehensive strategy to deal with invasives was under consideration and further, that the ECW would be invited to contribute to the development of a national policy. Following a 2001 request from ECW Chair Bob Blackshaw, the following update on progress was received from Marc Faille, National Manager, Grains and Field Crops Section of CFIA:

- A strategy dealing with both invasive plants and animals and is being addressed under the Convention on Biodiversity. Environment Canada is the lead department in this initiative.
- Participants include: Canadian Food Inspection Agency (CFIA), Agriculture and Agri-Food Canada, Parks Canada, Natural Resources Canada, Department of Foreign Affairs and International Trade and Environment Canada. The Provinces are to be consulted in the process.
- CFIA is identifying problems associated with invasive quarantine pests, including weeds. Required resources have been identified and CFIA is working to secure funding.

- CFIA's Plant Health Risk Assessment Unit recently employed a scientist (Claire Wilson) who is responsible for carrying out risk assessments for weeds and invasive plants.
- CFIA's Plant Health and Production Division is creating a new position, to be filled within the year, in which a policy officer will be responsible for weeds seeds and development of a national policy.

In other developments on this issue in 2001, both the Canada Committee on Crops and the Canadian Agri-Food Research Council(CARC) supported ECW's position that this was an important national issue requiring action in 2002. CARC has requested that both AAFC and CFIA work together, and with appropriate stakeholders, to develop a national policy on invasive plants.

Marcel Dawson, Grains and Field Crops Section, CFIA provided the meeting with an update on the role of the Plant Health and Production Division and indicated his desire to work closely with the ECW on invasive plant issues. Marcel also introduced Claire Wilson, Weeds Program Biologist, Plant Health and Risk Assessment Unit, CFIA who is responsible for undertaking risk assessments on invasive plants. (see weed risk assessment info provided by Claire below).

Weed Risk Assessment

Shaffeek Ali, Alberta Agriculture, provided an update on weed risk assessment initiatives in Australia. Following the meeting Shaffeek forwarded 3 related documents: Weed Assessment Guide; Recent Developments in Australia; and Weed Assessment Score Sheet (.xls). These are attached to the Minutes as .pdf files.

Claire Wilson, CFIA, discussed the template used within her Unit for undertaking weed risk assessments in Canada. Subsequent to the meeting, Claire provided the following:

> Within the CFIA, I work with the Plant Health Risk Assessment Unit. They have been doing Pest Risk Assessments (PRAs) for a number of years on plant pests of quarantine significance, mainly insects and pathogens. I have based my WRA template largely on their PRA template, for the sake of consistency within the unit and because we often work on projects together, with the results always going to the same client (CFIA's Plant Health and Production Division). The PRA template is in turn consistent with the guidelines for Pest Risk Analysis that have been established by the International Plant Protection Convention (IPPC).
>
> The questions asked in the process of a WRA can be very different from those asked when the plant pest is a pathogen, for example, and I had to tailor the PRA format to cope with weeds. I did this by studying the WRA systems of the U.S. and Australia, and I have included references to these systems for comparison.

The WRA system used by the U.S. is quite similar to our approach in that the output is a report summarizing available scientific information. It is administered by the USDA, Animal and Plant Health Inspection Service, Plant Protection and Quarantine. Links to the relevant documents can be found at: http://www.aphis.usda.gov/ppq/weeds/weedsrisk99.html

The main document is the WRA guidelines, and I have also attached a copy of this for convenience (USDA.WRA.Guidelines.pdf). The other document offered on the website is called the WRA template, but as far as I can tell it is the same thing exactly, only in slightly different format for encouraging members of the public to complete it rather than USDA staff.

The Australian WRA system is quite different, and involves a series of quick-answer questions and a scoring system, so that the result is an "accept or reject" rather than a report that summarizes information. In Canada we write PRA reports based on available scientific information, and make recommendations, but we do not make the decisions about management of the pest. That is the realm of the Plant Health and Production Division. In Australia, the WRA system is also a decision tool, so that the management decision is the outcome of the process (allow the plant in, or prohibit it). The Australian system is administered by Agriculture, Fisheries and Forestry Australia, Plant Biosecurity Branch, and it can be viewed at:
http://www.affa.gov.au/content/output.cfm?ObjectID=D2C48F86-BA1A-11A1-A2200060B0A04014

Weed Risk Assessment is very new to us in Canada, and in fact I have only completed WRAs on two species to date. I am very open to comments on the template, and it can be amended at any time. I would welcome any dialogue on WRA that may result from the posting of this introduction on the ECW website.

Thanks,
Claire Wilson

Claire Wilson
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Plant Health Risk Assessment Unit
Science Division
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Presentation

Richard Massicotte, Biologist, University of Quebec, Montreal presented results of cooperative research between Cornell University, McGill University and the Quebec Ministry of Transportation on use of cover crops for ragweed control. An abstract of this presentation titled **"Establishment of competitive vegetation cover to reduce common ragweed (*Ambrosia artemisiifolia*) along roadsides"** is available under Poster Abstracts in the Proceedings of the 2001 ECW Annual Meeting (click on Publications on the ECW homepage).

Provincial Reports

Reports on provincial enforcement initiatives, "Alerts", new invasives were presented for New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia.

Full text Provincial Reports are available online in the 2001 ECW Proceedings.

"ALERT" – Wooly Cupgrass

Stephen Darbyshire, AAFC, Ottawa reported on wooly cupgrass (*Eriochloa villosa*), a new weed introduction to Canada recently found in Quebec. Claire Wilson, CFIA forwarded the following alert on this plant:

PLANT HEALTH EARLY WARNING SYSTEM (PHEWS)

ISSUE: Woolly Cupgrass: New Weed Introduced and Spreading near Montreal, Québec

SOURCES: Allison, Ken. 2001. Identification of Woolly Cupgrass (*Eriochloa villosa* (Thunb.)
Kunth). The Seed Technologist Newsletter AOSA / SCST. In Press.

Darbyshire, S., ECORC research scientist: personal communication, October, 2001.

Strand, O.E. and G.R. Miller, 1980. Woolly cupgrass – A new weed threat in the midwest. Weeds Today 11(3):16.

USDA, NRCS 1999. The PLANTS database. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. (http://plants.usda.gov/plants).

BACKGROUND / ASSESSMENT: Woolly cupgrass (*Eriochloa villosa* (Thunb.) Kunth) is a tall (1-2 m) annual grass of the millet tribe (Paniceae) that is native to temperate Asia (eg. Japan, Korea, eastern Russia and China, Taiwan). It was introduced to the U.S. in the 1950s, apparently from ship's ballast near Portland, Oregon. First reported in Oregon and then Iowa, it is now rapidly spreading as a weed in the midwest, and is reported from nine additional states (Colorado, Illinois, Kansas, Minnesota, Mississippi, Missouri, Nebraska, Pennsylvania, Wisconsin). It is considered a serious pest in parts of the northern U.S. corn belt and is tolerant to several of the herbicides used in corn for control of annual grasses such as foxtails (*Setaria* spp.), to which it is related. It is a prolific seed producer (up to 164,000 seeds per plant) and germinates earlier than other annual C_4 grass weeds.

This item is raised as a PHEWS because woolly cupgrass has been reported for the first time in Canada. The plants were first noticed in 2000 by a seed company near Montreal, Québec, where they were infesting experimental plots of barley. Specimens were sent by the company to Ken Allison at the Central Seed Laboratory, CFIA, for identification. The identification was confirmed by Stephen Darbyshire, a botanist with AAFC. In September 2001, K. Allison and S. Darbyshire confirmed that the woolly cupgrass population near Montreal has successfully overwintered and continues to spread (K. Allison notes that the plants observed were shorter than those described in the literature, and measured about 45-60 cm in height). The evidence that populations of this weed can survive Canadian winters, together with its presence in the northeastern U.S. close to the Canadian border, highlights the possibility that it could become a serious problem in agricultural areas in Canada. K. Allison suggests that the corn and soybean growing areas of southern Ontario and Québec are particularly at risk.

PHEWS prepared by:
Claire E. Wilson,
Biologist
Science Division, PPCD, CFIA

Other Business

Danielle Bernier, Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, has accepted the position of Chair, Noxious Weed Working Group for the 2002 and 2003 Annual Meetings.

Check the attached file "reprints.pdf" provided by Stephen Darbyshire for a list of free reprints and books available from the Biological Resources Program, Eastern Cereal and Oilseeds Research Centre, Agriculture and Agri-Food Canada.

Working Group Report – Physical Weed Control

Submitted by Diane Lyse Benoit
Agriculture and Agri-Food Canada, St-Jean-sur-Richelieu, Québec

There were approximately 20 persons present. D.L. Benoit acted as moderator. Participants were invited to give their experience with physical weed control methods and the reasons for their presence at the working group. Some participants had worked with mulches (organic or synthetic) while others had experience with mechanical weeders. The variety of techniques and the reasons why they were used differed greatly with the crops and the geographic locations. These techniques had not been chosen originally for weed control purposes but were observed to be effective for specific production system and were generally integrated into the system afterward.

With the ongoing discussion, it became clear that there was a great need for solid scientific evaluation of theses methods. The ecological component of weed population dynamics associated with these techniques was missing. Participants wanted to know principally how to obtain more informations on the performance of these techniques in a Canadian agricultural context. Eleven (11) persons indicated their interest in participating actively in this working group.

Consequently, it was decided to submit a request to the executive board to form a new working group. The persons responsible for the group are: Diane L. Benoit (chair), Daniel Cloutier and Peter Regitnig. The principal activity for 2002 for the working group is to establish an information exchange on physical weed control on the ECW website. Three objectives were identified:

1. create a list of pertinent Canadian literature and provincial report on physical weed control and created a link to the literature of the EWRS Physical weed control working group
2. create a list of equipment and Canadian manufacturer of mechanical weeders with a link to EWRS Physical weed control working group glossary
3. create a discussion or chat line for the group

Provincial Reports

2001 Report to the ECW
Alberta

Prepared by Shaffeek Ali, P.Ag
Pest Prevention Unit, Alberta Agriculture Food and Rural Development

Overall Situation:

Weather was a major factor in weed growth and weed control during 2001. In areas where early season moisture was available, weed control was good and few problems occurred. In areas of dry spring conditions, weed control was poor and second flushes of both grassy and broadleaf weed occurred up to the end of July. This resulted in a higher use of pre-harvest glyphosate products.

In the dry areas, there were some problems with herbicide carryover; most noted was Everest and Odyssey. This has raised the question whether the recropping restrictions are still pertinent under dry conditions. Some non-performance of wild oat herbicides were also reported.

Weed Concerns:

Canada thistle showed some increase especially in Southern Alberta. Reasons cited include poor crop competition, increased pulse acreages and several years with poor conditions for the application of herbicides after harvest.

Spiny annual sow thistle showed a substantial increase in 2001. Increase is likely due to the early dry conditions and later moisture. Many seeds did not germinate until after spraying had taken place.

Common tansy is spreading prolifically in many areas around the province. In particular, the weed is becoming a problem in riparian areas and the environmentally sensitive locations. These areas are serving as a seed source to infest nearby land.

Kochia was a serious problem for many farmers because of the drought and suspected widespread prevalence of Group 2 herbicide resistance.

Weeds that are showing up in zero till situations are white cockle and common plantain. Wild buckwheat is also on the increase because of the less than adequate control from glyphosate.

Herbicide Issues:

Dry soil conditions are believed to have contributed to the carryover of several herbicides. These include Unity, Pursuit, Odyssey and Assert. Crop injury was difficult to detect without check strips and poor crop growth. Also noted was the reduction in wild oat control with some products.

Due to the dry spring and poor weed growth early in the season, the pre-seeding burnoff with glyphosate or first application of Roundup in Roundup Ready canola had very limited success.

Lack of weed control options (herbicides) for chickpea and fababean will limit expansion of these high value crops.

New weeds:

Orange and yellow hawkweeds, field violet and wild caraway have been noted as new weeds in some municipalities. These weeds have been declared as noxious weeds in the respective municipalities.

A threat of salt cedar and Russian olive to riparian areas in Southern Alberta is a concern. These weeds have been found in Montana and potential for movement and establishment in Alberta needs to be assessed.

Forage, Pasture and Rangeland

White cockle continues to spread in central and western Alberta and seems to be a weed of major concern with few options for control, especially in alfalfa. Trials are being conducted on the integrated control of white cockle using fall dormant herbicide applications and fertilizer. Orange and meadow hawkweed are also spreading in central Alberta but the agricultural fieldmen are co-operatively addressing the problem with diligent monitoring and spraying residual herbicides.

With the drought continuing in southern Alberta in 2001, there is concern with the spread of noxious pasture weeds with hay movement and also with the damaging effect of over-grazing.

A group is interested in conducting a weed survey of grazing land in Alberta. They are investigating interest, funding sources and methodology.

Minor Use

Through the Prairie Pesticide Minor Use Consortium (funded by a number of growers/grower organization) a part-time Minor Use procurement officer has been hired. The person work out of Brooks and is housed in Alberta Agriculture's office. The officer is doing a lot of the leg and paper work in submitting priority Minor Use applications. At present, only applications for consortium members are completed.

Biological Control

Information sheets on the seed weevil *Omphalapion hookeri* and the gall midge *Rhopalomyia tripleurospermi* for scentless chamomile control have been produced and distributed. These insects have been mass reared and provided to users for field release on a fee-for-service basis. At Vegreville, *O. hookeri* has now dispersed 14 km from the 1993 release site and *Rhopalomyia tripleurospermi* has dispersed 7 km from the 1999 release site. A new shipment of the scentless chamomile stem-mining weevil, *Microplontus edentulus*, was received from CABI Bioscience. Preliminary analysis of data from a field experiment suggests measurable reductions in scentless chamomile stem height due to *M. edentulus* and *R. tripleurospermi*. Studies on the effects of temperature on development of *M. janthinus* for the biological control of yellow toadflax suggest that development time may be a limiting factor for this species under the climatic conditions of central Alberta. Additional leafy spurge root-feeding beetles, *Aphthona lacertosa,* were obtained from North Dakota and Montana for larger releases in southern and central Alberta with plans to use them as collection and redistribution centers in the future. A fungal pathogen, *Plectosporium tabacinum,* is showing promise for cleavers control under field conditions. A bacterium (CW00B006C) has been selected and identified as a promising bioherbicide candidate for chickweed. Collaborative research is being conducted with USDA/ARS at Beltsville, Maryland on characterizing phytotoxin gene(s) or gene clusters of bacterium (16 C) isolated from Canada thistle plants.

Other issues:

Alberta completed a province-wide weed survey in 2001. Report is being prepared. Initial results indicate a weed shift from the last survey done in 1995.

Alberta Agriculture continued its Weed Free Forage program province-wide in 2001. Over 3800 acres were inspected and 87% of those were certified. These acreages were lower in 2001 because of the drought.

The purple loosestrife eradication program continued and the numbers of purple loosestrife plants continues to decline. Infestation levels are limited to scattered plants.

Extensive movement of forage due to the drought raised the concern for the spread of weeds. Weeds of concern were scentless chamomile, Persian darnel, leafy spurge, and toadflax. Buyers of forage were encouraged to enquire about weed content before purchasing the forage.

The trend continues toward fewer farm herbicide enquiries as industry crop advisors target this area for information delivery and sales support. Extension calls most often relate to weed control on forage, tough to control weeds like dandelion and new and emerging weed problems.

For the period May – September, Alberta Agriculture established a call center (1 – 800 # hot line) to handle farm calls. The call center was managed by three technical specialists. The project was very successful and has now been established on a permanent year- round.

2001 Report to the ECW
British Columbia

Prepared by Roy Cranston, Plant Industry Branch
B.C. Ministry of Agriculture, Food and Fisheries

Problem Weeds

- The relatively new invasive, **common bugloss**, is spreading rapidly in parts of the Okanagan, Boundary and East Kootenay regions. New infestations in 2001 included: **field scabious** in the Thompson, Peace River and Boundary regions; **wild chervil** in the Cariboo; **greater celandine** in the North Okanagan and **greater Centaurea** at Grand Forks. **Marsh Plume Thistle** is expanding rapidly on pastures, roadsides and forest cutblocks in east-central B.C.

- Efforts to increase awareness and control of **perennial pepperweed**, **bugloss**, **wild chervil, carpet burweed, field scabious, parasitic dodder, yellow nutsedge, velvetleaf, rush skeletonweed** and **horticultural escapes** were continued with distribution of "Alert" posters, newspaper/radio presentations, field days, educational seminars, etc. Increased awareness also resulted in discovery of new **tansy ragwort** sites in the Interior and **hound's-tongue** at the Coast. **Orange** and **yellow hawkweeds** continue to expand throughout the southern interior and Central B.C. Research trials continued in an effort to determine cost/effective hawkweed control (picloram plus 2,4-D, especially combined with N and S fertilization, best to date). **Japanese knotweed** and **Himalayan Balsam,** both horticultural escapes are spreading rapidly in coastal B.C., particularly in riparian habitats.

Weed Grants

- BCMAF provided incentive Grants-in-aid totalling $240,000 to regional district governments that undertake the noxious weed control function. Fourteen local Weed Control Programs were funded in 2001. BCMAF grants represent roughly 20% of total program expenditures. Increased funding allowed continued expanded efforts to control rush skeletonweed in the Okanagan.

Biocontrol

- B.C. (Ministries of Agriculture and Forests) contributed approximately $125,000 to weed bioagent collection, screening and shipment in 2001. Work was targeted at **hound's-tongue, Dalmatian toadflax, sulphur cinquefoil** and the **hawkweed complex**. B.C., in partnership with AAFC, Lethbridge leverages funding as part of an International Consortium on weed biocontrol. Specialized agents are reducing densities of the **knapweed species**, **tansy**

ragwort, hound's-tongue and **leafy spurge** in localized areas throughout B.C. A stem-boring weevil (*Mecinus janthinus*) is causing significant stunting and a complete loss of flowering on reproductive stems of **Dalmatian toadflax** over large areas. Introduction and provincial redistribution of many bioagents continues. There are currently 57 agents released against 20 serious weeds in B.C.

Publications

- BCMAFF is partnering with the Open Learning Agency in developing an extension/awareness package on integrated weed management. The project includes: 2 manuals ("Seven Steps to Managing Your Weeds" and "Guide to Weeds of BC"); 5 public service announcements to be aired 50 times each on Knowledge Network; video on impact of various invasive weeds; and a website (WEEDSBC – not currently online). Users will gain knowledge of weed identification, biology/ecology, weed legislation,, control strategies and the impact of invasive and nuisance weeds on the resources and economy of BC.

- BCMAFF published "Home and Garden Pest Management Guide for BC". This handbook details integrated pest management for homeowners and landscape professionals. "IPM for Turf Managers" will be available by March. Crop Production Guides for Vegetables, Berries, Tree Fruits, Nursery and Grapes are now published and distributed in partnership with commodity organizations. The full colour "Field Guide to Noxious and Other Selected Weeds of British Columbia" is currently being updated for its 4th press run since 1996. This guide as well as other weed information such as "Alerts", an IWM Manual and weed monographs are available on the BCMAF Website @ http://www.agf.gov.bc.ca/croplive/cropprot/weeds.htm

Minor Use

- The Minor Use of Pesticides Program continues to be critical to the needs of B.C.'s small acreage nursery, vegetable and berry producers as well as to tree fruit, cereal and forage producers in the Okanagan/Kootenay regions. BCMAF is expediting URMULE's for turf, landscape, forage corn, rangeland. Gene Hogue, AAFC, Summerland (ret.) continues work on tree fruits and special crops and Victoria Brookes, AAFC, Agassiz continues herbicide research on strawberries and vegetables.

- Research trials were successful in providing the required data for Minor Use Label Expansion of metsulfuron-methyl to include its use for all of BC (previously Peace only) and to approve addition of **field scabious** and **perennial pepperweed** to the label. Isoxaflutole was granted label expansion to allow its use for field corn in BC.

Legislation

- An Order-in-Council was approved in 2001 that resulted in addition of **bugloss, hoary alyssum** and **marsh plume thistle** to the Schedule of Regional Noxious Weeds, BC Weed Control Act Regulations. The Act is enabling legislation, allowing local governments to enforce provisions, if they so choose. Very little enforcement is undertaken in the province. There are currently 21 weed species designated "noxious" throughout all of B.C. and a further 27 species within the boundaries of specified regional districts.

2001 Report to the ECW
New Brunswick

Prepared by Kevin McCully, IPM Weed Specialist
New Brunswick Department of Agriculture, Fisheries, & Aquaculture

Weather Summary: New Brunswick weather was generally characterized by well below normal precipitation in July for most of the province, and very dry conditions in August particularly in the south and south eastern areas of the province (26 to 50 % of normal precipitation). Heat units were generally above normal for May, June, and August, and near normal for July at a number of locations. According to Environment Canada the Atlantic Region as a whole experienced the third driest summer in the period from 1948 –2001.

Weed Control Summary: Weed control was generally considered satisfactory in most crops. Adequate moisture was received to activate pre emergence herbicides. Post emergent weed control was less effective than normal due to the hot dry season.

Weed Problems in 2001:

Alfalfa: -	dandelion, quackgrass, corn spurry, hempnettle
cereals -	quackgrass, rough bedstraw, wild oats
wild blueberry-	bracken fern, wild rose, poverty oatgrass, three toothed cinquefoil, barren berry, spreading dogbane, black huckleberry, St.John's Wort, vetch, bulrush, goldenrods, trailing blackberry, lamb's quarters
pastures/hay -	smooth bedstraw, tansy ragwort, thistles, dandelion
strawberries -	toadflax, stitchwort, field pansy, groundsel, buttercup, sedges, bladder campion
vegetables -	quackgrass, purslane, smartweed, yellow nutsedge
potatoes -	marsh hedge nettle, goldenrod, perennial sow thistle, chickweed
corn -	quackgrass, triazine resistant weeds, annual grasses

Weeds on the increase:

Smooth bedstraw	triazine resistant weeds	St. John's Wort
common groundsel	purple loosestrife	rough bedstraw
toadflax	marsh hedge nettle	Angelica
field violet	stitchwort	Perennial sow thistle

Research Trials:

Wild Blueberries	*Evaluation of mid summer applications of Spartan (tribenuron methyl) for bracken fern control.
Apples	*Demonstration of herbicides for use on planting year Honeycrisp apple trees
Potatoes	* Evaluation of herbicides for use on early season potatoes grown under plastic mulch

Crops in which more research is required:

Alfalfa - lack of herbicide options
Vegetables - lack of herbicide options
Cranberries - lack of herbicide options
Strawberries - lack of post emergent weed control options

Issues and Concerns:

- In response to public concerns a hexazinone groundwater/surface water monitoring project was initiated to generate monitoring data on residue levels.
- Lack of biopesticide availability for weed control

Extension:

This past year the New Brunswick Department of Agriculture, Fisheries, & Aquaculture formed a new Integrated Pest Management Section for which the weed position now reports through. The positions role and responsibilities will as a result change somewhat.

Numerous requests for information on weeds and their control were answered by telephone, fax, e-mail, letters and farm visits. Weed control information was also presented in various newsletters. Presentations at numerous meetings were also given. A number of guides were updated. Newsletter articles were also written.

Through the weed diagnostic lab 68 weed species were sent in for identification. Herbicide injury was also diagnosed on 4 samples. Weed seeds were also sent in for positive identification.

2001 Report to the ECW
Ontario

Prepared by Leslie Huffman and Hugh Martin, Weed Management Specialists
Ontario Ministry of Agriculture, Food and Rural Affairs

Weed Control Results

Weed control was challenging again this year. A good April was followed by a cool damp May, not leaving many days with good soil conditions for planting late spring crops, and stressing the growth of early planted crops. Late frosts and hail hurt several areas, and windy conditions made spray applications risky at many times. Once the rain stopped, it didn't start again in many areas until harvest. The prolonged dry spell this summer was the worst in 50 years.

Soil applied herbicides worked very well in the corn crop, but spraying opportunities for soil applied herbicides in soybeans were infrequent. Postemergence spraying was also challenging. Many fields were sprayed beyond the optimum stage of growth, and control was reduced. Weed escapes were visible in many fields, especially as the crops stopped growing under severe drought. This weed competition through the critical period, in combination with the severe drought, and the infestation of a new pest, soybean aphids, hurt yields by as much as 50% in soybeans. The continued threat of soybean aphids may reduce the acres planted to soybeans next year.

Trends

- Use of postemergent herbicides in corn and soybeans continues to be widespread, but the development of new weed problems, including herbicide resistant weeds may slow this trend.
- Low drift nozzles continue to be widely used by both grower and custom applicators.
- Horticultural growers are increasing their use of plasticulture, mostly for vegetables.
- No-till or reduced tillage systems are increasing in most crops, and have altered the weed populations.
- GM crops continue to be planted, but market uncertainty will continue to temper the growth of this technology. Roundup Ready (RR) soybean varieties have about 25% of the acreage, while canola is greater than 50% RR varieties. There is an awareness of the risk of genetic drift in canola but it has not been documented in Ontario.
- The use of herbicide tolerant corn weed control systems are used on 5 -10% of the acreage.
- The market for Identity Preserved (IP) crops has softened, with lower premiums being offered, due to more competition from growers in the USA.

Problem Weeds

Common weeds like red root pigweed, ragweed and lamb's-quarters eluded many of our control programs this year. No-till weeds like spreading atriplex, sow-thistles, and prickly lettuce continue to increase. Lots of grassy weeds escaped herbicide treatments this year, with foxtails (especially yellow foxtail) being an increasing problem. Horticultural growers are challenged by common groundsel, yellow nut sedge, proso millet, hairy nightshade and controlling weeds in general.

Herbicide Resistance

Red root and green pigweed resistance to Group 2 herbicides are now common, especially in the areas first identified in 1997. New in 2001 is Group 2 resistance in common ragweed, with over 120 suspected samples from southern Ontario to be tested. Eastern black nightshade has also been confirmed with Group 2 resistance. Pigweed resistant to linuron has also been confirmed on carrot farms in several locations. There is awareness of the risk of resistance among farmers, especially with widespread use of glyphosate, and wider adoption of recommended resistance management techniques.

Weed Control Act

There were approximately 500 weed orders issued in 2001, which is similar to orders in recent years. The majority of these are in urban areas. Weed inspectors are encouraged to enforce the Weed Control Act only on properties adjacent to agricultural lands.

Minor Use Program for Herbicides

Jim Chaput is the new OMAFRA Minor Use Coordinator, located in Guelph, who maintains a website with updated information on Minor Use Proposals at www.omafra.gov.on.ca /english/crops/minoruse/. Currently there are 83 active minor use requests for herbicides of interest to Ontario growers. 16 herbicides were registered through the MUPP program this year that will be included in the 2002 Publication 75.

Extension Activities

The new organization of extension services across Ontario is now fully implemented with 2 provincial weed management specialists. The Weed Management Specialist (Field crops) position is currently vacant, with the competition closing November 30. OMAFRA also has engineering specialists in application technology, and crop specialists for each crop who handle all aspects of production, including weed management.

- Guide to Weed Control (Pub 75) remains as an annual publication. The 2002 version, revised by the Ontario Weed Committee, will be available in early January.
- Ontario Weeds (Pub 505) is in revision with publication in 2002. 37 new weed species are included.

- New Factsheets were published on Herbicide Resistance, Organic Farming, Cocklebur, Pigweed, and Field Bindweed. These can be found on our website.
- The Ontario Weeds page online at www.gov.on.ca/OMAFRA/english/crops/insects /weeds.html. A free subscription service has been added this year for notices of new content posted.

Rapport 2001 au CEM
Québec

Préparé par Danielle Bernier, agronome-malherbologiste, M.Sc.
Direction des services technologiques
Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec

Informations générales

Selon ses régions, le Québec a connu des températures très variables. Le printemps a été plutôt sec. Le début de l'été a été frais et humide. Ce n'est qu'à la fin juillet que le soleil et la chaleur sont revenus. L'automne a été relativement beau. L'efficacité des traitements herbicides fut assez variable selon la période d'application et le choix des produits. Les récoltes toutes confondues ont été supérieures en quantité et en qualité par rapport à l'année 2000. Ce sont les insectes, notamment la légionnaire, qui a causé le plus de dommages aux grandes cultures.

Dans le cadre du Salon de l'agriculteur 2001, l'équipe du MAPAQ responsable du développement du logiciel DESHERB s'est vue remettre le prix « Haute Distinction ». Seulement deux prix « Haute Distinction » ont été remis lors de l'événement. Près de vingt projets étaient en liste pour l'obtention des prix.

Un nouveau site Web (www.agrireseau.qc.ca) spécialisé en agriculture et agroenvironnement est maintenant disponible.

Laboratoire de diagnostic

La phytotoxicité par des résidus d'herbicides continue d'être un problème en croissance. Les produits du groupe 2 sont majoritairement la cause de ces problèmes. La dérive et le nettoyage inadéquat des pulvérisateurs sont aussi des causes de phytotoxicité. Nous les rencontrons de plus en plus fréquemment.

La formation des conseillers et des producteurs demeure essentielle pour familiariser les différents intervenants sur la complexité des nombreux produits disponibles sur le marché.

Commission de malherbologie

Au début juillet (le 4 et le 5) la « Tournée des mauvaises herbes » a réuni plus de 125 personnes dans la région de Montréal. La présence de plusieurs conseillers en agroenvironnement a contribué au succès de l'événement. Du nouveau cette année, des visites sur des fermes maraîchères ont suscité un vif intérêt de la part des participants.

La Commission de malherbologie a décidé d'arrêter la production de guides de traitements herbicides. Le manque de ressources humaines et financières pour la rédaction et la publication des ces guides a entraîné cette décision. La mise à jour du guide « Traitements herbicides-Grandes cultures 2000 » se fera cette année via Internet sur la plate-forme Phytoprotection d'Agri-Réseau.

Le réseau d'essais herbicides a poursuivi ses activités à l'Université Laval et au Campus MacDonald en 2001. Un processus de réévaluation pour tous les réseaux d'essai est en cours. Différents intervenants seront questionnés sur la nécessité du réseau. Une rencontre est prévue en février 2002. Les premiers constats tendent à démontrer que le réseau d'essai d'herbicides devrait s'accroître pour inclure davantage de cultures, cibler des problèmes particuliers et récurrents.

L'évaluation de produits pour usage mineur devrait faire partie du réseau. Les autres pesticides devraient aussi être évalués. Ce n'est qu'à la fin de l'hiver 2002 que nous serons fixés dans ce dossier.

La fusion entre la Commission de malherbologie et la Commission de Protection des cultures s'est faite le 5 septembre 2001. Les membres ont retenu le nom de Commission de Phytoprotection pour le groupe. La diminution des ressources humaines, la présence des mêmes personnes (environ la moitié) et l'objectif d'axer les interventions davantage sur la lutte intégrée ont encouragé cette fusion.

Législation (coll. Alain Garneau, agr.)

Révision réglementaire

La révision réglementaire prévue depuis deux ans n'a pas été réalisée. Une réflexion complète sur l'avenir de cette loi devrait se faire au cours de l'hiver 2002. Différentes options seront étudiées dont la création d'une loi spécifique sur les mauvaises herbes, l'incorporation du contrôle des mauvaises herbes dans la *Loi sur la protection des plantes* et même l'abolition de toute réglementation sur les mauvaises herbes.

Dans le cas où il serait décidé de conserver une législation sur le contrôle des mauvaises herbes, il faudra alors déterminer si son application sera limitée au secteur agricole ou à d'autres milieux.

Nouvelle introduction

L'Agence canadienne d'inspection des aliments vient d'identifier une population d'*Eriochloa villosa* (Thunb.) dans la région de Montréal. Cette plante semblerait être considérée comme un problème majeur dans les États américains producteurs de maïs. Elle tolère plusieurs herbicides. Une évaluation de la situation sera réalisée au cours de l'hiver afin de déterminer les actions à prendre pour la saison 2002 contre cette mauvaise herbe.

Stratégie phytosanitaire

La stratégie phytosanitaire continue ses activités. De nombreux cours, ateliers, visites, démonstrations ont été réalisés et financés durant la dernière saison. Une visite sur le site Web vous permettra de prendre connaissance des différents projets réalisés et en cours pour la prochaine année financière (www.agr.gouv.qc.ca/dgpar/agroenv/strategie-slv.html).

Indicateur de suivi

La pollution de l'eau a connu des changements ces dernières années. Les concentrations d'atrazine ont diminué. Elles respectent maintenant la plupart du temps le critère établi pour la protection de la vie aquatique.

Emplois mineurs (coll. Michel Letendre, agr.)

Le 3 octobre 2001, une réunion réunissant les sous-ministres adjoints, les directeurs, les coordonnateurs provinciaux du Québec, de l'Ontario et de la Colombie-Britannique et leurs vis-à-vis à l'ARLA (C. Franklin, W. Sexmith, D. Chaput) s'est tenue à Québec. Cette rencontre avait pour objectif de faire part à l'ARLA d'éléments irritants dans le système des homologations mineures pour ensuite discuter des solutions envisageables pour les supprimer.

Les sous-zones d'essais

Au départ, la mise en place des zones nord-américaines d'essais avait pour but d'harmoniser l'homologation des pesticides au Canada et aux États-Unis, en permettant le partage des données nord-américaines provenant de zones équivalentes. Or des sous-zones ont été ajoutées au Canada : la création, notamment, d'une zone 5b au Québec, empêche l'utilisation des données ontariennes et américaines.

Les représentants de l'ARLA ont reconnu qu'il s'agissait là d'un embêtement majeur. Ils ont accepté qu'un projet soit mis en place pour clarifier cette situation. Le Conseil canadien de l'horticulture compte utiliser les données des zones 5 et 5b, provenant des essais IR-4, afin de démontrer qu'elles sont identiques. Entre-temps, l'ARLA accepte d'ignorer les sous-zones à condition que les requérants assument les risques associés à d'éventuelles détections de surplus de résidus dans ces ex-sous-zones. La décision finale sera émise par les sous-ministres concernés.

Le groupe de travail technique sur les pesticides de l'ALENA, qui est responsable des orientations et des négociations en matière de pesticides en Amérique du Nord, a aussi demandé à L'ARLA d'abandonner cette notion de sous-zones, afin de mieux concentrer ses efforts sur l'harmonisation du processus d'homologation.

Le regroupement des cultures

Aux États-Unis, un produit peut être homologué pour toutes les cultures d'un groupe donné, essentiellement à partir des données de résidus obtenues pour les quelques cultures désignées de ce même groupe. Ce principe existe sur papier au Canada, mais n'est pas appliqué par l'ARLA, ce qui engendre un ralentissement du processus d'homologation. Certaines compagnies ont, incidemment, déjà déposé des demandes en ce sens. L'ARLA a accepté de réévaluer la situation.

Le programme PHULDU pour l'accès aux produits homologués aux États-Unis

L'ARLA a accepté la mise sur pied de projets pilotes afin de suivre et d'identifier les blocages qui mettent ce programme en péril.

Accessibilité aux produits à faible risque

Les ministres provinciaux de l'agriculture soutiennent que la difficulté d'accès aux biopesticides et autres produits plus doux freine le développement de stratégies de réduction des risques associés aux pesticides.

Cette problématique a récemment fait l'objet d'une déclaration de la part du ministre québécois de l'Environnement André Boisclair. Les autres ministres provinciaux de l'Environnement favorisent et supportent également toute démarche visant à faciliter l'accès à des produits moins dommageables pour la santé et l'environnement.

Conséquemment, il a été proposé à l'ARLA de créer, au Canada, une catégorie de produits « à risques réduits », comme c'est déjà le cas aux États-Unis, et d'élargir la définition de biopesticide afin d'y inclure les produits d'origine botanique ou à base d'huiles, etc.

Notion de " risk cup "

La loi américaine sur la protection de la qualité des aliments a pour objectif la révision des usages et des limites maximales de résidus dans les denrées comestibles, incluant toutes les sources de contact avec les pesticides (eau, usages domestiques), pour chaque matière active de produits antiparasitaires. Les concentrations cumulées acceptables de résidus pour une matière active donnée constituent alors la " risk cup " qui ne peut, en aucun cas, être dépassée par l'ajout de nouveaux usages. L'ARLA a adopté une politique semblable pour le Canada.

Michel Letendre a proposé que soit élaboré un projet pour caractériser les profils de cultures en ce qui a trait aux usages réels pour les différents produits, de façon à mesurer ces " risk cup " avec précision. L'ARLA pourrait alors évaluer les demandes d'homologation plus adéquatement.

Accès aux produits antiparasitaires américains

Le programme de soumissions conjointes permet aux compagnies de pesticides de présenter des demandes d'homologation, simultanément au Canada et aux États-Unis. Cette formule a l'avantage de réduire, théoriquement, les délais d'homologation et d'abaisser les coûts qui y sont associés. En 2001, 25 demandes d'homologation sur 50 ont été déposées dans le cadre de ce programme (document distribué).

Un projet pilote est prévu pour l'hiver 2002, concernant l'homologation mineure d'Elevate dans la framboise.

Le programme IR-4, concernant les homologations mineures aux États-Unis, permet, depuis 3 ans, la mise en place d'essais conjoints avec le Canada. Dix-huit (18) essais conjoints, financés en partie par les États-Unis, ont été réalisés au Canada en 2001.

Les organisations accréditées BPL

Les essais de résidus exigés dans le cadre du programme PEDUDU sont désormais soumis aux normes BPL (bonnes pratiques de laboratoire). Au Québec, seule la compagnie « Recherche Trifolium » est accréditée pour la partie terrain. Une réunion d'information est prévue avant le printemps 2002 afin d'intéresser d'autres organisations à demander leur accréditation.

Deux laboratoires sont actuellement accrédités au Canada pour effectuer les analyses. Les responsables du laboratoire d'analyse et d'expertise alimentaire au Complexe scientifique (Ste-Foy) ont été approchés à quelques reprises pour les inviter à proposer leur candidature pour accréditation. Une nouvelle rencontre est prévue sous peu, à ce sujet.

L'herbe à poux (coll. Claude J. Bouchard, agr.)

Bien que créée récemment, la Table québécoise sur l'herbe à poux (TQHP) compte déjà à son actif de nombreuses réalisations. La publication du bulletin d'information : *Le Flash herbe à poux* diffusé à fréquence régulière à toutes les municipalités concernées, la réalisation d'une enquête provinciale sur l'implication municipale dans le contrôle de l'herbe à poux, la parution de plusieurs articles de fond dans les revues spécialisées rejoignant les clientèles cibles, etc. Cette année le point d'orgue de la TQHP sera le lancement d'une trousse d'aide destinée aux responsables d'entretien des terrains, des services d'inspection ou des gestionnaires de l'environnement. Cet outil, qui se veut simple et efficace, couvre tous les aspects d'un plan d'intervention. Son efficacité sera en lien direct avec l'adhésion des élus et l'engagement des décideurs. Ainsi, le partenariat, largement inspiré par la Direction de la santé publique, sera un facteur déterminant d'influence dans la stratégie de communication et de diffusion.

2001 Report to the ECW
Saskatchewan

Prepared by Clark Brenzil, Provincial Weed Control Specialist
Saskatchewan Agriculture and Food

Weeds

The highlight of 2001 was the discovery of three new infestations of spotted knapweed *(Centauria maculosa)* in Saskatchewan. One site was near the town of Caronport, which is just west of Moose Jaw, and two sites in the city of Regina. One of the Regina sites is associated with a railroad siding and the other appears to be the result of contaminated ground cover seed on the grounds of a gym club near the downtown core. Until these sightings, spotted knapweed was rare in the province, being confined to near the western border of the province. The sightings in Regina could mark a significant change in the importance of the weed in Saskatchewan. Regina is located within the dark brown soil zone, which is the proposed area of adaptation of spotted knapweed in Saskatchewan.

This season marked the discovery of another rare weed in Saskatchewan. A cypress spurge (*Euphorbia cypressae*) colony was discovered by Saskatchewan Environment & Resource Management in a park area northeast of Regina. This colony of cypress spurge was found in association with an infestation of leafy spurge.

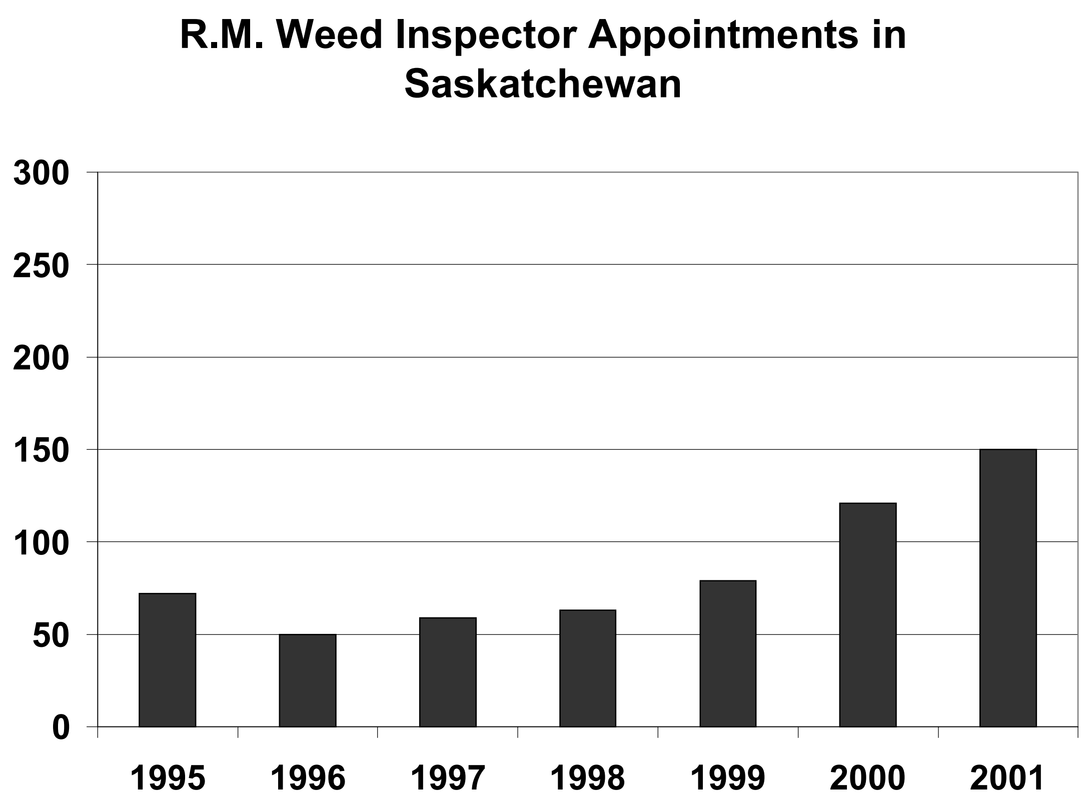
Perennial weeds in general faired very well in 2001 with the droughty conditions that enveloped all but the most south-easterly areas of Saskatchewan. The lack of competition from grass allowed perennial weeds to flourish. Perennial weeds that were of importance in 2001 were field bindweed (*Convolvulus arvensis*), leafy spurge (*Euphorbia esula*) and toadflax (*Linaria sp.*). With the increasing emphasis on the development of the livestock sector in Saskatchewan, these perennial weeds may increase in importance over time. Canada thistle *(Cirsium arvense)* is still a major concern for annual crop producers.

Annual weeds of increasing concern to producers are cleavers and wild buckwheat. Cleavers appears to establish where ever canola has been grown and as canola areas expand so does the range of cleavers. Wild buckwheat seems to be increasing in numbers in the fields where it is established. Many producers are vaguely worried about the possibility that resistance is developing in the weed although they are not specific about which group they are concerned about. The more probable scenario is that the increased us of HT canola varieties, in particular glyphosate tolerant types, is allowing wild buckwheat to escape control since glyphosate is not particularly strong on buckwheat.

Legislation and Enforcement

The numbers of Weed Inspectors in the province continues to grow. In 2001 more than one half of Rural Municipalities appointed a Weed Inspector. This is an increase of 24% over 2000. Efforts made to raise awareness at the municipal level of the impact of invasive plants/noxious weeds, assisting municipalities to understand the legislation and the offering of education opportunities for Weed Inspectors is probably responsible for this dramatic increase in appointments. The chart below shows the changes in the number of Weed Inspector appointments since 1995.

Saskatchewan Agriculture and Food (SAF) have begun a review of the Noxious Weeds Act. The report, which will be completed by the end of March 2002, will examine the Act as it currently stands in relation to other weed legislation across the country and in the northern United States. The goal is to develop a Noxious Weeds Act that meets Saskatchewan's needs for legislation to protect its changing agricultural industry and the environment from invasive and destructive plants while being easy to understand, and enforce.



Vegetation Management in Boreal Mixedwoods

A workshop held in conjunction with

The Annual Expert Committee on Weeds Meeting

Quebec City, Quebec, Canada

November 27-28, 2001

Introduction to the 2001 ECW Forestry Workshop

Robert A. Campbell
Chair, ECW Forestry and Industrial Working Group
Canadian Forest Service, Sault Ste Marie, Ontario

The Expert Committee on Weeds (ECW) has been the principal forum for weed science in Canada since 1954. There has been a forestry technical session associated with the annual meeting since 1984. At that time, the ECW made recommendations to the pesticide registration agency about the efficacy and crop tolerance of herbicides. In fact, it was unusual for a herbicide treatment to receive registration without a recommendation from ECW. The recommendations were based on data in research abstracts submitted to the Annual Research Report. In the 1980s and early 1990s, both forest researchers and herbicide manufacturers were interested in getting a number of herbicide treatments registered for forestry use – field and nursery. As a consequence, a considerable number of herbicide trial abstracts were submitted (120 in 1984) and the forestry technical session was well attended. By the mid 1990s, most of the forestry registrations which were likely to be obtained, had been, and ECW got out of the business of officially making treatment recommendations. Attendance at the forestry technical sessions waned. Nevertheless, several us felt that, because vegetation management is such an important component of forest renewal, there was still a need for a forum to discuss current status and define research priorities. A committee was struck to organize a series of workshops to fill that void, it consisted of Bob Campbell (Canadian Forest Service), Wayne Bell (Ontario Ministry of Natural Resources), Balvinder Biring (B.C. Ministry of Forests), Phil Comeau (University of Alberta), and Milo Mihajlovich (Incremental Forest Technologies). The committee chose *Vegetation Management in Boreal Mixedwoods* as the topic of the first workshop in November 2001. Workshops on other aspects of forest vegetation management will be organized every 2-3 years.

The first workshop was structured in two parts. During the first part, 16 invited presenters gave talks on topics relevant to vegetation management in boreal mixedwoods from ecophysiological to landscape levels. The second part comprised two concurrent breakout sessions: 1) Managing spruce-aspen mixtures, and 2) Extensive vs. intensive management of mixedwoods – what are the implications? The hope was that the breakout sessions would identify research and development priorities for boreal mixedwood management. While we did not succeed in delineating priorities as clearly as we would have liked, the summaries indicate that the sessions did get the participants thinking about the issues.

Summary of Breakout Session #1 of Vegetation Management in Boreal Mixedwoods. Managing spruce-aspen mixtures

Phil Comeau[1], and Milo Mihajlovich[2]
[1]*University of Alberta*
[2]*Incremental Forest Technologies*

Forest managers have several options for managing spruce-aspen mixtures. However, they are reluctant to manage mixtures with equal emphasis on both species. This is largely a reflection of uncertainty regarding the effectiveness of the tending options, their potential yield benefits, their potential impacts, and current tenure arrangements. Tending options are normally applied to improve the survival and growth of the white spruce (*Picea glauca* [Moench] Voss) component. From an aspen production standpoint, stand tending benefits remain speculative, although reducing density may accelerate achievement of merchantable diameters. The current array of management includes:

1) Do nothing, i.e.,allow mixedwood stands to develop without further intervention after harvest, perhaps with some planting to augment spruce regeneration. This is likely to result in a deciduous dominated forest, possibly with a spruce understory.

2) Control aspen within a specified radius of individual white spruce. Removing aspen within a 1 m radius appears to greatly improve white spruce survival, but at age 10, the treatment radius must be more than 2 m to benefit the spruce. Lees (1966) showed that white spruce grow much faster after aspen were cleared within a radius equal to two times the crown radius of the spruce. This option will create a vertically stratified (or cohort) mixture and can provide spruce in all canopy positions. The amount of aspen remaining will depend on the number of spruce treated and on the treatment radius. If the latter is sufficient, the number of spruce in taller height classes may increase, and co-dominant white spruce may develop rapidly.

3) Manipulate (i.e., reduce) aspen density throughout the stand to increase light levels and improve growth of understory spruce. This will create a vertically stratified mixture and should result in survival and growth of larger numbers of spruce than develop under option 2 and will accelerate growth of the remaining aspen. However, spruce growth into the co-dominant layer may be slower than under Option 2.

4) Use cluster or patch treatments remove aspen from patches in the block. These treatments will create a horizontally stratified mixture, i.e., a meso-scale mosaic. Patch size providing adequate light levels throughout much of the patch must be balanced with potential nursing influences of aspen on frost and other factors.

5) Grow temporal mixtures; plant spruce either immediately after harvest or at ages 40-50; harvest aspen with understory protection. Initially, the stand will develop similarly to Option 1. However, following harvesting of the aspen at ages 40-50, the stand will likely develop as a spruce-dominated mixedwood. This approach follows what is commonly

assumed as pattern of natural succession from pure aspen to spruce dominated mixedwoods stands.

While each of these options has potential application, there is a need for further study and communication of results to identify requirements for effective implementation and application of these options. Furthermore, managers need empirically validated yield data for each option as a basis for selecting the best array of options to apply across the landscape that meet forest level objectives. Questions remain regarding the ideal residual density of aspen in intimate mixture with spruce, and how this is influenced by site, stand, age, and other factors. There is a need for better information on the ideal size and orientation of spruce and aspen patches in a patch scenario, the ideal radius for individual tree treatments, and the impact of treating different numbers of spruce are unknown.

Mixedwood management requires careful consideration of both forest-level and stand level objectives. At the forest level, social, ecological, timber supply, and economic objectives must be identified and considered in the development of plans. A prudent first approach is to attempt to maintain the existing variety of stand structures and types within a forest management unit. However, we need better information to guide decisions as to what constitutes an ideal profile for a mixedwood stand at any landscape position. At the stand level, site factors must be evaluated and used as a basis for selecting appropriate species and mixtures. Yield, value, and wood quality objectives need to be considered along with ecological services provided by the stands in formulating silviculture plans and in identifying desired stand compositions and structures. Stand dynamics, with and without intervention, must be considered. Stochastic factors (i.e. cold injury, ice storms, insect and disease problems) must be considered in predictions of stand dynamics. Flexibility is required in managing mixedwood stands due to the imperfect nature of our current understanding, predictive tools, and of the potential impact of stochastic factors.

Tools for predicting the dynamics and growth of both young and mature stands, under a variety of management regimes are required as a basis for evaluating the benefits and impacts of different options and the impacts of these options on sustainability. Other research priorities include:

- Factors influencing aspen regeneration.
- Effective options for managing *Calamagrostis canadensis* in young aspen stands.
- Interactions and ecological services provided by mixedwoods.
- Long-term data on how stands develop following different management practices.
- Improved understanding of natural disturbance regimes, successional stand dynamics, and the role of stochastic factors in ecosystem dynamics as a basis for stand- and forest-level models.
- Forest health issues in mixedwood forests.

- Forest-level models to evaluate forest- and landscape-level impacts of mixedwood management options.

- A range of decision support tools to help foresters and other resource managers to select and evaluate appropriate management options.

As this list indicates, mixedwood management will continue to present researchers and operational foresters with interesting challenges.

Reference:

Lees, J.C. 1966. Release of white spruce from aspen competition in Alberta's spruce aspen forest. Can. Dep. For. Publ. No 1163.

Summary of Breakout Session #2 of Vegetation Management in Boreal Mixedwoods. Extensive vs. intensive management of mixedwoods - What are the implications?

Wayne Bell
Ontario Ministry of Natural Resources

Participants in this session discussed and contrasted the expected effects of natural disturbances and extensive, basic, intensive, and elite levels of silviculture on white spruce-aspen-dominated mixedwoods. All participants felt that the silvicultural activities needed to be site and objective driven; however, generic activities by disturbance type were suggested (Table 1). They also felt that as intensity increases so should the number of required decisions; thus decision support tools will likely be needed.

Table 1. Disturbance regime, stand-level objectives, and suggested activities for natural disturbances and extensive to intensive silviculture.

Disturbance	Objective	Activities
Natural	Maintain natural systems	• Fire, insects, disease, and severe weather (e.g., windthrow).
Extensive	Minimum conifer stocking 40%	• Use CLAAG[1] or HARP[2] to protect advanced regeneration where white spruce is available. • For jack pine-dominated mixedwoods, clearcut with site preparation and seeding.
Basic	Minimum conifer stocking 40% and F-T-G standards	• Use CLAAG or HARP to protect advanced conifer regeneration if available; clearcut where conifer understory is inadequate. • Patch scarify then fill plant where required. • Use directed foliar spraying or mechanical cutting to release conifers. Broadcast spray if conifer stocking is sufficient. • Remove balsam fir through harvest and site

		preparation; clean if these activities were ineffective.
Intensive	Minimum conifer stocking, 40 to 80%, F-T-G standards, with sawlogs and/or poles as final products from softwoods	• Use selective harvesting, CLAAG, or clearcutting depending on pre-harvest stocking and conifer density. • Mechanically site prepare (patch, systematic or strip) with chemical options if required. • Plant > 2000 stems/ha of conifer using improved stock if available. • Chemically or mechanically release conifers if necessary. • Pre-commercially thin (PCT) to all species to 2000 stems/ha by age 8-10 for pine and by 15 for spruce. • Conduct second PCT to reduce aspen density if interfering with spruce growth by age 25. • Commercially thin aspen and small spruce for pulp at age 35. • Commercially thin as often as dictated based on site index.
Elite	Same as above	• Same as above plus fertilize and prune.

[1] Careful Logging Around Advance Growth
[2] Harvesting with Regeneration Protection

Following a short break, the sub-groups merged and, using the above table as a guide, continued to contrast the natural disturbances with the four silvicultural regimes based on the following factors: a) fibre yields, wood quality, value/economic returns, and technology; b) biodiversity; c) soil conservation; and d) risk of loss to fire, insects, disease, and severe weather.

Wood reproduction (yield, quality and value) should increase as silvicultural intensity increases. Given the conifer focus of the objectives, conifer yields will likely increase as intensity increases, and hardwood yields will likely decrease. Product quality should improve as well, boosting total stand value. Pruning was discussed as being an intensive activity, but both sub-groups classified it as an elite treatment. Thus, the elite regime should result in the highest quality. Longer-term research is needed to determine if intensive and elite silviculture produces the yields and thus the anticipated economic returns.

Species and genetic diversity (richness and evenness) should change following each silvicultural activity, with the cumulative effect being a function of the entire suite of activities. Tree species richness is not likely to change. Evenness should be reduced by both extensive silviculture (since hardwoods are expected to dominate) and intensive/elite silviculture (since conifers will be favored). Participants were less certain about changes in genetic diversity. Extensive silviculture may not alter the genetic diversity of hardwoods (such as aspen and birch). The response to basic, intensive and elite silviculture could vary greatly, since mechanical site preparation would encourage regeneration through seed, increasing diversity. In addition, conifer release activities (e.g., broadcast applications of herbicides) could decrease stand-level diversity. Total plant species diversity could increase or decrease, depending on the degree to which harvesting, site preparation, release, and thinning activities control established species and create niches in which new species can establish.

Soils (erosion, compaction and nutrient loss) will be affected in various ways by silvicultural intensity. Erosion, associated mainly with road networks, should be highest under an extensive regime and lowest under intensive and elite regimes. Intensive activities would require more roads with better construction and maintenance standards. Increased compaction should occur on thinning trails, especially where they are used throughout a rotation. Nutrient losses should be greatest under basic and intensive regimes and least under an elite regime because of fertilizer use.

Risk of loss to fire, insects, disease and severe weather should be greatest under extensive and basic regimes and lowest under intensive and elite regimes. Extensive silviculture should increase the hardwood components, which in turn could suppress white spruce or pine and encourage balsam fir. Basic silviculture should increase the conifer component, but without density regulation self-thinning, overall stand health will likely decrease. In fact, high natural mortality should occur before surviving trees reach a merchantable size. Intensive/elite silviculture should decrease fuel loading by reducing balsam fir and coarse wood that could reduce the risk of fire laddering into the crown. Under these regimes, foresters should manage proactively to avoid planting species that are either off site or in a high hazard zone and to protect the trees as required.

Landscape level considerations in vegetation management for boreal mixedwood silviculture in Alberta

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Trembling Aspen and White Spruce dominate the productive forest landbase within Alberta's boreal mixedwood forests. These stands range in composition from pure deciduous or coniferous to mixtures of each and extend from the Lower Foothills in the west to the Central Mixedwood in the east to the Wetland Mixedwood in the north.

Forest management strategies in the boreal mixedwood forest of Alberta have historically assumed that harvested stands will regenerate to stands with the same species composition, and that within two years of harvest, all treatments required to regenerate a new crop are completed. Provincial reforestation standards evolved to support those assumptions with the introduction of a Mixedwood Reforestation Standard in 1991 and a further refinement of this standard into Coniferous/Deciduous and Deciduous/Coniferous Mixedwood Standards in 2000. These regulations have led to a stand-by-stand approach to reforestation. As a result, if a stand naturally regenerates along a trajectory that is not in alignment with the assumptions outlined above, various practices are used to control the stand trajectory in order to get the alignment. Consequently, there has been an ever-increasing use of tools such as glyphosate to manage the composition of regenerating stands.

To improve vegetation management results in Alberta's boreal mixedwoods it's important to give consideration to the how aspen and spruce are adapted to a range of sites, and their autecological niches, so that a less intrusive and more efficient strategy for boreal mixedwood management can be implemented. There are two opportunities for this.

1. Spatial Assignment

The first opportunity is to spatially assign regeneration objectives as a function of site as opposed to solely considering previous stand composition. The ecological classification system used in Alberta classifies sites on the basis of moisture and nutrient regimes. Pure deciduous, coniferous, and mixedwood stands of aspen and spruce are found within a wide range of sites, from medium rich - submesic to very rich - hygric. Within this range, the presence or absence of each species, or combinations, is a function of stand history and successional development as opposed to site characteristics. The suitability of spruce and aspen to occupy a range of sites offers the opportunity to choose regenerated stand composition objectives on a basis that is broader than the pre-harvest composition.

In addition to site characteristics, variables such as stand condition, lesser vegetation establishment, type of harvest, and season of harvest can have an influence on the amount and vigor of the resulting deciduous stand. By way of example, it would make sense to adjust the stand reforestation objective to target growing a deciduous crop where the potential for natural deciduous regeneration is high. Conversely, it does not make sense to rely on natural regeneration of a deciduous crop where the potential is low. By redistributing the assignment of regeneration objectives based on the potential of natural deciduous regeneration, the need to intervene with inter-species vegetation management activities is reduced.

2. Temporal Shift

The second opportunity is to temporally shift the establishment and removal of species components. Aspen is a pioneer species in Alberta's boreal mixedwood. White spruce has adapted to establish and grow under a canopy of aspen. However, as the aspen canopy develops it blocks light transmission to young spruce seedlings, which in turn suppresses growth and in some cases causes mortality. In a natural system the aspen canopy goes through a stem exclusion phase as it lifts. Available light increases and the surviving spruce is able to respond and develop. In this process, lesser vegetation is also suppressed by the aspen canopy.

By temporally shifting the establishment of spruce by establishing it under immature aspen canopies, concerns with competition from aspen canopy and lesser vegetation can be reduced. In essence, the aspen canopy can been used as a mechanism to manage the vegetation competition and the spruce can take advantage of the aspen's natural tendency to self-thin.

To effectively utilize the spatial and temporal reallocation of regeneration, assumptions on the use of these tactics need to be modeled and incorporated into strategic level landscape plans. If this is done, the characteristics of boreal mixedwoods can be maintained and vegetation management interventions minimized.

To manage or not to manage the vegetation: Living up to one's decisions

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The Quebec Forest Law created a tenure system where all contract holders have a right to particular trees species or parts thereof. The long term management plan has to ensure that all species are produced on a sustainable yield basis. Quebecers have also decided to take the unique position of banning the use of chemical herbicides by January 2001. This decision was made more than seven years ago in order to promote the development of options to the chemical control of vegetation. The author presents some of the solutions adopted in order to overcome the competition problem. Difficulties and cost issues will be addressed as well as impacts on yield in the context of a shrinking land basis.

Potential barriers to silviculture in Canada's Boreal Forest

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There are at least 3 different levels of analysis that could contain significant barriers to silviculture in Canada's Boreal Forest. First, at the stand level, financial analysis shows very poor returns to most silvicultural activities. Second, at the forest level, financial analysis in terms of increased AACs, is mixed, and highly dependent on starting forest structures and current sustained yield policies. Third, at the administrative level, provinces have generally failed to put in place incentives to invest in increased AACs through the Allowable Cut Effect (ACE). The above three levels of barriers may combine to create a situation where silviculture is largely undertaken within a command and control system, where costs may be minimized, where benefits of a desired future forest are rarely considered, and where private firms have almost no incentives to inquire into promising new silvicultural practices.

Silvicultural systems in boreal mixedwoods: results from long-term research trials

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The Canadian Forest Service, in cooperation with Daishowa-Marubeni International Ltd., Manning Diversified Forest Products Ltd., Millar Western Forest Products Ltd., Blue Ridge Lumber (1981) Ltd., Weldwood of Canada, Weyerhaeuser Company Ltd., the Forest Engineering Research Institute of Canada (FERIC) and Alberta Sustainable Resource Development have developed innovative approaches to managing western Canada's boreal mixedwood forests. Studies at sites in central and northern Alberta are directed toward perpetuating healthy boreal mixedwoods by testing conventional harvesting equipment and various silvicultural systems designed to protect and minimize wind damage to immature white spruce residuals and encourage vigorous hardwood regeneration following harvest of the aspen overstory.

Research studies by the Canadian Forest Service, FERIC and the Western Boreal Growth and Yield Cooperative include investigation of the biological response to the treatments as well as testing the efficiency of equipment and harvesting costs. Research has determined the best systems to reduce the loss of immature white spruce during harvest, while maximizing post-harvest wind protection and growth response of these trees. These systems can be modified and applied to a variety of stand composition, density and stocking situations.

Results from this ongoing research are currently being used to develop longer-term growth projections and determine potential tradeoffs between coniferous and deciduous users of the mixedwood landbase. This includes examining the development of coniferous and deciduous regeneration established after an understory-protection harvest and the influence of pre-and post harvest mixedwood density and spatial relationships in subsequent stand development and growth and yield.

This research is assisting companies in more efficiently coordinating their harvesting and stand-tending activities in order to improve forest management for both conifer and deciduous users. It has provided an operational-scale demonstration of alternative harvesting systems in a boreal mixedwood landscape for maintaining biodiversity and ecosystem sustainability.

Linking white spruce ecophysiology and boreal mixedwood silvicultural systems

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The establishment of planted white spruce (*Picea glauca* (Moench) Voss) seedlings following forest harvesting is often hindered by slow early growth or high mortality. These are symptoms of a complex of ecophysiological responses to unfavourable environmental conditions including low light levels, low soil temperatures, deficient or excessive surface soil moisture, low atmospheric humidity, low nutrient availability and low night-time air temperatures.

Any one of these unfavourable environmental conditions can be ameliorated by silvicultural treatment, such as vegetation control, site preparation and the provision of shelter. Improving white spruce establishment may require treating a number conditions simultaneously, however. This is a challenge, because a treatment that alleviates one environmental limitation may exacerbate another.

A promising silvicultural combination is the early and regular control of lower vegetation in sheltered small forest openings (e.g., Groot 1999). The optimum size of small openings is constrained to a narrow range because adequate light levels occur above a minimum size of opening, while nighttime temperature and daytime vapour pressure deficits are ameliorated below a maximum opening size.

Although small forest openings can be an effective silvicultural treatment, they must be designed to accommodate harvesting and silvicultural operations, and their spatial and temporal arrangement must be planned as part of a long-term silvicultural system.

Groot, A. 1999. Effects of shelter and competition on the early growth of planted white spruce. Can. J. For. Res. 29: 1002-1014.

Using mechanical site preparation to control vegetation during plantation establishment in boreal forests

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In the boreal forest of western Canada, the primary reasons for prescribing mechanical site preparation is to control competing vegetation and to enhance the ability for the desired crop trees to establish themselves in as short a period as possible. The Silviculture Operations Innovation Group with the Canadian Forest Service in Edmonton has been developing, testing, and monitoring various mechanical site preparation techniques and treatments for the past 17 years through the establishment of numerous head-to-head demonstrations and growth response monitoring trials from southeastern Manitoba to southwestern Northwest Territories. During this period, the innovations group have developed systematic and selective high-speed mixing tools, elevated bed mixing tools and chemi-mechanical combinations for use with a wide range of prime movers, including; excavators, tracked crawlers, skidders, tractors and skid-steer loaders.

Scalping, mounding, mixing, continuous and intermittent trenching and plowing all impact various sites in specific ways. Forest floor surface and sub-surface mechanical disturbances impact the local microenvironment or local ecology by altering its physical and biological structure. Soil heating, surface and sub-surface moisture management and light availability are all influenced by the mechanical site preparation treatments and the pattern in which the treatments are completed and therefore must be incorporated when prescribing site preparation treatments for vegetation control.

This presentation will describe a variety of mechanical site preparation treatments and technologies as they relate to controlling specific competitor types and relate case studies from western Canada to quantify the impact various mechanical site preparation treatments and techniques have on the desired crop tree species and competing vegetation.

Site preparation and vegetation management: long term implications

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After harvesting in coniferous and mixedwood ecosystems in the boreal forests of north-eastern British Columbia, the three most common plant communities are: 1) *Calamagrostis* dominated, 2) tall shrub complexes of willow and alder, and 3) broadleaf dominated. In the mid 1980's a series of replicated trials were established to evaluate site preparation treatments for establishing white spruce. Trial sites were generally mesic. Prolonged periods of flooding or saturated soils were not limiting factors on these sites. The treatments (which varied at each trial location) included B.C. Ministry, Sinkkila and Bracke mounds, Bracke mounds manually supplemented with 20, 14- or 6- cm cappings of mineral soil, fertilized Sinkkila mounds; Bracke patches; fertilized Bracke patches; bladed strips; plowed ground; herbicide; burned windrows, disc trenching (with plantings in hinge, furrow and mound-in furrow positions as three separate treatments), and untreated controls, separately with both standard and nominally superior "alternate" planting stock. The randomized complete block trials have been annually monitored for conifer performance through to 2001. Assessments of plant communities and soil properties on the trial sites have been done at less frequent intervals.

Within *Calamagrostis* dominated plant communities, herbicide, plowing treatments, and mounds capped thickly enough with mineral soil to inhibit *Calamagrostis* regrowth, were clearly superior to other treatments for initial establishment and growth of white spruce. Survival rate increased with capping thickness up to 14 cm, but significant differences among mounding treatments were few after 15 growing seasons.

Within tall shrub and broadleaf tree dominated communities, neither high survival rates nor mechanical site preparation guaranteed good growth of conifers; greatest growth occurred on 'broadcast' treatments which provided good initial control of vegetation e.g. herbicide without site preparation, burned windrows, and site preparation treatments such as plowing or high speed mixing. Mechanical treatments such as disc trenching were not effective due to overtopping vegetation originating from between the treated strips. Ten and 12 year post-treatment effects of broadcast and spot application of glyphosate were examined within this group of trials. At the broadcast sprayed site, reduced dominance of the tall shrub layer was associated with increased structural diversity and increased richness of the herb layer 10 years after treatment. At the spot-sprayed site, no significant differences in plant community structure or diversity could be detected after 12 years. At both sites, glyphosate application increased the growth of planted white spruce seedlings without eliminating deciduous trees and shrubs.

Appropriate vegetation management techniques can successfully establish conifers in tall shrub and broadleaf tree communities by affecting the spatial arrangement, structure, and successional trajectory. Within broadleaf tree communities, additional stand manipulations will be required to maintain optimal conifer growth rates.

Improving seedling competitiveness through nutrient loading

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Most black spruce (*Picea mariana* [Mill.] BSP) seedlings planted in Ontario are produced in containers by private nurseries and greenhouses. Establishment of these seedlings on boreal mixedwood sites is hampered by severe competition from naturally regenerating hardwoods, thus managing competing vegetation on recently harvested areas is critical for successful regeneration of black spruce. Strategies that enhance seedling survival and competitive ability are of high priority to the forest industry as a means of reducing costs while enhancing productivity. Traditionally, competition has been controlled by herbicides because of their effectiveness and economic efficiency, but public resistance to this approach is increasing and finding alternatives to chemical control is imperative. This paper will report on the role of nutrient loading as a possible alternative. The practice involves high fertilizer use during nursery culture to induce luxury uptake by raising internal nutrient reserves without altering seedling size. These reserves are depleted later to support current growth in newly planted seedlings, promoting tree competitiveness and suppressing neighbouring natural vegetation. The improved performance of loaded trees is attributed to higher nutrient reserves that lead to greater partitioning of carbon and nutrients to current needles and roots, accelerating photosynthesis and nutrient uptake. Nutrient retranslocation for the production of new tissues in trees is a key mechanism affecting early seedling establishment, and its relative importance has been shown to vary within and between species, and environmental conditions. Nutrient-loaded seedlings exhibited an exploitative nutrient-use strategy that favoured current growth, the enhanced retranslocation was driven by the magnitude of internal nutrient reserves. Implications of these findings are discussed in relation to intensive management of boreal mixedwoods.

Use of large conifer stock for planting on brush-competition sites in Quebec

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In the Province of Quebec, use of chemical herbicides for forest vegetation management has been gradually reduced since 1994, and was completely eliminated on public lands in 2001. A silvicultural approach based on the use of large conifer seedlings outplanted the spring following a final harvest has been developed. The objective of this regeneration strategy is to confer a competitive advantage to the planted stock over competing species such as red raspberry (*Rubus idaeus* L.), fireweed (*Epilobium angustifolium* L.), or graminoidspecies. Since 1992, this strategy has been supported by a number of research projects designed to evaluate the conditions for successful establishment of large transplants.

Early research projects were concerned with selecting the optimum seedling size with respect to various types of vegetation competition, by evaluating growth, survival, and transplanting shock. Experimental sites established on sites characterized by different competition environments were planted in 1993 with four types of container stock of black (*Picea mariana* (Mill.) BSP) and white (*P. glauca* (Moench) Voss) spruce seedlings, each representing a different seedling size. For the various vegetation types under investigation, results clearly demonstrated the advantage of using a 340 cc container stock size, as compared to the smaller or larger seedling stock sizes. These results also emphasized the importance of planting seedlings with high quality root systems to overcome the generally observed increased water stress created by the greater transpirational surface area of large conifer stock.

Recent research activities have focused on the interactions between silvicultural activities and nursery practices. Large containerized and bare-root spruce stock were planted on sites with heavy competition in eastern Quebec and physiological and growth responses were subsequently evaluated. During the first three years, disk trenching did not show any beneficial effect on establishment of large spruce stock. No significant effect of site preparation on light availability, soil temperature, soil water content, and nutrient availability was observed. Containerized seedlings showed similar water relations and nutritional status as bare-root seedlings, but performed slightly better both in terms of diameter and height growth. Findings from these studies also indicate that vegetation management is by far the most important factor to assure expected growth of forest plantations.

Results obtained so far in Quebec show that large spruce seedlings can be successfully outplanted on various reforestation sites of the moist boreal and sub-boreal mixedwood regions of the province. With use of large seedlings of high growth potential on rich sites with aggressive competition, the needs for mechanical release treatments are reduced, and seedling growth response to the treatments is enhanced, as compared to smaller seedling stock.

Options for managing *Calamagrostis*

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Calamagrostis canadensis is a widespread competitor in juvenile boreal forests. The following describes efforts over the last decade to find the Achilles' heel of this grass. Provided that the canopy is not too dense, *Calamagrostis* can usually survive in the understory of mixedwood stands and then spread rapidly by clonal expansion when the forest is cut. It can, however, be killed when light levels fall below 10% of above canopy light. Shelterwood and other systems providing partial shade will suppress the development of the *Calamagrostis*. Chemical herbicides can control Calamagrostis, but users must be remember that these chemicals also suppress the shrubs and hardwoods that may control the grass naturally by shade. Often interception of the herbicide by hardwoods actually releases the grass from its competitors and promotes it growth; this requires a second application of herbicide after leaves of the hardwoods have fallen. Clipping and grazing of *Calamagrostis* must be sustained over several years to hold back the grass sufficiently to allow trees to overtop it. As rhizomes of *Calamagrostis* are slow to expand in mineral soil, especially if soil is compacted, there are some types of mechanical site preparation that can suppress the spread of this grass. Slashburning or biocontrol agents also could suppress *Calamagrostis* under the right conditions.

Mechanical site preparation and stand tending impacts on aspen health

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In Ontario, conifer management practices, including site preparation and stand tending, are aimed toward removing competing vegetation, including aspen (*Populus tremuloides* Michx.) from the site. Historically, these practices were not always successful in removing aspen, mainly due to this species' ability to regenerate from root suckers and stem sprouts. Aspen has often become a substantial component of the resulting mixedwood stands. In the meantime, the status of aspen has changed from being regarded as a weed to become one of Ontario's major industrial tree species. As the industrial demand increases, concern has developed over the internal quality of aspen growing in these mixedwood stands.

A number of studies were initiated in northwestern Ontario to assess the quality of regenerating aspen in conifer plantations. A study of the effects of scarification (1976-1986) indicated that the presence of wound-caused root and stem decay would substantially reduce the quality of aspen in the future stand. However, during a re-survey of the study site in 2000, no residual signs of scarification damage and little decay were found. In 2000, a separate study was conducted in a white spruce (*Picea glauca* [Moench] Voss.) plantation to examine the effects of 4 conifer release treatments (Vision®, Release®, brushsaw, Silvana® selective) on the quality of regenerating aspen. The Vision® treatment virtually eliminated aspen from the site. The

Release® treatment led to top kill of the aspen, resulting in some staining but very little decay. The brushsaw and Silvana® selective treatments both resulted in decay at the base of a large proportion of stem sprouts originating from the cut stumps. These stem sprouts are unlikely to develop into merchantable trees and may rapidly fall out of the stand. However, no decay was observed in the vigorous root suckering stimulated by the cutting treatments, thus ensuring aspen will remain a substantial component of the stand.

Commercial thinning technologies and other partial-cutting opportunities

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Interest is growing in commercial thinning (CT) and other forms of partial cutting in eastern Canadian boreal forests. As part of a program in intensive forest management, CT can help to avoid fiber shortages and improve stand quality. CT programs in Canada usually target pure and unmanaged natural forests. In mixedwood forests, selecting appropriate stands is the key to permitting a viable operation, but the task becomes very difficult. Specialized equipment that is suitable for commercial thinning in softwood stands may have problems handling and processing the large poplars and birches often found in these stands. With such machines, treatments are limited to stands with small or medium-sized hardwoods.

The use of full-sized machines such as those used in clearcutting is one possible alternative. Using modified trail patterns may compensate for the relatively short reach of harvester booms and the wide forwarders used in such operations. With bigger trees, CT can be used to control the stand's composition and structure. Partial cutting in mature or nearly-mature stands may become increasingly frequent in the future. For example, shelterwood regeneration systems will be implement more often in an effort to improve the number of appropriate seedlings on a site. The combination of partial cutting with site preparation before final felling is a new application that FERIC is currently studying.

Ten year stand level impacts of vegetation management in boreal mixedwoods

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In forestry, vegetation management treatments are widely used to enhance establishment of young stands and achieve free growing requirements. This study was established in 1988-89 in the sub-boreal spruce biogeoclimatic zone to examine the long-term effects of glyphosate treatment: i) on the growth of white spruce (*Picea glauca*); ii) on the development of vegetation community; and, iii) on mixed-stand timber yield. This study is replicated 3 times and conducted at three suitable sites: Goose Lake, Pinchi Lake, and Tsilcoh River in the Prince

George Forest Region of British Columbia. At each study site, two 100 x 100 m (1 ha) treatment plots were established before treatment application. Using large plots (1 ha) has allowed us to apply the treatments in a way that emulates operational practice and encompass the large amount of variation that is typically present within forestry sites in the province. The herbicide glyphosate (Roundup®) was applied in one of the treatment plots on each site to control target vegetation. To test the statistical significance of the treatment effect over a range of sites, an ANOVA of the combined data was performed using a randomized-block design. Over the 10-year period following the treatment white spruce seedlings in plots treated with glyphosate showed significantly better growth in diameter, height, crown radius, and volume than seedlings in the untreated plots. Overall vegetation cover and height were significantly reduced in the treated plots compared with that in untreated plots, for a period lasting up to five years after the herbicide was applied. This reduction was correlated with crop-tree growth. The glyphosate treatment seems to have been effective in reducing the occurrence, or curtailing the growth, of the main species that compete with crop trees, while maintaining much of the plant species diversity. Stand yield projections based on Mixed Growth Model suggest that glyphosate treatment applied to control broadleaves and shrubs has the potential to increase conifer yield and reduce conifer rotation age.

Longer term stand level responses to vegetation management in Ontario

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A summary of experimental results of the effect and utility of manual and chemical vegetation management techniques on the early development of coniferous crop trees will be presented. Experimental evidence clearly illustrated that substantial increases in size for jack pine, white spruce and black spruce were attainable using chemical and manual techniques: ranging from 150-350% increases in size at year 5. Percent conifer composition of the regenerating stands also increased in response to chemical and manual vegetation management techniques. Past emphasis in this research was on conifer wood production. More recently, we are re-measuring all the trials and quantifying both conifer and hardwood wood production.