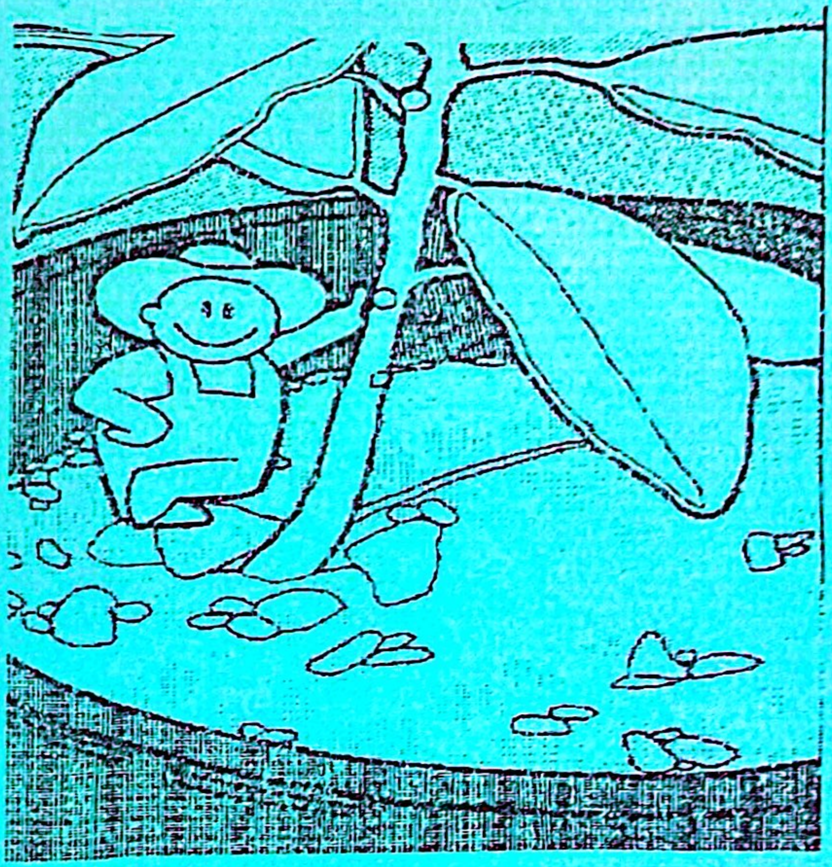
16th Annual Plant Science



Graduate Student Symposium

March 3-4, 2000
University of Manitoba

MARNIE

February 22, 2000

Fellow Plant Science Grad Students:

On behalf of the Plant Science Graduate Students at the University of Manitoba I would like to welcome you to the 16th Annual Plant Science Grad Symposium. I hope this opportunity to present your research will not only help you to perfect your presentation skills, but also bring you new friends and contacts who you will find invaluable throughout your career. This symposium is an excellent place to share your thoughts and open your mind to new exciting ideas in the field of Plant Science.

You should feel at home here, and make sure you take part in all the symposium festivities. A good time will be had by all thanks to the fine organizers we had working on the assembly of this symposium. A special thanks should be extended towards; Shauna Humble, Theingi Aung, Marnie Hamill, Kristen Bryson, Steve Martin, Sarah Savchuk, and Eymond Toupin.

Again WELCOME ALL!!!

Sincerely,

Quinn Holtslag

Quinn Holtslag,
Co-President Plant Science Grad Studies, University of Manitoba

Shauna Humble

Shauna Humble,
Co-President Plant Science Grad Studies, University of Manitoba

Table of Contents

Schedule of Events

Friday March 3, 2000

7:00 pm **"Meet and Greet "**
Location: Alley Cats Piano Bar, Canad Inn

Saturday March 4, 2000

7:30 am **Continental Breakfast**
Location: Agriculture Building, University of Manitoba

8:00 am **Section 1: Agronomy and Physiology Session**
Location: Carolyn Sifton Theatre, Agriculture Building, University of Manitoba
Chair: TBA

8:00 am **Seed Size and Planting Depth Influence on Canola Performance.** Kenneth E. Lamb and Dr. Burton Johnson, Graduate Research Assistant, Professor Department of Plant Sciences, NDSU, Fargo, ND 58105

8:15 am **The Role of Forage Legumes in Reducing On-Farm Non-Renewable Energy Use.** Jeff Hoeppner, Department of Plant Science, University of Manitoba.

8:30 am **Effect of fertilizer addition and weed density on spring wheat yield at two landscape positions.** D.M. Ross* and R.C. Van Acker, University of Manitoba, Winnipeg Canada.

8:45 am **Effect of Rotation and N Fertilizer on Growth, Development, and Water Use of Tall and Semi-Dwarf Oat Cultivars.** P.J. Knaggs*, M.H. Entz, University of Manitoba.

9:00 am **Effect of Crop Sequencing on Soybean Yield.** Ryan Moeller, Dwain Meyer, Graduate Research Assistant, Professor, Department of Plant Sciences, NDSU, Fargo, ND 58105

9:15 am **Effect of Residue Management on Dry Bean Growth, Maturity, and Yield.** L. D. Shaw and S. J. Shirtliffe Department of Plant Sciences, University of Saskatchewan, 51 Campus Dr., Saskatoon SK Canada S7N 5A8. e-mail: shawl@skyway.usask.ca.

9:30 am **Agronomic and processing characteristics of waxy and partial waxy durum wheat.** Nathalie Vignaux. North Dakota State University.

9:45 am **Transferring high grain protein content (GPC) genes to hard white spring wheat (*Triticum aestivum* L.) and evaluating the impact of GPC on end-use quality.** David J. Boehm and William A. Berzonsky, NDSU

10:00 am Break

10:30 am **Morphological Analysis of S9240 Crested Wheatgrass (*Agropyron cristatum*).** Angus Mellish[1,2] and Bruce Coulman.[1] [1]AAFC, Saskatoon Research Center, 107 Science Place, Saskatoon, SK. S7N 0X2. [2] Department of Plant Sciences, University of Saskatchewan, Saskatoon, SK. Canada S7N 5A8. Email: mellisha@em.agr.ca

10:45 am **Developmental Regulation of Cold Hardiness in Cereals.** Mahfoozi, S., Limin, A.E. and Fowler, D.B. Department of Plant Science, University of Saskatchewan, 51 Campus Dr., Saskatoon SK Canada S7N 5A8. e-mail: Mahfooz@sask.usask.ca

11:00 am **Freezing Resistance in the Genus *Phaseolus*.** Parthiba Balasubramanian, Albert Vandenberg, Pierre Hucl and Lawrence Gusta. Department of Plant Sciences, University of Saskatchewan, Saskatoon, SK. Canada S7N 5A8 e-mail: parthiba@sask.usask.ca

11:15 am Section 2: Breeding and Pathology
Location: Carolyn Sifton Theatre, Agriculture Building, University of Manitoba
Chair: TBA

11:15 am **Improving Production Traits using Contrasting Methods of Development in *Brassica* Species.** J.L. Lisakowski and P.B.E. McVetty, Department of Plant Science, University of Manitoba, Winnipeg, MB, Canada. R3T 2N2

11:30 am **Marker-Assisted Interspecific Gene Transfer from Raphanus to Brassica.** Kirstin Bett [1,2] and Derek Lydiate [1] [1]AAFC Saskatoon Research Centre , [2]Dept of Plant Sciences, Univ. of Saskatchewan

11:45 am **Genetic engineering of plants for enhanced phytoremediation potential.** C.A. Sonntag, W.A. Keller, R.S. Datla, G.J. Scoles. Department of Plant Sciences, University of Saskatchewan, 51 Campus Drive, Saskatoon, Saskatchewan, Canada, S7N 5A8. e-mail: sonntagc@sas.nrc.ca.

cancelled

12:00 pm **_Triticum turgidum_ L. var. _dicoccoides_ [LDN(Dic-3A)] chromosomes for the development of _Fusarium_ head blight (FHB) resistant durum and common wheat.** Carla Otto, NDSU

12:15 pm **Inheritance of Resistance to Loose Smut caused by _Ustilago tritici_ (Pers.) Rost. In Durum Wheat** Yosep S. Mau, Department of Plant Sciences, University of Saskatchewan, 51 Campus Dr., Saskatoon SK, Canada S7N 5A8. Email: mau@skyway.usask.ca

12:30 pm Lunch
Location: Atrium, Agriculture Building, University of Manitoba

1:30 pm **Evaluation of "novel" scald (_Rhynchosporium secalis_) resistance from three NZ barley (_Hordeum vulgare_ L.) genotypes.** Asheesh Singh, B.G. Rossnagel and G.J. Scoles. Department of Plant Sciences, 51 Campus Drive, University of Saskatchewan, Saskatoon, Canada. S7N 5A8. E-mail: singha@sask.usask.ca

1:45 pm **Inheritance and Allelic Studies for Chlorotic Component of Tan Spot of Wheat (Triticum aestivum L.).** P.K. Singh and G.R. Hughes, Dept. of Plant Sciences, University of Saskatchewan, Saskatoon, Canada, S7N 5A8. Email: singhp@sask.usask.ca

2:00 pm **Microscopic examination of necrosis induced by _Pyrenophora tritici-repentis_ Ptr ToxA toxin.** Eymond Toupin, University of Manitoba.

2:15 pm **Creating a Disease Forecast Model for _Amelanchier alnifolia_.** Q. A. Holtslag, W. R. Remphrey, W. G. D. Fernando, University of Manitoba.

2:30 pm **Effect of fungicide seed treatment on rhizobial survival and nodulation of chickpea.** S. Kyei-Boahen[1], F. L. Walley[2] and A. E. Slinkard[1]. [1]Department of Plant Sciences, [2]Department of Soil Science University of Saskatchewan, 51 Campus Dr., Saskatoon SK Canada S7N 5A8. email: Stephen.kyei-boahen@sask.usask.ca

2:45 pm Section 3: Weed Science
Location: Carolyn Sifton Theatre, Agriculture Building, University of Manitoba
Chair: TBA

2:45 pm **Modeling Weed Seedling Emergence.** A. M. Marginet and R. C. Van Acker, Department of Plant Science, University of Manitoba, Winnipeg, MB, Canada, R3T 2N2

3:00 pm **Evaluating Competitive Differences Among Barley Cultivars (*Hordeum vulgare*) Against Wild Oat (*Avena fatua*).** C. Feschuk, AAFC and University of Manitoba.

3:15 pm **Biology of Biennial Wormwood (*Artemisia biennis* Willd.).** Kris J. Mahoney and George O. Kegode. Graduate Research Assistant and Assistant Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.

3:30 pm Break

4:00 pm **Interference of Biennial Wormwood (*Artemisia biennis* Willd.) In Soybean [*Glycine max* (L.) Merr].** Eric A. Nelson and George O. Kegode. Graduate Research Assistant and Assistant Professor. Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.

4:15 pm **Control of Biennial Wormwood in Soybean.** Bradley E. Fronning and George O. Kegode. Graduate Research Assistant and Assistant Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.

4:30 pm **The critical period of weed control in canola (*Brassica napus* L.)** S. Martin and R. Van Acker, Department of Plant Science, University of Manitoba, Winnipeg, MB, R3T 2N2, Canada

4:45 pm **Nightshade control in pinto bean with herbicides applied at reduced rates.** Chad A. Ringdahl and Calvin G. Messersmith, Graduate Research Assistant and Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.

5:00 pm **Postemergence Weed Control in Transgenic Sugarbeet (*Beta vulgaris* L.).** Ines Rothe, Alan G. Dexter, and John L. Luecke, North Dakota State University.

5:15 pm **Control of Acetolactate Synthase Resistant Kochia in Dry Edible Beans.** Richard J. Walker II and Calvin G. Messersmith, Graduate Research Assistant and Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND, 58105.

5:30 pm **Control of ALS-Resistant Kochia in Sugarbeet.** Donald L. Vincent III, Alan G. Dexter, and John Luecke, Graduate Research Assistant, Professor, and Research Specialist, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105

5:45 pm	**Comparison of Adjuvants with Postemergence Herbicides at the Micro-rate in Sugarbeet.** Trevor M. Dale, Alan G. Dexter, and John L. Luecke, Graduate Research Assistant, Professor, and Research Specialist, Department of Plant Sciences, North Dakota State Univ.-Univ. of Minnesota, Fargo, ND 58105.
6:00 pm	**Drift-reducing Nozzle and Drift Retardant Effects on Weed Control Efficacy.** Joel S. Roehl and Calvin G. Messersmith, Graduate Research Assistant and Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND, 58105.
6:30 pm	**Cash Bar** **Location:** University Club, Pembina Hall, University of Manitoba
7:00 pm	**Awards Banquet** **Location:** University Club, Pembina Hall, University of Manitoba **Guest Speaker:** John Morriss, Manitoba Co-operator
9:00 pm	**Social Event** **Location:** Wise Guys on Campus, University Centre

Section 1: Agronomy and Physiology

Seed Size and Planting Depth Influence on Canola Performance. Kenneth E. Lamb and Dr. Burton Johnson, Graduate Research Assistant, Professor Department of Plant Sciences, NDSU, Fargo, ND 58105

Canola (*Brassica napus L.*) acreage has increased dramatically in North Dakota over the past 5 years with new cultivars being introduced for production by many new growers. Evaluation of new cultivars for seedling vigor and stand establishment prompts investigation into reexamination of proper planting depth. This study was conducted to determine the influence of cultivar, seed size, and planting depth on seedling emergence, stand establishment and canola performance. The study was conducted at Casselton and Prosper, ND field sites in 1999. Four seed size fractions of a open-pollinated and a hybrid cultivar were planted at 25 and 50 mm depths. Determinations were made for percent live seed (PLS) emergence, final plant population, stand mortality, and seed yield. At Casselton greater PLS emergence, final plant population, stand mortality, and seed yield were indicated from the 25 mm planting depth compared with the 50 mm depth. Greater PLS emergence, stand mortality, and final plant population were also observed from the 25 mm planting depth at Prosper but yield was similar from both 25 and 50 mm plantings. Cultivar differences at Prosper indicated that the open-pollinated cultivar, Hudson, produced higher PLS emergence and final plant population than the hybrid cultivar Hyola 401. Cultivars produced similar values for these characteristics at Casselton. The hybrid cultivar produced greater yield at both sites. First year study results indicate that increasing planting depth reduced PLS emergence, final plant population, and stand mortality at both sites. Yield, however, was not reduced by at the deeper planting depth at either site. Further study replication is recommended.

The Role of Forage Legumes in Reducing On-Farm Non-Renewable Energy Use. Jeff Hoeppner, Department of Plant Science, University of Manitoba.

During the past few decades, there has been increasing concern over the state of the environment. Part of this concern stemmed from the large amounts of fossil fuels being consumed by industry, and the atmospheric pollutants that resulted from their use. Agriculture was criticized for being inefficient in terms of fossil fuel energy inputs per unit of food energy produced. As a result of this, research on how to decrease energy use and increase energy efficiency in crop production has been undertaken. Production of nitrogen fertilizer accounts for the greatest share of energy consumed in a crop production system; it is believed the incorporation of legumes into a cropping system can aid in the reduction of this energy consumption. Legumes are plants that can utilize nitrogen from the atmosphere, in conjunction with rhizobial bacteria. When plant residue from the legumes decomposes, nitrogen contained within becomes available for use by subsequent non-legume crops. By including forage legumes in a crop rotation, a producer can decrease his/her need for nitrogen fertilizer, which in turn should decrease energy use, and perhaps increase energy efficiency. When examining a number of crop rotation studies located in Western Canada, it was found that crop rotations containing perennial forage legumes (grown for 2 or more years and harvested as forage) used less energy, and were more energy efficient than more conventional annual crop rotations that did not contain legumes. It was also found that including green manure legumes (grown for 1 year or less as a fallow replacement - not harvested) in a crop rotation resulted in lower levels of energy being expended, but did not affect energy efficiency when compared to a continuous wheat rotation. However, including green manure legumes in a crop rotation is a more agronomically-sustainable practice, as organic matter and nitrogen are being added to the soil instead of being depleted by continuous cropping of wheat.

Effect of fertilizer addition and weed density on spring wheat yield at two landscape positions. D.M. Ross* and R.C. Van Acker, University of Manitoba, Winnipeg Canada.
Site-specific fertilizer applications may have implications for weed population dynamics that have been largely ignored. The purpose of this study was to determine the effect of landscape specific nitrogen application on wild oat (*Avena fatua* L.) and wild buckwheat (*Polygonum convolvulus* L.) competitiveness in spring wheat. This experiment was a split-split plot design wherein the main plot was landscape position, the subplot was nitrogen rate, and the sub-subplot was target weed density. The main plots were planted with either wild oats or wild buckwheat. The experiment was conducted at two sites near Birtle and Carman, Manitoba. Measurements of weed competitiveness included wheat grain yield per plot (as percentage of weed-free treatment), and plant dry biomass (g/m^2). Other measurements included soil fertility levels, gravimetric moisture levels, soil profile characterization, and site topographical characterization to provide a detailed description of the landscape encountered at each site. Results from three site years indicate that under high nitrogen rates relative wild oat competitiveness may increase with increasing density. Results from three site years suggest that increasing wild buckwheat density caused no consistent decline in wheat yield. Slope position has no apparent effect on either wild oat or wild buckwheat competitiveness, though analysis is ongoing. Birtle 1999 plots and biomass data from all site-years have yet to be analyzed. Independent soil characteristics will be tested for correlation to yield, biomass, density and landscape position.

Effect of Rotation and N Fertilizer on Growth, Development, and Water Use of Tall and Semi-Dwarf Oat Cultivars. P.J. KNAGGS*, M.H. ENTZ, University of Manitoba.
New semi-dwarf oat cultivars provide an opportunity to compare the growth, development, and water use patterns of tall and semi-dwarf cultivars. The semi-dwarf characteristic is associated with increased yield potential through a higher harvest index, increased number of productive panicles and number of seeds per panicle. Cultivar, soil fertility, and rotation influences soil water use patterns. Previous research in wheat has shown no correlation between plant height and soil water extraction. Fertilizer N enhances top growth and increases total soil water uptake, but the extent to which residual N from previous crops influences depth of soil water use has not been documented in oats. An experiment is being conducted at Carman (1999 & 2000) and Winnipeg (2000) to evaluate the effect of rotation and N fertilizer on the growth, development and water use of semi-dwarf and tall statured oat cultivars. Comparisons of water use will be made to a tall and semi-dwarf wheat cultivar (AC Barrie and AC Taber, respectively). Oat cultivars include Triple Crown and two unreleased semi-dwarf lines, OT 296 and OT 288.
P.J. Knaggs, (204) 474-6073, umknagg0@cc.umanitoba.ca

Effect of Crop Sequencing on Soybean Yield. Ryan Moeller, Dwain Meyer, Graduate Research Assistant, Professor, Department of Plant Sciences, NDSU, Fargo, ND 58105

There are many reports of the beneficial effects of crops such as corn (Zea mays L), hard red spring wheat (Triticum aestivum L.), durum wheat (Triticum turgidum), canola (Brassica juncea), sunflower (Helianthus annuus L.), field pea (Pisum sativum L.), and sudangrass (Sorghum bicolor L.) when they follow soybean {Glycine max L. (Merr.)} in a cropping sequence. However, with the exception of corn, few studies have been done on the effect of these crops on soybean yield. The objective of this study is to measure the impact of wheat, durum wheat, canola, sunflower, field pea, sudangrass and soybean crops on the yield of soybean when compared to the yield of soybean in a traditional corn-soybean rotation. The three-year study to be conducted at two locations will be managed for maximum crop yield. Cropping sequences will consist of continuous soybean, soybean following corn, soybean

following wheat, soybean following canola, soybean following sunflower, soybean following field pea, and soybean following sudangrass. 1999 was the initial year of the experiment and all crops were seeded in test plots at both locations. Soybean will be seeded on these plots in the spring of 2000. The results of this experiment hopefully will reveal the various rotational effects of these crops on soybean yield due to their possible inhibitory or stimulatory effects.

Effect of Residue Management on Dry Bean Growth, Maturity, and Yield. L. D. Shaw and S. J. Shirtliffe Department of Plant Sciences, University of Saskatchewan, 51 Campus Dr., Saskatoon SK Canada S7N 5A8. e-mail: shawl@skyway.usask.ca.

The effect of residue management on black bean (*Phaseolus vulgaris* L.) height, maturity, and yield was studied at two sites in Saskatchwan in 1999. Treatments were spring cultivated, mowed or left as standing stubble prior to seeding. CDC Nighthawk was damaged by fall frost. Tillage reduced emergence in cultivated treatments compared to no-till, possibly by causing compaction, reducing macroporosity and creating conditions suitable for root diseases. Plant density differences largely determined yield, biomass at physiological maturity, and pod clearance. Yields were 682 kg/ha, 838 kg/ha, 880 kg/ha for cultivated, mowed and stubble respectively. Plant height was not significantly affected by tillage. Bean pod clearance under conventional tillage was 5% higher than under no-till, regardless of stubble height, possibly because of the lower plant density in cultivated treatments. Differences among treatments for internode length were not statistically significant. Residue management had no effect on maturity of either black bean cultivar studied.

Agronomic and processing characteristics of waxy and partial waxy durum wheat. Nathalie Vignaux. North Dakota State University.

Starch is the major storage carbohydrate in cereal grains. It mainly consists of two types of glucan polymers, the essentially linear amylose (10to 37% of starch content) and highly branched amylopectin. In many crops, improved processing properties have been correlated with low levels of amylose. The low amylose characteristic is caused by mutations at the waxy locus that encodes the granule-bound starch synthase (GBSS) protein, also called waxy protein. This enzyme is involved in amylose synthesis and its entire or partial loss results in no or low amylose content. The seconditions have respectively been termed waxy and partial waxy character. The development of well-adapted waxy and partial waxy durum germplasms is currently underway at North Dakota State University.

Durum wheat is mainly used for semolina and pasta production. The use of low amylose content durum wheat offers new potentials in food and non-food industry. The ultimate objective of this research is to determine the potential applications of waxy and partial waxy durum wheat. Waxy and partial waxy lines will be planted in three locations with a Random Complete Block Design. Heading date and height will be recorded and seeds will be analyzed as for their physical and starch properties as well as semolina and pasta quality. Waxy and partial waxy pasta will also be characterized for their potential of been further processed (canning, freezing). This study will allow us to determine the effect of the amylose content(partial to full waxy) on processing properties of durum wheat. The results will determine the potential of waxy and partial waxy durum germplasms. New industrial applications for durum might be found, and it could result in the start of a breeding program for developing waxy durum cultivar from the waxy germplasm.

Transferring high grain protein content (GPC) genes to hard white spring wheat (*Triticum aestivum* L.) and evaluating the impact of GPC on end-use quality. David J. Boehm and William A. Berzonsky, NDSU

Interest in producing hard white wheat (*Triticum aestivum* L.) is growing. Compared to hard red wheat, white wheat has color and grain quality characteristics more desirable for potential domestic and export markets. It has higher milling extraction rates, a milder taste, and a preferred lighter color for wheat products. Grain protein content (GPC) is a critical factor in bread quality. A promising high GPC gene was detected in *Triticum turgidum* var. *dicoccoides* (6B), and it has been transferred to hexaploid wheat cultivar Glupro. Nitrogen soil treatments impact GPC. However, while most studies have shown an increase in GPC with increased nitrogen application, some have shown that the timing of application may be more important. Project goals are to use marker assisted selection to transfer the DIC(6B) high GPC gene to white wheat and to study the relationship between nitrogen fertilizer application, GPC, and end-use quality. Glupro, a high GPC cultivar, will be used as the source of the high GPC gene. Backcross F_1 generations to white wheat lines will be screened for presence of high GPC by using PCR-based markers. The desired genotypes will be used to initiate development of pure lines. Glupro and Glenlea, along with moderate to low protein cultivars Argent, Grandin, HJ98, and McVey will be grown in replicated trials across four North Dakota locations. The trials will be conducted using three levels of spring applied nitrogen and one split-application, 60% N applied at establishment and 40% N applied at anthesis. Yield, maturity, percent protein, 1000 kernel weight, kernel size distribution, falling number, kernel color, test weight, and the end-use quality of frozen doughs will be evaluated. It is expected that new high protein hard white wheat lines will be developed, while a better understanding of the relationship between GPC, N fertilization, and end-use quality is attained.

Morphological Analysis of S9240 Crested Wheatgrass (*Agropyron cristatum*). Angus Mellish[1,2] and Bruce Coulman.[1] [1]AAFC, Saskatoon Research Center, 107 Science Place, Saskatoon, SK. S7N 0X2. [2] Department of Plant Sciences, University of Saskatchewan, Saskatoon, SK. Canada S7N 5A8. Email: mellisha@em.agr.ca

S9240 crested wheatgrass was produced by colchicine-doubling the chromosome number of diploid *A. cristatum* cv. Parkway, followed by several cycles of selection for height, seed size, floret fertility, and forage yield. Some limited outcrossing with tetraploid *A. cristatum* cv. Kirk occurred during the selection cycles. The goal of this study was compare S9240 with other crested wheatgrass cultivars in seed size, height, crown width, tiller number, tiller weight, and ability to emerge from deep seedings. The seed weight of S9240 was significantly ($p<0.05$) heavier than other tested crested wheatgrass cultivars. In seedings in greenhouse soil flats at a 7.5 cm depth, S9240 showed higher emergence and larger seedlings. S9240 was significantly ($p<0.05$) taller than other crested wheats in both spaced-plantings and solid swards, and had narrower crowns and fewer, heavier tillers. Heritabilities of crown width and plant height will be calculated to determine the potential effectiveness of further selection for these traits. From the results of the present study, and associated yield trials, S9240 shows potential as a productive hay-type cultivar of crested wheatgrass that can emerge from deeper seedings.

Developmental Regulation of Cold Hardiness in Cereals. Mahfoozi, S., Limin, A.E. and Fowler, D.B. Department of Plant Science, University of Saskatchewan, 51 Campus Dr., Saskatoon SK Canada S7N 5A8. e-mail: Mahfooz@sask.usask.ca
The objective of this study was to determine the interralationships among the developmental stages and low-temperature (LT) gene expression. LT response curves were determined for 3 winter wheat cultivars with sensitivity to photoperiod grown at 4 C under 8 (SD) and 20-h (LD) day lengths for 0 to 98 days. All cultivars under LD reached vernalization saturation by 49 days. Plants grown under SD remained vegetative for longer time. After 56 days in cold, a second set of plants were exposed to SD and LD for 14 days at 20 C then 21 days at 4 C. The plants from SD treatment were still vegetative and had the ability to reharden. Plants hardened and dehardened under LD conditions had gone to the reproductive phase and had lost the ability to reharden. These results supports the hypothesis that LT tolerance genes are developmentally regulated and plants in the reproductive phase have a limited ability to express LT genes.

Freezing Resistance in the Genus *Phaseolus*. Parthiba Balasubramanian, Albert Vandenberg, Pierre Hucl and Lawrence Gusta. Department of Plant Sciences, University of Saskatchewan, Saskatoon, SK. Canada S7N 5A8 e-mail: parthiba@sask.usask.ca
Dry bean (*Phaseolus vulgaris* L.) yield on the Canadian prairies is primarily limited by the number of frost-free days. The objective of this study was to investigate the mechanism of freezing resistance in the primary (cultivated and wild *P. vulgaris*) and tertiary (related species) gene pools of dry bean. Leaflets of several species of *Phaseolus* grown under both controlled environment and field conditions were evaluated for their freezing tolerance and avoidance. To evaluate freezing tolerance, leaflets were nucleated at –2°C and the glycol bath or air temperature decreased to –5°C at the rate of 1°C h^{-1}. The percentage electrolyte leakage ratio or LT_{50} was determined. To evaluate freezing avoidance, non-nucleated leaflets were subjected to decreasing air temperatures of up to –10°C cooled at the rate of 1°C h^{-1}. The freezing tolerance study on controlled environment chamber leaf samples showed that the tertiary gene pool species of common bean suffered less than 50% damage to their leaves at –2°C compared to the accessions of the primary gene pool. This was further confirmed by the LT_{50} means of the field sample. As for the freezing avoidance study, leaflets of the primary gene pool froze at –7°C (controlled environment sample) or –4°C (field sample). The leaflets of the tertiary gene pool with the exception of *P. acutifolius*, either froze at temperatures < -8°C or did not freeze at the temperatures tested indicating their ability to supercool extensively. Freezing

tolerance and avoidance observed in the tertiary gene pool, if proven suitable under field conditions, can then be introgressed into the primary gene pool.

Section 2: Breeding and Pathology

Improving Production Traits using Contrasting Methods of Development in *Brassica* Species.
J.L. Lisakowski and P.B.E. McVetty, Department of Plant Science, University of Manitoba, Winnipeg, MB, Canada. R3T 2N2
Optimum utilization of the resources required for the development of any cultivar can result in efficient advancements in production traits for researchers. This could help to decrease the time period which exists between farmers requests for improved cultivars to researchers developed products. Pedigree selection and double haploid line development are two contrasting processes used to improve Brassica cultivar characteristics. Pedigree selection uses traditional approaches to breeding while double haploid line, a newer method uses novel approaches that incorporated advancements in biotechnology. This type of research will be first of its kind to quantify resource requirements such as space, time, labour, materials and supplies, as well as consideration of genetic traits that are desired. An in-depth cost analysis will compare resources associated with the development of new cultivars, from initial parental crosses to registration along with genetic consideration. This could help to conclude the superiority of method to justifiable cost versus ultimate result value. As this project is only at its early research stage, comparative data is limited at this time.

Marker-Assisted Interspecific Gene Transfer from Raphanus to Brassica. Kirstin Bett [1,2] and Derek Lydiate [1] [1]AAFC Saskatoon Research Centre, [2]Dept of Plant Sciences, Univ. of Saskatchewan
Raphanus contains several genes of interest to canola (*Brassica napus* and *B. rapa*) breeders. Interspecific crosses are often associated with linkage drag which can have a deleterious effect on plant vigour and other important traits. We have chosen to overcome this by using natural homoeologous recombination to transfer a small, defined segment of *Raphanus* into the equivalent region on the *Brassica* A genome. To transfer this small segment, accurate comparative maps of the *Raphanus* and *Brassica* A genomes are needed to identify which chromosome segments are primary homoeologues. Interspecific hybrids with relaxed control of homologous pairing are also necessary to allow for homoeologous recombination between the genomes. We are well advanced in the development of these technologies, including the construction of the first high density map of the entire *Raphanus* genome. This map is based on RFLP probes already mapped in the *Brassica* A and C genomes which has allowed for comparative mapping amongst the species. The necessary interspecific hybrids have been developed to allow for the transfer of a specific *Raphanus* segment.

Genetic engineering of plants for enhanced phytoremediation potential. C.A. Sonntag, W.A. Keller, R.S. Datla, G.J. Scoles. Department of Plant Sciences, University of Saskatchewan, 51 Campus Drive, Saskatoon, Saskatchewan, Canada, S7N 5A8. e-mail: sonntagc@sas.nrc.ca.
Organic chemicals, such as toluene, have the ability to accumulate in the environment to levels that threaten both human health and environment quality (Atlas, 1995). Environmental remediation strategies employ physical, chemical and/or biological processes to eliminate, reduce, isolate or stabilize contaminants. Non-biological remediation strategies are costly whereas phytoremediation

can be a cost-effective alternative. Plant tissues, however, are not viable in the presence of toluene or some of its metabolites. Pseudomonas putida F1 is able to metabolize toluene to non-toxic end-products and has a well characterized biochemical pathway (Zylstra & Gibson, 1989). We have cloned one of the genes involved in toluene degradation (todE) into Agrobacterium tumefaciens. todE encodes 3-methylcatechol 2,3-dioxygenase and converts 3-methylcatechol to 2-hydroxy-6-oxo-2,4-heptadienoate. Using Agrobacterium-mediated gene transfer with a suitable plant species, we hope to demonstrate an increased tolerance of the plant material to 3-methylcatechol as well as demonstrate enzymatic activity of 3-methylcatechol 2,3-dioxygenase by the degradation of 3-methylcatechol to 2-hydroxy-6-oxo-2,4-heptadienoate.

***Triticum turgidum* L. var. *dicoccoides* [LDN(Dic-3A)] chromosomes for the development of *Fusarium* head blight (FHB) resistant durum and common wheat.** Carla Otto, NDSU
The extensive damage caused by *Fusarium* head blight (FHB) has made it necessary to develop resistant lines of durum and common wheat. Unlike hexaploid wheat there are no usable sources of resistance in domesticated tetraploid cultivars. One species that shows promise as a source for FHB resistance is an accession of *Triticum turgidum* L. var. *dicoccoides* (Joppa, 1997). Langdon-dicoccoides disomic substitution lines [LDN(Dic)] were analyzed for Type II resistance. The Langdon durum line with a pair of chromosomes from an accession of *Triticum turgidum* L. var. *dicoccoides* [LDN(Dic-3A)] was shown to have reduced infection to FHB relative to the parents (Elias et al., 1996). A Recombinant Inbred Chromosome Line (RICL) population of 83 individuals derived from LDN(Dic-3A) has been analyzed over three seasons. These data, molecular marker (RFLP, AFLP, and microsatellite) mapping data and QTL analysis results further delineating the location of FHB resistance loci on 3A are presented.

Inheritance of Resistance to Loose Smut caused by *Ustilago tritici* (Pers.) Rost. In Durum Wheat
Yosep S. Mau, Department of Plant Sciences, University of Saskatchewan, 51 Campus Dr., Saskatoon SK, Canada S7N 5A8. Email: mau@skyway.usask.ca
The objectives of this study are: **1)**. To determine the inheritance of resistance to several races of *U. tritici* causing loose smut disease in durum wheat, **2)**. To find resistance to a broad ranges of races of *U. tritici* that is simply inherited. Three crosses were studied, resulting from crosses between three resistant lines and a susceptible line, Sceptre. The crosses are Orgaz/Sceptre, Tripolitico/Sceptre and VIR53877,Hordeiforme/Sceptre. The resulting F_1, F_2, and F_3 seeds of those crosses were inoculated with race T26, T32, T33, and a mixture of the three races. Inoculation was done at anthesis based on needle method. The inoculated F_1, F_2, and F_3 seeds were grown in green house to see their reaction. The parents of each cross were also inoculated and grown in the green house along with the F_1, F_2, and F_3 of each cross. The F_1 data of each of the three crosses suggested that dominant genes are controlling resistance to the three races and the race mixture. Based on F_2 and F_3 smut incidences, in the cross Orgaz/Sceptre, one gene was suggested to control resistant to race T26, two genes control resistance to race T32 as well as to race T33, and one gene controls resistance to the race mixture. In the cross Tripolitico/Sceptre, one gene was suggested to control resistance to race T26, two genes control resistance to each of the race T32, T33, and the race mixture, respectively. In the last cross, VIR53877,Hordeiforme/Sceptre, resistance to race T26 was suggested to be controlled by one gene, and resistance to each of the race T32, T33, and mixture, respectively, were controlled by two genes.

Evaluation of "novel" scald (*Rhynchosporium secalis*) resistance from three NZ barley (*Hordeum vulgare* L.) genotypes. Asheesh Singh, B.G. Rossnagel and G.J. Scoles. Department of Plant Sciences, 51 Campus Drive, University of Saskatchewan, Saskatoon, Canada. S7N 5A8. E-mail: singha@sask.usask.ca

Scald (*Rhynchosporium secalis*), a foliar fungal disease of barley (*Hordeum vulgare* L.) can cause significant yield and quality losses in cool moist areas of western Canada. The use of resistant cultivars is most efficient control method, since it is environmentally safe and cost effective. There is an ongoing need to introduce new sources of resistance into local breeding populations due to continuous evolution of more virulent and aggressive scald pathotypes. The overall objective of this study is to evaluate three New Zealand (NZ) breeding lines as potential donors of "novel" scald resistance. Primary objectives include: evaluation of the effectiveness of the resistance under Canadian conditions; the 'novelty' of the resistance vs. known resistance sources; evaluation of the inheritance of the resistance; and identification of molecular markers associated with the novel resistance. To date two NZ lines demonstrate good resistance. The resistance gene(s) are definitely different than resistance known to reside on chromosome 3. Field screening of F_1 and F_2's in our 1999 scald nursery suggest qualitative inheritance. F_5 SSD RIL's will be screened at the same scald nursery in 2000 to confirm these findings.

Inheritance and Allelic Studies for Chlorotic Component of Tan Spot of Wheat (Triticum aestivum L.). P.K. Singh and G.R. Hughes, Dept. of Plant Sciences, University of Saskatchewan, Saskatoon, Canada, S7N 5A8. Email: singhp@sask.usask.ca

Tan spot of wheat is caused by fungus Pyrenophora tritici-repentis (Died.) Dreches. Tan spot on an average cause 3-15% yield losses but under favorable conditions can be as high as 60%. The infected seeds are shriveled and show pink discoloration thus reducing the commercial value of the grains. There has been an increase in disease incidence in recent years and has been largely attributed to changes in cultural practices and the growing of susceptible wheat cultivars. The tan spot syndrome consists of two phenotypically distinct symptoms: tan necrosis and extensive chlorosis. Genetic information is necessary to efficiently develop adapted resistant varieties. The objectives of this study were to determine the inheritance of resistance to chlorosis component of tan spot and to study the allelic relationship among the resistant sources. For the inheritance study six crosses involving resistant sources Erik, Hadden, Red Chief, Glenlea and 86 ISWN 2137 and the susceptible line 6B-365 were studied. For the allelic study all possible half diallel crosses among the five resistant sources were studied. For both the allelic and inheritance study F1, F2, and F2:3 families were screened with isolate Ptr 94-8-2 (race 3) which induces chlorosis only. Plants were inoculated at 2-leaf stage and disease rating was done based on presence or absence of extensive chlorosis. In all the six crosses studied the F1 plants were resistant while the segregation pattern observed in F2 population indicate that a single dominant gene controls resistance. The confirmation of monogenic control for chlorosis component of tan spot was made in F2:3 families which showed segregation pattern of 1:2:1. Lack of segregation in all the crosses involving the resistant sources indicate that the resistant sources share at least one gene(s) for resistance.

Microscopic examination of necrosis induced by *Pyrenophora tritici-repentis* Ptr ToxA toxin. Eymond Toupin, University of Manitoba.

The incidence of tan spot, an important leaf spot disease of wheat, seems to have increased with the recent adoption of conservation tillage practices. *Pyrenophora tritici-repentis*, the causal organism of tan spot, synthesizes Ptr ToxA, a 14 kDa protein which induces necrosis in sensitive hosts, as well as two other chlorosis inducing toxins. These toxins are considered pathogenecity factors because their activity is required for disease development. Determining the mode of action of these toxins will lead to a greater understanding of both the physiology of wheat and the role of these toxins in host pathogen interactions. In this study, fluorescence, light and electron microscopy were used to characterize the histology of Ptr ToxA toxin activity. The microscopic toxin effects were compared to other cellular disruptive treatments such as freezing, desiccation, and plasmolysis. The effect of humidity on symptom development was also examined. Ptr ToxA causes mesophyll and epidermal cells to collapse. In the densely stained collapsed cells, the thylakoid stacks of chloroplasts are well preserved but other organelles cannot be distinguished. Also, the walls of these cells are severely invaginated but calcofluor and PAS staining did not indicate a loss or digestion wall carbohydrates. As was found in previous studies, bundle cells are unaffected by Ptr ToxA. The plasmolysis treatment, which consisted of fixing cells in a highly hyperosmotic solution, demonstrated that the plasma membrane could separate from the wall and that hyperosmotic conditions during fixation did not damage cellular ultrastructure. Desiccated and frozen leaf tissues also had deformed cell walls, densely staining contents and preserved thylakoid structure. Toxin-treated tissues maintained in a humid environment had fewer collapsed cells, more organelles preserved, and their appearance suggested a loss of tonoplast integrity as an early toxin effect.

Creating a Disease Forecast Model for *Amelanchier alnifolia*. Q. A. Holtslag, W. R. Remphrey, W. G. D. Fernando, University of Manitoba.

Disease forecasting models are valuable tools in which a schematic description of pathological system is developed in order to estimate or calculate disease outbreaks in advance. These models are often based on meteorological data, as there is a strong relationship between host, pathogen and the environment. Disease forecast models simultaneously help to minimize production inputs and maximize disease control. There are many economic and environmental benefits that follow controlled spraying. Adcon Telemetry is a weather monitoring system that collects field data and helps to produce disease forecasting models. The Adcon addVantage software runs disease forecasting models and lets producers know what the disease pressure index is given a set of weather conditions. Accuracy of these models is constantly improved with each year's set of weather data. Currently demand for saskatoon fruit is not being met because of constraints imposed by diseases like Entomosporium leaf and berry spot. A predominant disease of saskatoons, Entomosporium leaf and berry spot has to be controlled if the industry is to survive and flourish. The first step in the modeling process is to identify favorable climatic conditions that favor disease development. Preliminary data suggests that cool wet conditions favor *Entomosporium* proliferation. A complete disease forecast model should include success of conidiospore infection, disease development, and effectiveness of pesticide control. Essentially, points will be added and subtracted from a predetermined disease severity index based on environmental conditions and pesticide applications. Ultimately, with an effective disease forecast model, producers will be able to minimize the labor required to attain a high value crop, while maximizing the effectiveness of crop inputs.

Effect of fungicide seed treatment on rhizobial survival and nodulation of chickpea. S. Kyei-Boahen[1], F. L. Walley[2] and A. E. Slinkard[1]. [1]Department of Plant Sciences, [2]Department of Soil Science University of Saskatchewan, 51 Campus Dr., Saskatoon SK Canada S7N 5A8. email: Stephen.kyei-boahen@sask.usask.ca
Chickpea seeds are often treated with fungicides to control soil pathogens and pests, but can be incompatible with *Rhizobium* inoculation. This study examined the effect of four commonly used fungicides, Apron, Arrest 75W (Thiram), Crown and Captan on the survival of *Rhizobium ciceri* inoculated on seeds, and on nodulation and dry matter production of chickpea. Fungicide treatment decreased the number of viable rhizobia on seed. In general, the toxicity of the fungicides increased in the following order: Control < Crown < Arrest = Apron < Captan. Crown had no effect on rhizobial viability but significantly reduced nodulation, N_2 fixation, and shoot dry matter. Seed-applied Arrest decreased rhizobial numbers considerably and resulted in a significant reduction in nodulation, dry matter yield and N_2 fixation. Although Captan was the most toxic to rhizobial survival, it had no apparent effect on nodulation and shoot dry weight. Apron had the least detrimental effect on inoculation evaluated at the early pod-filling stage and can be considered to have acceptable compatibility with chickpea inoculation.

Section 3: Weed Science

Modeling Weed Seedling Emergence. A. M. Marginet and R. C. Van Acker, Department of Plant Science, University of Manitoba, Winnipeg, MB, Canada, R3T 2N2
Different weed species are known to have predictable, seasonal emergence patterns. The emergence pattern is influenced by environmental conditions and species' physiological characteristics. Emergence patterns also can be influenced by agronomic practices. If interactions between weed species and field environments are quantified, models to accurately predict emergence could be created. In 1999, fifteen fields under either zero- or conventional-tillage, were selected in southern Manitoba on the basis of location, crop rotation, and weed diversity. The field locations were grouped into three regions based on growing degree day (GDD), precipitation, and soil type. The main target weeds for the study were wild oat (*Avena fatua*), green foxtail (*Setaria viridis*) and wild buckwheat (*Polygonum convolvulus*). Four 0.25 m^2 permanent quadrats were placed in representative field areas in each field to assess weed emergence. Quadrats were checked every 2 to 3 days and emerged plants were identified and recorded. Colored rings were placed around the base of plants to differentiate the emerging plants, with different colors designated for different days. For each field, soil temperature, moisture, and air temperature were recorded during the sampling period as well as agronomic practices such as tillage, seeding date, and crop rotation. Differences in emergence periodicity were observed between species. Furthermore, differences in timing of emergence for a single species were observed between different tillage systems and different regions. Models of weed seedling emergence will be developed based on these field observations and will include parameters such as air temperature, soil temperature, precipitation and soil moisture data. These models will assist producers in determining the optimum timing of herbicide applications or other weed control measures.

Evaluating Competitive Differences Among Barley Cultivars (*Hordeum vulgare*) Against Wild Oat (*Avena fatua*). C. Feschuk, AAFC and University of Manitoba.

Until recently the goals of barley breeding programs have focused on disease resistance and producing plants with desirable agronomic characteristics (lodging resistance, higher protein levels, good malting qualities, etc). Breeders may have, however, unknowingly selected for barley cultivars with different competitive abilities against weeds. Recently, researchers have realized the importance of competitive cultivars in managing weed problems, however, research in western Canada is still lacking. Since herbicide efficacy increases with increasing crop competitiveness, quantifying traits that enhance varietal competitiveness is important for developing new cultivars that can improve herbicide performance or mitigate the need for herbicides all together. Competitive traits can be bred into new cultivars as part of an Integrated Weed Management (IWM) strategy, a strategy that is becoming increasingly more important due to high production costs and weed resistance. Since competitive cultivars can be used to decrease the reliance on chemical weed control, producers can use the new cultivars for specialized purposes such as buffer zones or in novel production practices like Pesticide Free Production (PFP).

Research was conducted in 1998 and 1999 at the Brandon Research Center, Brandon, Manitoba. Eight barley varieties, 3 hulless and 5 hulled, were selected based on contrasting growth characteristics. The experiment was a randomized complete block design with two sites each year (sandy loam and silty clay soils). Wild oats were sown with the barley at density of 60 plants/m^2. Dose-response relationships were used to assess the relative competitiveness of the barley varieties. Seven herbicide treatments (Imazamethabenz – group 2) ranging from the recommended rate (.65 l/acre; 488 ai/ha) to no herbicide at 20% increments were used. 1998 and 1999 results showed no significant advantage in either wild oat seed production or in barley yield occurring with herbicide rates higher than 20 to 60 percent of the recommended rate depending on variety. Concurrent research is being conducted to determine the traits that lead to competitive superiority but preliminary results indicate fast emergence (fast emergence may increase the critical weed free period) and early canopy closure as being most important for competition.

Biology of Biennial Wormwood (*Artemisia biennis* Willd.). Kris J. Mahoney and George O. Kegode. Graduate Research Assistant and Assistant Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.

Biennial wormwood, a native weed of the Northern Great Plains, has spread throughout northern United States and southern Canada. Biennial wormwood is estimated to produce over one million seeds per plant, but additional information on biology of the species is limited. The objective of this research was to study morphology and life cycle characteristics of biennial wormwood. In 1999, an experiment was conducted to determine the influence of biennial wormwood transplanting date on flowering, biomass, and seed production. Seedlings were started in a greenhouse 2 weeks prior to 9 transplanting date treatments (May 21, May 30, June 15, June 30, July 15, July 30, August 15, August 30, and September 15). Weekly destructive sampling began 2 weeks after transplanting and ended on September 29. Plants from cohorts 1 through 7 flowered between August 18 and September 15, whereas those from cohorts 8 and 9 had not flowered by September 29. Plants from cohorts 1 through 9 produced an average of 252, 514, 474, 247, 76, 16, 1, 0.3, and 0.1 grams of dry matter per plant, respectively, by September 29. Based on flower production at the first flowering date, plants from cohorts 1 through 7 produced approximately 33,000, 24,000, 19,000, 13,000, 6,000, 400, and 150 seeds per plant, respectively. On the last sampling date, plants from cohorts 1 through 7 produced approximately 80,000, 160,000, 170,000, 94,000, 37,000, 9,300, and 230 seeds per plant, respectively. Biennial wormwood exhibits an annual life cycle, and biomass production is related to seed production.

Interference of Biennial Wormwood (*Artemisia biennis* Willd.) in Soybean [*Glycine max* (L.) Merr]. Eric A. Nelson and George O. Kegode. Graduate Research Assistant and Assistant Professor. Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.
Biennial wormwood is a weed that has recently become problematic in soybean and dry bean in the Northern Great Plains, because it is tolerant to many herbicides commonly used for weed control in these crops. A field experiment was conducted in 1999 to evaluate the competitiveness of biennial wormwood in soybean as influenced by duration of interference. Biennial wormwood density was 8 plants m^{-1} of soybean row. The durations of interference were 0 to 10 weeks and season-long. Biennial wormwood did not reduce soybean yield until after 7 weeks of interference. The period of most rapid yield loss due to biennial wormwood interference occurred in a 2 week period from the beginning bloom (R1) soybean stage to full pod (R4) soybean stage. In this short period, soybean yield dropped from 2760 kg ha^{-1} to 1940 kg ha^{-1}. At 6 weeks of competition, biennial wormwood dry weight exceeded 2300 kg ha^{-1} and reduced soybean yield by more than 18% compared to the weed-free control. Once 2320 kg ha^{-1} of biennial wormwood biomass was produced, the soybean seed yield dropped rapidly from 2760 kg ha^{-1} to 1600 kg ha^{-1}. Therefore, biennial wormwood should be removed from soybean within the first six week 6 weeks of the crop growing season to minimize yield loss.

Control of Biennial Wormwood in Soybean. Bradley E. Fronning and George O. Kegode. Graduate Research Assistant and Assistant Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.
Biennial wormwood (*Artemisia biennis* Willd.), a native species of the temperate region of North America, has become a problem weed in the Northern Great Plains of the USA. Biennial wormwood has serious affects on soybean [*Glycine max* (L.) Merr.], and can also be found in dry edible bean (*Phaseolus vulgaris* L.) and canola (*Brassica napus* L.). Biennial wormwood can produce woody stems with a diameter up to 5 cm. These woody stems can impede crop harvest. The seeds of biennial wormwood are very small (1.0 x 0.4 x 0.25 mm) and easily spread during harvest. Biennial wormwood also causes significant soybean yield losses through competition. Biennial wormwood needs to be controlled and one option is with herbicides. However, there are few herbicides labeled on soybean that can control biennial wormwood. The use of genetically modified crops is another option since glyphosate and glufosinate are effective in controlling biennial wormwood. The objective of this research is to evaluate herbicides that control biennial wormwood and are safe to conventional soybeans. Preliminary studies indicate that bentazon, lactofen, sulfentrazone, and flumetsulam are good candidates for controlling biennial wormwood. Field experiments will be conducted to evaluate biennial wormwood control and crop safety with these herbicides. Greenhouse experiments will also be conducted to determine (i) the influence of different adjuvants (methylated seed oil, crop oil concentrate, nonionic surfactant and petroleum oil) have on uptake of bentazon and

lactofen by biennial wormwood, (ii) the optimal plant size for maximum control of biennial wormwood, and (iii) the application rate of bentazon, lactofen, sulfentrazone, flumetsulam herbicide that results in the best control of biennial wormwood.

The critical period of weed control in canola (*Brassica napus* L.) S. Martin and R. Van Acker, Department of Plant Science, University of Manitoba, Winnipeg, MB, R3T 2N2, Canada

The critical period of weed control is the time during the lifecycle of a crop in which it must be kept weed-free to prevent yield loss from weed competition. The advent of soil-applied herbicides and herbicide-tolerant canola varieties in western Canada has increased interest in this area of research to find the proper timing for weed control in canola. A critical period experiment was performed at three sites in southern Manitoba in 1998 and 1999 and consisted of two sets of treatments. The first was kept weed-free for increasing lengths of time to find the minimum weed-free period required to maintain maximum yield. In the second set, weeds were permitted to grow for increasing lengths of time to find the maximum tolerable weed-infested period. It was found that canola must be kept weed-free until the 4th leaf stage (39 DAE) to consistently prevent greater than 10% yield loss. In addition, the crop required the removal of weeds by the 4th leaf stage (17 DAE) to prevent greater than 5% yield reduction from interference-induced competition. It was also found that after the 4th leaf stage not many weeds emerged and these did not accumulate significant biomass to compete with the crop. In the future, this information will become very useful for making weed control recommendations to canola producers.

Nightshade control in pinto bean with herbicides applied at reduced rates. Chad A. Ringdahl and Calvin G. Messersmith, Graduate Research Assistant and Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND 58105.

Nightshade spp. interference reduces dry edible bean production in the northern United States and Canada. Acifluorfen, fomesafen, imazamox, imazethapyr and lactofen provide good control of nightshade in soybean. Field experiments were conducted in 1999 near Oakes and Wyndmere ND, to evaluate the effectiveness of these herbicides at reduced rates for hairy nightshade control in pinto bean. The first application of two and three split treatments was applied to 2- to 4-leaf nightshade. Subsequent treatments were applied when 90% of nightshade had 2 to 4 leaves. Single application treatments were applied to 6- to 8-leaf nightshade. All treatments were applied with methylated seed oil at 1.5% v/v. Visual evaluations of nightshade control and crop injury were made 7 days after each application. All treatments except acifluorfen provided 96% or better nightshade control. Acifluorfen provided 81-90% control. Acifluorfen, fomesafen and lactofen controlled nightshade in 3- to 5-days. Imazamox and imazethapyr controlled nightshade in 7- to 10-days. Although, acifluorfen, fomesafen and lactofen also caused greater pinto bean injury. Crop injury increased with multiple applications of acifluorfen, fomesafen and lactofen, whereas less injury was observed with multiple applications of imazamox and imazethapyr. All treatments reduced the number of physiologically mature pods by 6%, but these reductions did not affect seed yield.

Postemergence Weed Control in Transgenic Sugarbeet (*Beta vulgaris* L.). Ines Rothe, Alan G. Dexter, and John L. Luecke, North Dakota State University.

Generally weeds are removed from sugarbeet (*Beta vulgaris* L.) so losses due to competition are not large. However, weed control in sugarbeet is expensive and difficult. The narrow time frame in which most broadleaf weeds are susceptible to current conventional postemergence (POST) herbicides greatly restricts the window for timing of sequential POST herbicide applications. Sugarbeet has been genetically altered to resist highly effective broadspectrum herbicides such as glyphosate or glufosinate. Transgenic sugarbeet, unlike the untransformed cultivar, is not damaged by the herbicide to which it is resistant. Therefore, normally non-selective herbicides can be used in-season to kill weeds at any stage of development. Field experiments were conducted to determine weed control efficiency of glyphosate and glufosinate in transgenic sugarbeet cultivars, to determine optimum use rate and application starting times to avoid yield loss due to weed competition or crop injury, and to investigate possible herbicide induced growth stimulation of sugarbeet. 'Beta 2012 Liberty Link' and 'Hilleshog Empire Roundup Ready' sugarbeet were seeded in adjacent, but separate experiments in three locations. Treatments were arranged in a randomized complete block design and replicated five times. Glyphosate and glufosinate provided excellent broadleaf weed control (99-100%) at all starting times and rates. Slightly less grass control (between 94% and 98%) was observed with glyphosate and glufosinate across all herbicide rates. Plots that were handweeded and treated with glyphosate yielded more extractable sucrose per hectare than plots that were only handweeded. Extractable sucrose significantly declined and sugarbeet injury increased in all locations when glufosinate applications were started three weeks or longer after the cotyledon sugarbeet growth stage. Sugarbeet had approximately between six and nine leaves at the cotyledon plus 3 week stage. Injury levels were observed as chlorosis of the sugarbeet leaves. The sugarbeet crop recovered up to approximately 50% of the initial phytotoxic symptoms within three weeks after the last application.

Control of Acetolactate Synthase Resistant Kochia in Dry Edible Beans. Richard J. Walker II and Calvin G. Messersmith, Graduate Research Assistant and Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND, 58105.

Kochia [*Kochia scoparia* (L.) Schrad.] resistant to acetolactate synthase inhibiting (ALS) herbicides is increasing as a problem in dry edible beans (*Phaseolus vulgaris* L.) in North Dakota because of frequent uses of ALS herbicides in dry edible beans and other crops. Few options are currently available for control of ALS-resistant kochia in dry edible beans; the only registered post-emergent herbicide is bentazon. The objective of this study is to evaluate herbicides for safety on dry edible beans and efficacy on ALS-resistant kochia. In previous studies, lactofen, fomesafen and acifluorfen at rates labeled in soybean [*Glycine max* (L.) Merr.] have caused excessive injury to dry edible beans. These herbicides will be applied as reduce-rate sequential treatments in the field and will be evaluated for efficacy on ALS-resistant kochia and injury to dry edible beans. Greenhouse experiments will be conducted to determine the optimum treatment stage for the kochia and to evaluate herbicide efficacy.

Control of ALS-Resistant Kochia in Sugarbeet. Donald L. Vincent III, Alan G. Dexter, and Jo Luecke, Graduate Research Assistant, Professor, and Research Specialist, Department of Pla Sciences, North Dakota State University, Fargo, ND 58105

The objective of these experiments is to control kochia (*Kochia scoparia*) resistant to acetolacta synthase (ALS)-inhibiting herbicides in sugarbeet. The micro-rate system was used by 94% of th sugarbeet growers in eastern North Dakota and Minnesota in 1999. The micro-rate system uses one third to one-fourth of normal rates of herbicides in combination applied three or more times at a 5 t 7 day interval starting when weeds are just emerging. The most common micro-rate treatment in 199 was desmedipham (Betanex) at 0.09 kg ai/ha plus triflusulfuron (UpBeet) at 0.004 kg ai/ha plu clopyralid (Stinger) at 0.03 kg ai/ha plus clethodim (Select) plus a methylated seed oil (MSO adjuvant at 1.5% v/v. The primary herbicide for controlling kochia in the micro-rate program i triflusulfuron, a sulfonylurea, which controls plants by inhibiting the ALS enzyme. The micro-rate system will not control kochia resistant to ALS-inhibitor herbicides. Sugarbeet growers are searching for a new herbicide with a different mode of action that will control kochia in sugarbeet. These experiments will use fluroxypyr (Starane) to control kochia. Fluroxypyr is a plant-growth-regulator herbicide that provides excellent control of kochia, including ALS- and dicamba- resistant types. Fluroxypyr at 0.105 kg ai/ha controls kochia less than 10 cm tall, but usually causes injury to sugarbeet. Fluroxypyr will be tested in the micro-rate program at 0.0131 kg ai/ha, 0.0262 kg ai/ha, and 0.0525 kg ai/ha to determine control of ALS-resistant kochia and injury to sugarbeet in the summer of 2000.

Comparison of Adjuvants with Postemergence Herbicides at the Micro-rate in Sugarbeet. Trevor M. Dale, Alan G. Dexter, and John L. Luecke, Graduate Research Assistant, Professor, and Research Specialist, Department of Plant Sciences, North Dakota State Univ.-Univ. of Minnesota, Fargo, ND 58105.

The objectives of these experiments were to compare weed control, and precipitate from the micro-rate as influenced by various adjuvants. The micro-rate used in the field and lab experiment was desmedipham at 0.09 kg a.i./ha + triflusulfuron at 0.004 kg a.i./ha + clopyralid at 0.03 kg a.i./ha + methylated seed oil (MSO) at 1.5% (v/v). In 1998, 64% of the sugarbeet growers in eastern North Dakota and western Minnesota used the micro-rate. And all growers reported that precipitate and nozzle plugging from the micro-rate was observed in ground sprayers. Precipitate and nozzle plugging was not a problem with aerial application or when using normal rates. The precipitate study included nine adjuvants, and three herbicides, desmedipham, or desmedipham + phenmedipham, or desmedipham + phenmedipham + ethofumesate. Precipitate formation was measured using a pump, a single nozzle with a 100 mesh screen and 5.6 L of spray solution. The precipitate on the 100 mesh screen was measured. Experimental design was a RCB design with five replicates. Field experiments were conducted near Breckenridge and Crookston, MN and Fargo, ND in 1999. The center 2.2 m of 3.4 m wide plots were sprayed with a bicycle wheel type plot sprayer. Treatments were applied four times starting at the cotyledon to two leaf stage of sugarbeet, and were separated by approximately one week. Experimental design was a RCB with four replicates. No significant differences were detected when adjuvants were combined across locations. However, there was a significant difference in canola and foxtail control in Crookston. Breakout, Superb, and Quad 7 produced very little precipitate with the micro-rate and provided good to very good weed control.

Also desmedipham + phenmedipham and desmedipham + phenmedipham + ethofumesate produced significantly less precipitate when used with the micro-rate compared to desmedipham.

Drift-reducing Nozzle and Drift Retardant Effects on Weed Control Efficacy. Joel S. Roehl and Calvin G. Messersmith, Graduate Research Assistant and Professor, Department of Plant Sciences, North Dakota State University, Fargo, ND, 58105.

Two non-selective herbicides, glyphosate [*N*-(phosphonomethyl)glycine] and glufosinate [2-amino-4-(hydroxymethylphosphinyl)butanoic acid] are increasingly being utilized for weed control since the introduction of transgenic crops, such as corn (*Zea mays* L.) and soybean (*Glycine max* L.), that are specifically resistant to either herbicide. Spray drift of these non-selective herbicides onto susceptible crops and other non-target plants has increased as a management problem. However, there are management practices including drift-reducing nozzles and drift retardant spray additives that decrease the possibility of drift and the resulting liability. Drift-reducing nozzles include designs that create larger spray droplets than conventional nozzles either by operating at reduced pressures or by air-induction which creates air-filled spray droplets. Drift retardants are spray additives, usually composed of either a polyvinyl or polyacrylamide polymer, that thicken the spray solution thereby increasing droplet diameter and density. These two drift-reducing options will be compared in this research to determine which method most effectively reduces drift while maintaining or possibly increasing herbicide efficacy. Field research data regarding drift-reducing nozzles and drift retardants will be presented.

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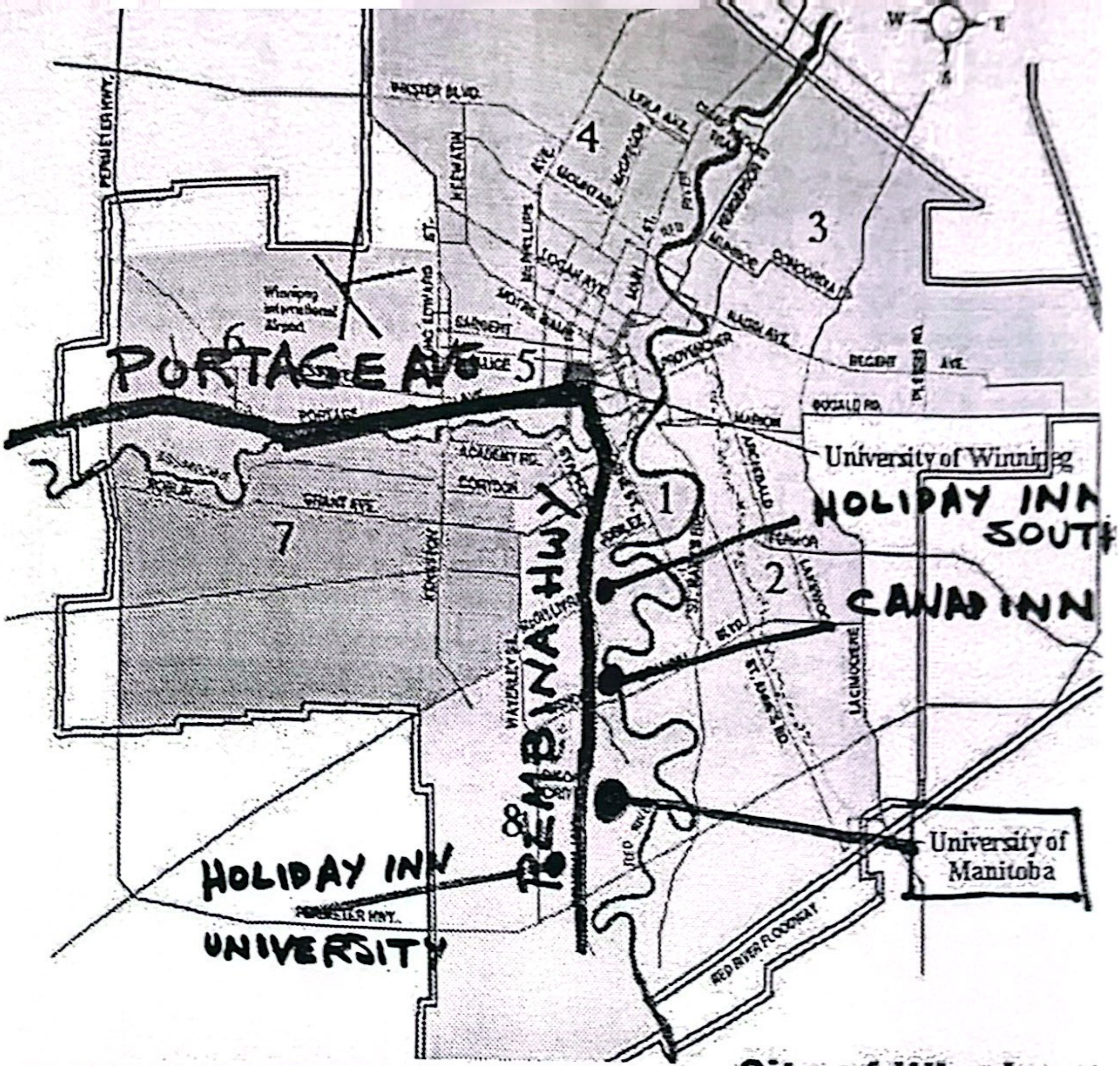
Speaker's Name:

Marks	Comments	
20	1.	Speech: Could the speaker be heard clearly? How was the enunciation, audibility, clarity, speed and enthusiasm for the subject matter?
25	2.	Organization and content: Were there clear objectives stated at the beginning of the talk? Was the talk presented in an organized fashion with a logical development of ideas? Did the speaker make effective conclusions? Was the content appropriate for the audience?
20	3.	Visual Aids: Were the visual aids effective, easy to see, understandable and presented effectively? Were they pleasing to the eye?
25	4.	Command of the subject matter: Did the speaker show a clear knowledge of the literature he/she was presenting and did the speaker understand the topic being presented?
10	5.	Questions: How well did the speaker handle questions?
Total	6.	Any other comments which would help the speaker become more effective in the future.
100		



City of Winnipeg

49°53' N. Latitude 97°09' W. Longitude

0 1 2 3 4 5 km