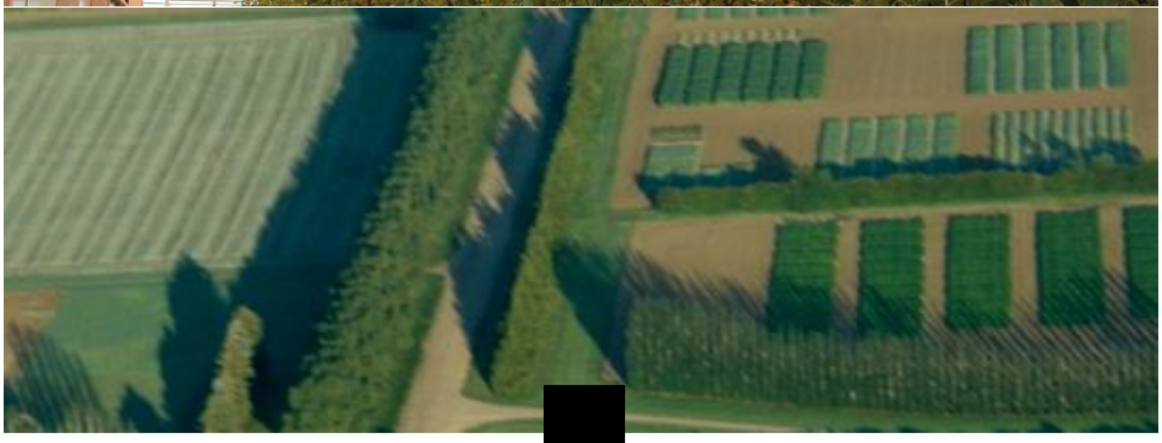
PROCEEDINGS OF THE 34TH ANNUAL MEETING OF THE PLANT PATHOLOGY SOCIETY OF ALBERTA – Brooks, AB November 4-6, 2013



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Program and Agenda

Monday, Nov. 4th

6:30-8:30pm Registration at Heritage Inn, 1217 2nd Street West, Brooks, AB
7:30-9:00pm Reception at Heritage Inn

Tuesday, Nov. 5th

8:00-8:30am Registration at CDCSouth, Griffin Building, 301 Horticultural Station Road East, Brooks
Poster Set-up CDCSouth, Hargrave Building

8:30-9:15am Welcome and Opening Remarks (Griffin Building)

- Dr. Michael Harding, PPSA President
- Dr. Darcy Driedger, CDCS Site Manager
- Dr. James Calpas, Crop Research & Extension Division Director
- Dr. Janice Elmhirst, CPS-SCP President

9:15-10:00am Paper Session I – Stripe Rust: a Disease of Concern in Alberta (Griffin Building)
Moderator – Dr. Michael Harding

9:15 – O1 - Byron Puchalski – Stripe rust in southern Alberta
9:30 – O2 - Denis Gaudet – Fungicide control of stripe rust in Western Canada
9:45 – O3 - André Laroche – Differential gene make-up in older and newer stripe rust races

10:00-10:15am Refreshment Break (Griffin Building)

10:15-12:00pm Paper Session II (Griffin Building) – Student and Technician Presentations
Moderator – Dr. Ron Howard

10:15 – T1 (Technician) - Michele Frick – Molecular characterization of Pst races from Alberta
10:30 – T2 (Technician) - Dustin Burke – Differential effects associated with daytime versus nighttime spraying of fungicides
10:45 – T3 (Technician) Victor Manolii - Continued dissemination of *Plasmodiophora brassicae* (clubroot) on Canadian canola in Alberta
11:00 – S1 (Student) Krista Zuzak – Managing clubroot *(Plasmodiophora brassicae)* in canola *(Brassica napus)* using Vapam as a soil fumigant
11:15 – S2 (Student) Michelle Fraser – Assessment of fungicidal treatments for control of blackleg (*Leptosphaeria maculans*) in canola
11:30 – S3 (Student) Barbara Ziesman - Initial validation of a quantitative PCR-based system for detection of *Sclerotinia sclerotiorum* on canola
11:45 – S4 (Student) Alizreza Akhavan - Genetic structure of *Pyrenophora teres f. teres* (net form net blotch of barley) populations from the Canadian Prairies as revealed by simple sequence repeats analysis

Tuesday, Nov. 5th Continued

12:00-12:45pm Lunch (Griffin Building)

12:45-1:00pm Greenhouse tour instructions and organization (Griffin Building Lobby)
1:00-1:50 pm Guided Tour of Greenhouse Research and Production Complex (GRPC)

2:00-3:00pm Paper Session III – New Diseases, Population Evaluations and Research Results (Griffin Building)
Moderator – Dr. Melanie Kalischuk

- 2:00 – O4 - Ron Howard - Goss's Wilt of Field Corn: A New Disease for Alberta
- 2:15 – O5 - Syama Chatterton - Race structure of *Pseudomonas syringae* pv. *phaseolicola* from dry bean fields in Western Canada
- 2:30 – O6 - Kelly Turkington - The Impact of seed treatment, foliar fungicide and variety resistance on barley leaf disease severity and crop productivity
- 2:45 – O7 - Larry Kawchuk - Population dynamics of the Irish potato famine pathogen in Alberta
- 3:00 – O8 - Michael Harding - Evaluations of plant resistance activators for management of Sclerotinia diseases in edible bean and canola

3:15-3:30pm Refreshment Break (Griffin Building)
3:30-3:45pm Group Photo (Hargrave Building Atrium)
3:45-5:00pm Poster Session (Hargrave Building Atrium)
Note: presenters must be at posters during this time

6:00-6:30pm Cocktails **(Heritage Inn, Brooks)**
6:30-8:30pm Banquet and Awards **(Heritage Inn, Brooks)**

Wednesday, Nov. 6th

8:30-9:30am PPSA Business Meeting (Griffin Building)

9:30-10:00am Refreshment Break (Griffin Building)

10:00-12:00pm Greenhouse Disease Mini Symposium (Griffin Building)
Moderator – Mr. Robert Spencer, AARD

- 10:00 – MS1 - Dr. Ron Howard – Root diseases in greenhouse production
- 10:30 – MS2 - Dr. Jian Yang – Internal fruit rot of pepper
- 11:00 – MS3 - Dr. John Zhang – Cucumber Green Mottle Mosaic Virus
- 11:30 – MS4 - Dr. Mohyuddin Mirza – Alberta greenhouse industry - How diseases have shaped its past, present and future

12:00pm Lunch & Adjourn

Poster Presentations

ID#	Presenter	Title
P1	Syama Chatterton	**Prevalence of root rot pathogens in Alberta field pea in 2013**
P2	Jie Feng	**Study on the interaction between clubroot resistant and susceptible cultivars**
P3	Krishan Kumar	**Evaluation of Seed Assay to Screen Barley for Fusarium Head Blight Resistance**
P4	Melanie Kalischuk	**Genomic sequence and small RNA analysis of pararetrovirus infecting raspberry**
P5	Bruce Gossen	**Reaction of Tillage Radish (*Raphanus sativus var. longipinnatus*) to Clubroot**
P6	Bruce Gossen	**Mechanisms of Spread of Clubroot of Canola on the Canadian Prairies**
P7	Bruce Gossen	**Longevity and ploidy of secondary zoospores of *Plasmodiophora brassicae***
P8	Michael Holtz (Technician)	**Distribution and Frequency of Mating Types of *Rhynchospoium commune* in Central Alberta**
P9	Michael Holtz (Technician)	**Aggressiveness and temperature adaptation in distinct genetic groups of *Puccinia striiformis* in North America.**
P10	Alireza Akhavan (Student)	**Genetic diversity of the spot form of the net blotch pathogen of barley (*Pyrenophora teres* f. *maculata*) on the Canadian Prairies as revealed by simple sequence repeats analysis**
P11	Mirko Tabori (Student)	**Evaluation of soil properties and *Plasmodiophora brassicae* spore concentrations in soils cropped to canola in Alberta, Canada**
P12	Gregory Holmes (Student)	**The Impacts of *Aulacidra pilosellae* and *Puccinia hieracii* on *Pilosella ceaspitosa* and their potential as classical biological control agents**
P13	Jonathon Reich (Student)	**Tracking the development of *Botrytis cinerea* and *Sclerotinia sclerotiorum* in seed alfalfa fields of southern Alberta**
P14	Ronald Nyandoro (Student)	**The occurrence and severity of soybean root rot in southern Alberta, Canada in 2013**
P15	Hui Zhang	**Evaluation of resistance to Canadian *Plasmodiophora brassicae* pathotypes in *Brassica rapa* and *B. juncea* varieties in China**
P16	Champa Wijekoon	**Characterization of *Apioplagiostoma populi* causing bronze Leaf Disease in Poplar**

Oral Paper Abstracts

O1 - The occurrence of stripe rust in Southern Alberta 2012-2013. B. PUCHALSKI, D. A. GAUDET, H. RANDHAWA, S. WOGSBERG, K. KUNDRIK, M. FRICK, T. DESPINS, A. LAROCHE. *Agriculture and Agri-Food Canada, Lethbridge Research Centre, 5403 1st Avenue South, Lethbridge, AB T1J 4B1, Canada.*

In 2011, wheat in Southern Alberta experienced severe stripe rust (*Puccinia striiformis* Westend.) epidemic. In this year, over-wintering occurred as rust was observed in late April and juvenile infections were common in both commercial fields and in nurseries of both spring and winter wheat. In 2012 only a single field of winter wheat near Taber suggested overwintering whereas such occurrences were not observed in 2013. Environmental conditions in all three years were conducive to epidemic conditions; however the losses of 2011 were not matched in 2012 and 2013. The decrease in losses can be attributed to reduced stripe rust levels in the Pacific Northwest, the decrease in the cultivation of susceptible spring wheat cultivars in the stripe rust areas and aggressive fungicide application on both sides of the border. Most of the winter wheat acreage is now sprayed routinely as the susceptible variety Radiant still dominates acreage. Spraying of spring wheat fields for rust control has also increased considerably in 2013 .Fields in the Lethbridge, Taber and Seven Persons areas are consistently the most at risk for stripe rust outbreaks. Stripe rust was not observed in either triticale or barley in 2012 or 2013.

O2 – Fungicide control of stripe rust in western Canada. D. A. GAUDET, B. PUCHALSKI, H. RANDHAWA, T. DESPINS, A. LAROCHE. *Agriculture and Agri-Food Canada, Lethbridge Research Centre, 5403 1st Avenue South, Lethbridge, AB T1J 4B1, Canada.*

Severe epidemics of stripe rust (*Puccinia striiformis* Westend.) can cause extensive yield and quality losses and fungicides are recommended to reduce losses. However, studies are required under Western Canadian production conditions to associate disease severity levels with thresholds for spraying recommendations. The spring wheat cultivars 'Barrie' (susceptible), 'Imagine' (intermediate), and Lillian (resistant) were seeded on two dates in May-June at Lethbridge, AB in 2012 and 2013. Infection originated from natural inoculum and inoculation of winter wheat cultivar 'Radiant' with a local isolate in spreader rows among plots. The systemic fungicide Folicur® was sprayed at the recommended rate as individual treatments on 3 dates during July-August, one treatment received all 3 sprays on these dates, and control treatments remained unsprayed. Plots were scored for disease severity five times during the growing season using a modified Cobb scale and were harvested at full maturity. Plant height, maturity, yield, test weight (TW), and thousand kernel weights (TKW) were recorded. Final mean rust severities of 66% and 71% were recorded in control treatments of 'Barrie' in 2012 and 2013, respectively, whereas severities in corresponding treatments were 14% and 36% for 'Imagine' and 0.5% and 8% for 'Lillian'. Reductions in height, maturity, TW, and TKW observed on 'Barrie' in specific fungicide treatments were observed on specific planting dates but not in 'Imagine' or 'Lillian'.

O3 – Differential gene make-up in older and newer stripe rust strains. A. LAROCHE, M. FRICK, BYRON PUCHALSKI, BRENT PUCHALSKI, A. SINGH, H. RANDHAWA, R. GRAF AND D. GAUDET. *Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, Alberta T1J 4B1, Canada*

The stripe (yellow) rust pathogen of wheat, *Puccinia striiformis* f. sp. *tritici* (*Pst*) is highly aggressive and evolves new races rapidly that overcome host resistance genes. In contrast to races that predominated during 1960-2000 that optimally germinate at cooler temperatures of 12-14°C, races became widespread in 2000 that germinate optimally at higher temperatures of 16-18°C that are more virulent than the earlier races. The main objective of the project is to identify genetic elements in *Pst* related to virulence and tolerance to high temperature germination. The genomes of 11 races, that included both pre-2000 and post-2000 races, have been sequenced using next-generation sequencing (Illumina) technology. The sequence reads were assembled using both de novo and the reference strain *Pst*78 (Dr. Cuomo, Broad Institute, Cambridge, MA, USA). Unique sequences were enriched using BLAST2GO. Sequences unique to stripe rust races sampled since 2010 when compared to those of races sampled in 1990s', where identified. The unique (88) and enriched (137) genes included numerous genes related to transport, response to exogenous molecules, RNA metabolism and modification of cell wall. Results will be presented in terms of evolutionary advantages for races that have evolved since year 2000. These races are generally high temperature tolerant and more aggressive.

T1 – Molecular characterization of *Pst* races from Alberta. M. FRICK, BYRON PUCHALSKI, BRENT PUCHALSKI, A. SINGH, D. GAUDET, H. RANDHAWA, R. GRAF AND A. LAROCHE. *Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, Alberta T1J 4B1, Canada*

The stripe (yellow) rust pathogen *Puccinia striiformis* f. sp. *tritici* (*Pst*) is highly aggressive and quickly evolves new races that overcome existing resistance genes in wheat. The genome size of this pathogen is ≈110 Mb. In contrast to races that predominated during 1960-2000 that optimally germinate at cooler temperatures of 12-14°C, races became widespread in 2000 that germinate optimally at higher temperatures of 16-18°C. The goals of this project are to identify genetic elements in *Pst* that related to race virulence or preference to high temperature germination and subject these sequences to molecular phylogenetic analysis. Genomic DNA from eleven strains of *Pst* sampled between 1990 and 2012 has been sequenced using the MiSeq and HiSeq instruments (Illumina). Assembly of three races sampled in 1990`s and three races since 2010, yielded a similar number of contigs (≈16,700). A phylogenetic tree based on rRNA IGS was obtained. To evaluate the robustness of the analysis results, we selected sequences from additional contigs to generate additional phylogenetic trees for *Pst* races from Southern Alberta. Results will be discussed in terms of number and identity of genes the permit meaningful classification among *Pst* races.

T2 – Efficacy and crop tolerance of fungicides applied at distinct times of day. D.A. BURKE, M.W. HARDING, K. COLES, S.L.I. LISOWSKI AND C.A. PUGH. *Alberta Agriculture and Rural Development, Crop Diversification Centre South, 301 Horticultural Station Road East, Brooks, AB T1R 1E6, Canada; and (K.C.) Farming Smarter, 100 5401 First Avenue South, Lethbridge, AB T1J 4V6*

Chemical control of fungal diseases on four field crops (barley, canola, pea and wheat) were evaluated when fungicides were applied at three distinct times during a 24-hour day; noon, dusk and dawn. This was done to assess impact of time-of-day environmental conditions on fungicide efficacy. Registered, industry standard, fungicides were applied according to label recommended rates and timings. Disease incidence and severity was evaluated multiple times for each crop throughout the season and seed yield was taken. Cereal leaf spot diseases were evaluated on wheat and barley, Mycosphaerella blight and Ascochyta leaf and pod spot were evaluated on pea and Sclerotinia stem rot on canola. Experiments were not artificially inoculated and disease pressure was relatively low. With respect to disease severity, the dawn and dusk fungicide applications performed better than the noon application for net blotch and scald of barley and dusk and dawn fungicide applications performed better than the noon application for Mycosphaerrella blight and Ascochyta leaf and pod spot of pea. Significant differences in seed yield of barley, with respect to product and the untreated check, as well as timing of fungicide application, were observed. Differences in seed yield of and pea were observed with respect to product and the untreated check.

T3 – Continued dissemination of *Plasmodiophora brassicae* (clubroot) on Canadian canola. S. E. STRELKOV, V. P. MANOLII, and S. F. HWANG. *Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada; (S.F.H.) Crop Diversification Centre North, Alberta Agriculture and Rural Development, Edmonton, AB T5Y 6H3, Canada*

Clubroot, caused by the obligate parasite *Plasmodiophora brassicae* Wor., is an important soilborne disease of the Brassicaceae family. In Alberta, Canada, clubroot was first identified in canola (*Brassica napus* L.) in 2003, when 12 clubroot infested crops were found near the City of Edmonton. Annual surveys have since revealed a rapid increase in the number of clubroot infestations in Alberta, with the occurrence of *P. brassicae* confirmed in >1,400 fields as of 2013. To document spread, 25 fields in each of three municipalities where clubroot is highly prevalent (Sturgeon County), moderately prevalent (Wetaskiwin County) or rare (Lac Ste. Anne County), and which had been found to be free of the disease in surveys conducted from 2006-2009, were surveyed again in 2013. In Sturgeon County, 19 of 25 re-surveyed fields were found to be clubroot infested; in Wetaskiwin County, 17 of 25 fields were now infested; and in Lac Ste. Anne County, 8 of 25 previously non-infested fields were infested in 2013. Clubroot symptoms in the newly infested fields were most severe in Sturgeon County. These results indicate continued dissemination of *P. brassicae*, most likely as the result of movement of infested soil on machinery, but possibly also through the movement of spores via wind and water erosion.

S1 – Managing clubroot (*Plasmodiophora brassicae*) in canola (*Brassica napus*) using Vapam as a soil fumigant.
K. A. ZUZAK, S. F. HWANG, G. D. TURNBULL, V. P. MANOLII AND S. E. STRELKOV. *Department of Agricultural, Food and Nutritional Science, 410 Agriculture/ Forestry Centre, University of Alberta, Edmonton, AB T6G 2P5, Canada; (S.F.H., G.D.T.) Crop Diversification Centre North, Alberta Agriculture and Rural Development, 17 507 Fort Road N.W., Edmonton, AB T5Y 6H3, Canada.*
The soilborne pathogen clubroot (*Plasmodiophora brassicae* Wor.) poses a serious threat to the Canadian canola (*Brassica napus* L.) industry. As of 2013, over 1400 fields in Alberta were confirmed to be clubroot-infested. Clubroot is also spreading to previously non-infested regions, as isolated cases of the disease have been identified in Saskatchewan and Manitoba. It is important to consider alternative control measures, such as soil fumigation, to mitigate the disease. The soil fumigant Vapam is a metam sodium solution applied to the soil to suppress weeds, nematodes, insects and soil-borne diseases in various cropping systems. In 2012, two heavily infested field locations in Edmonton, Alberta, were selected to analyze the efficacy of various Vapam application rates for the control of clubroot of canola. A clubroot-susceptible canola cultivar was sown into treated soil to assess the impact on a number of traits including clubroot severity, plant height, plant weight and gall weight. In 2013, the experiment was repeated at two new sites at the same locations, while the sites from 2012 were sown to the same canola cultivar to assess any residual action by the fumigant. Preliminary results suggest significant differences between treatment and control plots for above ground canopy weights and pod numbers at one of the field sites.

S2 – Assessment of fungicidal treatments for control of blackleg (*Leptosphaeria maculans*) in canola.
M. C. FRASER, S. F. HWANG, G. D. TURNBULL, H. U. AHMED, W. BARTON, S. E. STRELKOV. *Department of Agricultural, Food and Nutritional Science, University of Alberta Agriculture/Forestry Centre, 116 Street and 85 Avenue, Edmonton, AB T6G 2P5, Canada; (S.-F.W, G.D.T, H.U.A) Crop Diversification Centre North, Alberta Agriculture and Rural Development, 7000-113 Street, Edmonton, AB T5Y 6H3, Canada; (W.B.) BASF, Research & Commercial Development, 100 Milverton Drive, Mississauga, ON L5R 4H1, Canada.*
Levels of blackleg disease, caused by *Leptosphaeria maculans*, are increasing in Canadian canola fields. This disease can cause serious yield losses due to seedling death and stem cankers. The purpose of this study was to evaluate the performance of fungicide treatments as a tool in managing blackleg. Field experiments were conducted in 2012 and 2013 in Edmonton, Camrose and Namao, Alberta; a greenhouse experiment was also conducted in 2013. The experiment was designed as a randomized complete block, and included a susceptible and moderately resistant canola cultivar. The seed treatments consisted of Prosper FX (carbathiin, trifloxystrobin, and metalaxyl), and an experimental treatment (pyraclostrobin and fluxapyroxad) at the half and full rates. Foliar treatments included Priaxor (pyraclostrobin and fluxapyroxad) and Tilt 250 EC (propiconazole), which were applied in combination with the experimental seed treatment. All plots were inoculated with *L. maculans*. In 2012, Priaxor significantly reduced stem infection compared to the inoculated control in the susceptible cultivar. In Edmonton in 2013, Priaxor significantly reduced stem infection compared to the experimental seed treatment (half rate) in the susceptible cultivar, and yielded significantly more than the control and seed treatments. These preliminary results suggest a potential for combining seed and foliar treatments to manage blackleg, particularly when a susceptible cultivar is grown.

S3 – Initial validation of a quantitative PCR-based system for detection of *Sclerotinia sclerotiorum* on canola.
B. R. ZIESMAN, T. K TURKINGTON, U. BASU AND S. E. STRELKOV. *(B.R.Z., U.B., S.E.S.), Dept. Agricultural, Food and Nutritional Science, University of Alberta, 410 Agriculture/Forestry Centre, Edmonton, AB, T6G 2P5, Canada; and (T.K.T.) Lacombe Research Centre, Agriculture and Agri-Food Canada, 6000 C&E Trail, Lacombe, AB, T4L 1W1, Canada.*
Sclerotinia sclerotiorum de Bary is a ubiquitous ascomycete fungus that causes numerous diseases including stem rot of canola (*Brassica napus* L.). Stem rot is a sporadic disease that can cause devastating yield losses and is primarily managed with routine fungicide application. Fungicides are often applied without any indication of disease risk, highlighting the need for a reliable risk prediction system. This study looks at using a *S. sclerotiorum*-specific Taqman® quantitative (q) PCR assay to estimate stem rot risk in canola fields. Canola petals were collected from 10 commercial fields in central Alberta in 2013 on two different sampling dates. The amount of *S. sclerotiorum* DNA on canola petals was determined for each sampling date. Regression analysis was used to

investigate the relationship between qPCR estimates of petal infestation and final disease incidence. A relationship was observed between qPCR-based estimates of petal infestation and final stem rot incidence, but additional analyses are underway to test the strength of this correlation. Preliminary analyses also indicate that seeding date may play a role in stem rot development, suggesting that additional factors may need to be considered to fully understand the relationship between the amount of *S. sclerotiorum* inoculum, as determined via qPCR, and final stem rot incidence in the field.

S4 – Genetic structure of *Pyrenophora teres* f. *teres* (net form net blotch of barley) populations from the Canadian Prairies as revealed by simple sequence repeats analysis. A. AKHAVAN, T.K. TURKINGTON, B. KEBEDE, A. TEKAUZ, K. XI, R. KUTCHER, J. TUCKER, C. KIRKHAM, K. KUMAR, D. RENNIE AND S.E. STRELKOV. *Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5, Canada; (T.K.T.) Agriculture and Agri-Food Canada; Lacombe Research Centre, Lacombe, AB, T4L 1W1, Canada; (A.T.) Agriculture and Agri-Food Canada, Cereal Research Centre, Winnipeg, MB, R3T 2M9, Canada, (K.X. and K.K.) Alberta Agriculture, Food and Rural Development, Field Crop Development Centre, Lacombe, AB, T4L 1W1, Canada; (R.K.) Crop Development Centre, University of Saskatchewan, Saskatoon, SK, S7N 5A8, Canada; (J.T.) Agriculture and Agri-Food Canada, Brandon Research Centre, Brandon, MB, R7A 5Y3, Canada; (C.K.) Agriculture and Agri-Food Canada, Melfort Research Farm, Melfort, SK, S0E 1A0, Canada*
A collection of 126 *Pyrenophora teres* Drechs. f. *teres* Smedeg. isolates from the Canadian Prairies were analyzed to determine the genetic structure of pathogen populations from this region. A total of 94 alleles were detected among the isolates at 13 polymorphic simple sequence repeat loci, with 3 to 11 alleles per locus. High levels of diversity were found among the isolates with a clonal fraction of approximately 12%. Following clone-correction, a significant genetic differentiation (PhiPT = 0.038, P = 0.001) was detected among populations collected from Alberta, Saskatchewan and Manitoba, although analysis of molecular variance showed that 96% of the genetic variation occurred within populations and only 4% between populations. Employing the unweighted pair group method with arithmetic mean procedure and Jaccard's similarity coefficient, cluster analysis revealed that isolates clustered in two main clades. Most isolates collected from Alberta (69%) grouped in the first clade, while most isolates collected from Saskatchewan (67%) grouped in the second clade. Isolates collected from Manitoba grouped in either clade in statistically equal numbers. The clonal fraction observed within the population, combined with an equal ratio of both pathogen mating types, suggests that *P. teres* f. *teres* goes through regular cycles of sexual recombination on the Prairies.

O4 – Goss's Wilt of Field Corn: A New Disease for Alberta. R.J. HOWARD, M.W. HARDING, N.M. RASMUSSEN, S.L.I. LISOWSKI, C.A. PUGH, AND L.M. KAWCHUK. *Crop Diversification Centre South, Alberta Agriculture and Rural Development, 301 Horticultural Station Road East, Brooks, AB, T1R 1E6, Canada; (NMR) DuPont Pioneer, 4233- 56 Avenue, Taber, AB T1G 0A8, Canada; and (LMK) Lethbridge Research Centre, Agriculture and Agri-Food Canada, 5401 – 1 Avenue South, Lethbridge, AB T1J 4B1, Canada*
Goss's wilt, caused by *Clavibacter michiganensis* subsp. *nebraskensis* (Vidaver and Mandel) Davis et al. (Cmn), was detected in irrigated field corn in southern Alberta in August 2013. This is believed to be the first confirmed record in the province. Goss's wilt can cause systemic wilt and foliar blight, eventually leading to plant death. It was first reported in Nebraska, USA in 1969 and has since spread to many Great Plains and Corn Belt states, where heavy yield losses have sometimes occurred in susceptible hybrids. The disease was discovered in Manitoba in 2009, and surveys in 2011 revealed that it occurred in 224 of 270 fields examined. The initial discovery of the disease in Alberta was by field representatives of DuPont Pioneer, and subsequent surveys of 45 silage and grain corn fields showed that it was present in six of them. In addition, a positive sample was detected in a corn research plot near Edmonton. Presence of the disease was confirmed by using the Agdia ImmumoStrip® test kit and Gram staining technique on symptomatic leaf tissues. DNA extraction and sequencing was used to verify Cmn in some leaf samples. The origin of the disease remains unknown, but possibilities include infected corn seed, infested machinery and long-distance airborne dispersal of the causal agent.

O5 – Race structure of *Pseudomonas syringae* pv. *phaseolicola* from dry bean fields in western Canada. S. CHATTERTON, P. M. BALASUBRAMANIAN, D. L. MCLAREN, R. L. CONNER, AND R. J. HOWARD. *Lethbridge Research Centre, Agriculture and Agri-Food Canada (AAFC), 5403–1 Avenue South, Lethbridge, AB T1J 4B1,*

Canada; (D.L.M) Brandon Research Centre, AAFC, 2701 Grand Valley Road, Brandon, MB R7A 5Y3, Canada; (R.L.C.) Morden Research Station, AAFC, Unit 100-101 Route 100,Morden, MB R6M 1Y5, Canada; and (R.J.H.) Crop Diversification Centre South, Alberta Agriculture and Rural Development, 301 Horticultural Station Road East, Brooks, AB T1R 1E6, Canada.

Bacterial diseases of dry bean, such as common blight (*Xanthomonas axonopodis* pv. *phaseoli; Xap*) and halo blight (*Pseudomonas syringae* pv. *phaseolicola; Pph),* can significantly impact production in western Canada. Dry bean cultivars in several market classes with moderate resistance to *Xap* have recently been developed. Nine races of *Pph* have been identified based on their virulence on a differential set of dry bean cultivars. In order to accurately screen breeding lines for resistance to both bacterial diseases, the races of halo blight present in western Canada need to be determined. The objectives of this study were to assess the incidence of multiple bacterial diseases on dry beans in southern Alberta using a multiplex PCR diagnostic assay and to determine the prevalent halo blight races in western Canadian dry bean fields. Eighty-one *Pph* isolates were recovered from symptomatic dry bean fields surveyed in Alberta, Saskatchewan and Manitoba in 2010-2013. Virulence testing of these isolates on the dry bean differential set is currently on-going. Results to date indicate that *Pph* isolates from southern Alberta bean fields belong to race 2, while isolates from Manitoba bean fields belong to race 2 or 6. Polymerase chain reaction was used to confirm the presence of specific avirulence genes that determine *Pph* race structure. The presence of the avirulence gene *PphE*, and absence of genes *PphF* and *PphB* indicated that all collected *Pph* isolates belong to either race 2 or 6.

O6 –- The impact of seed treatment, foliar fungicide, and variety resistance on barley productivity. T.K. TURKINGTON, K. XI, G. PENG, K.N. HARKER, AND J.T. O'DONOVAN. *(T.K.T., K.N.H. J.T.O.) Lacombe/Beaverlodge Research Centre, Agriculture and Agri-Food Canada (AAFC), Lacombe AB, T4L 1W1; (K.X.) Field Crop Development Centre, Alberta Agriculture and Rural Development, 6000 C & E Trail, Lacombe, AB T4L 1W1, Canada; (G.P.) Saskatoon Research Centre, AAFC, Saskatoon, SK, S7N 0X2.*

Fungicides are becoming a key strategy for barley disease management. However, little information exists regarding this practice when using seed treatments and resistant varieties. At Lacombe, AB and Melfort, SK, the impact of seed treatment and foliar fungicide (treated versus untreated), and variety resistance (susceptible, intermediate and resistant) on barley productivity was assessed. The focus of the trial at Lacombe was scald, while at Melfort net-form net blotch was the main disease issue. Insure™ (triticonazole + pyraclostrobin + metalaxyl) seed treatment was used at two times the recommended rate, while Twinline™ (metconazole + pyraclostrobin) fungicide was applied at the recommended rate at flag leaf emergence. Disease assessments using leaf samples collected during the summer are underway for both sites. Variety had a significant impact on yield at Melfort, with the susceptible variety having lower yield compared to varieties with net blotch resistance. In contrast, no effect of variety was observed at Lacombe. Seed treatment alone increased grain yield at Lacombe, while fungicide increased yield at both sites. At Melfort, there was an interaction of fungicide and variety resistance, where the susceptible variety had similar yields to both resistant varieties when a fungicide was applied, but not for the check treatments. In addition, fungicide response was greatest for the susceptible variety, intermediate for the moderately resistant variety, but limited for the resistant variety.

O7 – Population dynamics of the Irish potato famine pathogen in Alberta. L. KAWCHUK, M. KALISCHUK, M.W. HARDING, R. SPENCER, AND R. HOWARD. *(L.K.) Research Centre, Agriculture & Agri-Food Canada, 5403 - 1 Avenue South, Lethbridge, AB T1J 4B1 Canada; (M.K.) Environmental Sciences, Lethbridge College, 3000 College Drive South, Lethbridge, AB T1K 1L6 Canada; (M.W.H. and R.H.) Crop Diversification Centre South, 301 Horticultural Station Road East, Alberta Agriculture and Rural Development, Brooks, AB T1R 1E6 Canada; (R.S.) Alberta Ag-Info Centre, Alberta Agriculture and Rural Development, 4705 - 49 Avenue, Stettler, AB T0C 2L0 Canada*

Late blight, caused by *Phytophthora infestans* (Mont.) de Bary, is a devastating, worldwide disease of potatoes and tomatoes. A comprehensive survey conducted between 2010 and 2013 indicated that, although the US-8 genotype of *P. infestans* previously dominated pathogen populations in Canada and the United States, the US-11 and new US-23 and US-24 genotypes rapidly became established in many areas, including Alberta. Only the A1 mating type of the pathogen has been found in Alberta to date, thus precluding sexual recombination and the generation of new strains through the production of oospores that may be able to overwinter and survive in the

absence of host tissue. Our results indicate that the predominant *P. infestans* genotype may change within a single season, and long-distance movement of inoculum via seed or transplants is being augmented by sporangia produced on infected volunteer potato and tomato plants and in commercial fields and backyard gardens. Different *P. infestans* genotypes were sometimes observed in the potato crops in the predominantly seed-growing areas of central Alberta when compared with those genotypes found in processing fields of the south, but the inherent characteristics of US-23 appear to be supporting its rapid establishment as the dominant genotype in Alberta and most other potato growing areas of Canada and the United States.

O8 - Evaluations of plant resistance activators for management of Sclerotinia diseases in edible bean and canola.

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Resistance priming in plants refers to the ability of a molecule or, signalling compound, to enhance the readiness of basal plant defenses. Some priming compounds have been used as seed treatments to reduce the impact of subsequent disease challenges by priming the host's resistance mechanisms Priming compounds described in peer-reviewed articles include β-aminobutyric acid (BABA), jasmonic acid (JA) and acibenzolar-S-methyl (ASM). A product discovered and developed in western Canada (Heads Up®) also claims to have resistance priming qualities when applied to seed. The product label lists the active ingredient as extract from *Chenopodium quinoa* that contains triterpene bidesmosidic glycosides, hederagenin and phytolaccagenic acid. In this study we evaluated the ability of Heads Up® seed treatment to reduce sclerotinia diseases in edible bean and canola in replicated, small-plot field trials. Our evaluations also compared Heads Up® with other resistance priming compounds (BABA, JA and ASM), and evaluated the compatibility of Heads Up® with two registered fungicidal seed treatment formulations. The results showed that dry bean seed treated with Heads Up® consistently had significantly lower disease incidence and severity than the untreated check treatments. The compatibility of Heads Up® with other fungicidal seed treatments varied with concentration and formulation. Additionally, preliminary results at one of two locations showed that Heads Up® may reduce stem rot severity on canola.

Poster Abstracts

P1 – Prevalence of root rot pathogens in Alberta field pea in 2013.

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Field pea is the largest acreage pulse crop in Alberta, recently approaching 1 million acres across the province. Late season root rot of field pea, causing wilting and death of mature plants, is threatening sustainable pea production in some fields. Experienced growers, with a long history of pea production, have reported severe stand and yield losses. To assess the prevalence and severity of root rot in Alberta, pea fields were surveyed in July 2013 for above- and below-ground symptoms of root rot. Roots from 5-10 plants were dug up at each of 10 sampling sites/field, washed and assigned a visual rating for disease severity (1=healthy up to 7=dead). Surface sterilized roots were plated onto acidified PDA. Root rot symptoms were found in 143 of the 145 fields surveyed with disease incidences ranging from 0 to 100%, and an average disease severity index (DSI) of 3.0. In east-central Alberta, 85% of sample sites had root rot, and 65% of roots showed root rot symptoms. The average DSI was highest in this region at 3.6, and 22% of roots had a rating of 7. West-central Alberta had the highest incidence with root rot found at all sites, and in 78% of roots. However, the average DSI was lower than east-central Alberta at 2.9. Disease incidence and severity was lowest in southern Alberta where an average root rot incidence of 77% was observed and 50% of roots had root rot with an average DSI of 2.4. *Fusarium* spp. were predominantly isolated from roots. Identification of *Fusarium* spp. from cultures and directly from infected roots is currently on-going using species-specific PCR primers.

P2 – Study on the interaction between clubroot resistant and susceptible cultivars. J. FENG, S. F. HWANG and S. E. STRELKOV. *Crop Diversification Centre North, Alberta Agriculture and Rural Development, Edmonton, AB T5Y 6H3, Canada; and (S.E.S.) Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada*

Clubroot, caused by *Plasmodiophora brassicae*, is an important root disease of crucifers worldwide. Without a host, the resting spores of the pathogen can persist in the soil for as long as 20 years, until suitable environmental factors induce their germination. These factors include not only the physical and chemical components of the soil environment, but also biological signals from the host, which are components of the root exudates. To study the interactions of resistant and susceptible canola genotypes on the development of the pathogen during clubroot infection, experiments were conducted by seeding resistant and susceptible canola cultivars together in the same pots. The data indicated that mixed seeding could reduce clubroot severity and single-gall weight on the susceptible cultivar compared to the seeding of the susceptible cultivar alone, and that on the resistant genotype, the severity and gall weight remained unchanged. This result suggests that the resistant cultivar could change the environment in the vicinity of the roots, making it unsuitable for *P. brassicae* germination or infection and that the negative effect of the resistant cultivar on the pathogen could overwhelm the positive effect of the susceptible cultivar.

P3 – Evaluation of Seed Assay to Screen Barley for Fusarium Head Blight Resistance. K. KUMAR, P. JUSKIW, K. XI, S. LOHR, K. STEENBERGEN, J. ZANTINGE AND M. HOLTZ. *Field Crop Development Centre, Alberta Agriculture Food, 6000 C & E Trail, Lacombe, AB, T4L 1W1,Canada; (P.J., S.L.) Field Crop Development Centre, Alberta Agriculture Food, 5030 50 St., Lacombe, AB, T4L 1W8, Canada.*

Fusarium graminearum Schwabe is the major causal agent of fusarium head blight (FHB) of barley. Two experiments were conducted to evaluate FHB resistance in barley lines from the FCDC breeding program using a seed assay. Seeds were inoculated *in vitro* with a *F. graminearum* macroconidia suspension and incubated for 6 days at 15°C with a 12 hr light period. Seedling weight, seed germination percentage and *in vitro* DON content were measured. The resistant checks had heavier seedling weight and higher seed germination percentage than susceptible checks. As well, the *in vitro* DON rankings for the susceptible checks were higher compared to the resistant checks. The lines evaluated were found to rank between the resistant and susceptible cultivars in seedling weight and seed germination percentage. In Experiment 1, of the five lines tested in the field to have low DON, four of the lines would have been selected for resistance using the seed assay based on low *in vitro* DON. Of the 21 lines tested in Experiment 2, eight were identified as high DON and four as low DON that agreed with field assessments. In conclusion, the seed assay has potential to rapidly screen barley lines for FHB resistance.

P4 – Genomic sequence and small RNA analysis of a pararetrovirus infecting raspberry. M. KALISCHUK, A. FUSARO, P. WATERHOUSE, H. PAPPU, AND L. KAWCHUK. *(M.K.) Environmental Sciences, 3000 College Drive South, Lethbridge College, Lethbridge AB, T1K 1L6 Canada; (A.F. and P.W.) School of Molecular Bioscience, University of Sydney, Sydney, NSW, 2006 Australia; (H.P) Department of Plant Pathology, Washington State University, Pullman, WA,99164 U.S.A.; (L.K.) Research Centre, 5403 – 1 Avenue South, Agriculture & Agri-Food Canada, Lethbridge, AB T1J 4B1 Canada*

Rubus yellow net virus (RYNV) was cloned and sequenced from a red raspberry (*Rubus idaeus* L.) plant exhibiting symptoms of mosaic and mottling in the leaves. Its genomic sequence indicates that it is a distinct member of the genus *Badnavirus*, with 7932 bp and seven open reading frames (ORFs). The first three ORFs corresponded in size and location to the other ORFs found in the type member *Commelina yellow mottle virus*. Subsequent sequencing of the small RNAs (sRNAs) from RYNV-infected leaf tissue was used to determine RYNV sequences targeted by RNA silencing. An abundance of 22-nt virus-derived small RNAs (vsRNAs) were identified in RYNV infected tissue. Further, we observed a highly uneven genome-wide distribution of vsRNAs with strong clustering to small defined regions distributed over both strands of the RYNV genome. Together, our data show that sequences of the aphid-transmitted pararetrovirus RYNV are targeted in red raspberry by the interfering RNA pathway, a predominant antiviral defence mechanism in plants.

P5 – Reaction of Tillage Radish (*Raphanus sativus* var. *longipinnatus*) to Clubroot. T. CRANMER, B. D. GOSSEN, and M. R. McDONALD. *Plant Agriculture, University of Guelph, Guelph ON N1G 2W1, Canada; (B.D.G.) Agriculture & Agri-Food Canada, Saskatoon, SK, S7N 0X2, Canada*.

Tillage Radish (*Raphanus sativus* var. *longipinnatus* (Bailey) 'Tillage Radish') is a cruciferous crop that can enhance the yield of subsequent crops by building up top soil, increasing earthworm populations, and improving soil and plant health. *Plasmodiophora brassicae* (Woronin), the causal agent of clubroot of crucifers, is an important pathogen of canola (*Brassica napus* L.) in Canada. There was a concern that resting spore populations of *P. brassicae* might build up on crops of 'Tillage Radish', to the detriment of subsequent canola crops. Therefore, the reaction of 'Tillage Radish' to Canadian pathotypes (pathotypes 2, 3, 5 and 6) of *P. brassicae* was assessed in a replicated growth room study. Shanghai pak choy (*B. rapa* subsp. *chinensis* var. *communis*) was included as a highly susceptible control. Plants were harvested at 6 weeks after seeding and were rated for clubroot severity using a standard 0–3 scale and a disease severity index (DSI) was calculated. 'Tillage Radish' remained free of symptoms throughout the study. Shanghai pak choy had a mean of 95.0% incidence (range 93–98%) and 91.7 DSI (range 88–95). These results indicate that 'Tillage Radish' will not contribute to the resting spore concentration of *P. brassicae,* and has potential for use as a cover crop in fields infested with *P. brassicae*.

P6 – Mechanisms of spread of clubroot of canola on the Canadian prairies. B. D. GOSSEN, S. E. STRELKOV AND M. R. McDONALD. *Agriculture and Agri-Food Canada, Saskatoon Research Centre, Saskatoon, SK, S7N 0X2, Canada;(S.E.S.) Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5, Canada; (M.R.M.) Department of Plant Agriculture, University of Guelph, Guelph, ON, N1G 2W1, Canada.*

On the Canadian prairies, clubroot (*Plasmodiophora brassicae* Wor.) was discovered on canola (*Brassica napus* L.) for the first time in 2003 on 12 infested fields in a localized area in Alberta. Since then, clubroot has been confirmed in > 1000 fields across large areas of Alberta, and could eventually affect much of the > 8 M ha of canola in the Prairie region each year. Movement of infested soil on farming (and other) equipment is an important mechanism of short-distance dispersal. Clubroot has recently been identified from widely separated sites in Saskatchewan and Manitoba, which indicates that long-distance dispersal is also occurring. Transmission of spores on seed produced in infested fields has been demonstrated previously, but is likely not an important mechanism of dispersal. Long-distance dispersal likely occurs primarily via movement of infested machinery or wind erosion of infested fields. Heavily infested canola fields represent a potential source of trillions of spores per erosion event. Also, endemic susceptible weeds can function as hosts even where a canola crop is not present. As a result, there is potential for establishment of clubroot at previously clean sites whenever moisture and other environmental conditions are conducive for the pathogen. The risk of clubroot establishment is lower on dry, alkaline soils high in calcium or boron (unfavourable for infection), compared to wet, acidic soils that drain slowly (favourable). Once the pathogen is established at a new site, short-distance dispersal could quickly result in a new focus of infection.

P7 – Longevity and ploidy of secondary zoospores of *Plasmodiophora brassicae*. B. D. GOSSEN, K. SHARMA, A. DEORA AND M. R. McDONALD. *Agriculture and Agri-Food Canada, Saskatoon Research Centre, Saskatoon, SK, S7N 0X2 Canada; (K.S., A.D., M.R.M.) Department of Plant Agriculture, University of Guelph, Guelph, ON, N1G 2W1, Canada.*

The disease cycle of *Plasmodiophora brassicae* Wor. consists of a primary phase in root hairs, initiated by primary zoospores from resting spores, and a secondary phase in the root cortex, initiated by secondary zoospores from root hairs. Primary and secondary zoospores are visually indistinguishable, but primary zoospores infect only root hairs, while secondary zoospores infect root hairs and the root cortex. A study was conducted to determine how long secondary zoospores survived in the absence of a host, based on infection success. Healthy 5-day-old canola seedlings (five seedlings/replicate, four replicates) were transplanted into soil at 0, 1, 2, 3, and 4 days after inoculation of the soil with 1×10^5 secondary zoospores. After 5 days, the seedlings were transplanted into much larger pots of noninfested soil and assessed for clubroot severity at 37 days after transplanting. The trial was repeated. The viability of secondary zoospores decreased rapidly and no symptoms developed when seedlings were introduced later than 2 days after inoculation. To determine if secondary zoospores fuse prior to secondary infection, pure suspensions of secondary zoospores were collected, fixed in glutaraldehyde, stained with DAPI (4'-

6-diamidino-2-phenylindole), and the number of nuclei in each zoospore was assessed using epifluorescence microscopy. At least 25 flagellated and 25 encysted zoospores were examined, and the study was repeated. All of the secondary zoospores were uni-nucleate. This observation does not support previous reports that secondary zoospores fuse to form bi-nucleate zoospores prior to infection of the root cortex.

P8 (Technician) – Distribution and frequency of mating types of *Rhynchosporium commune* in central Alberta. M. D. HOLTZ AND K. XI. Field Crop Development Centre, Alberta Agriculture and Rural Development, 6000 C and E Trail, Lacombe, AB T4L 1W1, Canada

Scald of barley is caused by the fungus *Rhynchosporium commune* Zaffarano et al. (formerly *R. secalis* (Oudem.) J.J. Davis). The species is heterothallic where individuals contain one of two mating types and the presence of individuals with alternative mating types would be necessary for sexual reproduction. The sexual state of *R. commune* has never been detected, but population analyses from other countries suggest that it does occur. In this study, the presence and distribution of *R. commune*'s mating types was determined in central Alberta by multiplex PCR. Ten field sites were sampled. Four hundred and ten scald lesions from 297 leaves were successfully tested for mating type. Mating type 1-2 was more common than mating type 1-1 with five of the ten locations significantly deviating from a 1:1 ratio, based on Chi-square tests. Both mating types did occur at all locations though. Additionally, 23% of leaves which had multiple lesions assessed had lesions of different mating type and 11% of all lesions contained both mating types. The results of this study suggest it is possible that *R. commune* could be reproducing sexually in the field.

P9 (Technician) – Aggressiveness and temperature adaptation in distinct genetic groups of *Puccinia striiformis* in North America. M. D. HOLTZ, K. KUMAR AND K. XI. Field Crop Development Centre, Alberta Agriculture and Rural Development, 6000 C and E Trail, Lacombe, AB T4L 1W1, Canada

Puccinia striiformis Westend., the cause of stripe rust, is a major pathogen of wheat and a regular occurrence on barley. The increased severity of stripe rust on wheat in North America has been attributed to the introduction of a more aggressive strain adapted to a wider range of temperatures that replaced the pre-existing wheat stripe rust population. This study attempted to determine if there were differences in aggressiveness and adaptation to higher temperatures in additional genetic groups of stripe rust. Twenty four isolates were selected, four from each of six groups. Four groups were wheat stripe rust and two were barley stripe rust. Components of pathogen aggressiveness including latent period, infection efficiency, and disease severity were examined on wheat and barley seedlings at two different temperatures (15°C and 21°C). Urediniospore germination was also determined at the same temperatures *in vitro*. Assessment of aggressiveness on seedlings did not consistently produce clear evidence of adaptation to higher temperatures. Urediniospores of the lineages responded differently to the temperature regimes, however. The two most common wheat stripe rust groups germinated well at both temperatures, one of the barley stripe rust groups was intermediate with the remaining groups germinating poorly at 21°C.

P10 (Student) – Genetic diversity of the spot form of the net blotch pathogen of barley (*Pyrenophora teres* f. *maculata*) on the Canadian Prairies as revealed by simple sequence repeats analysis. A. AKHAVAN, T.K. TURKINGTON, B. KEBEDE, A. TEKAUZ, K. XI, R. KUTCHER, J. TUCKER, C. KIRKHAM, K. KUMAR, D. RENNIE AND S.E. STRELKOV. *Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5, Canada; (T.K.T.) Agriculture and Agri-Food Canada; Lacombe Research Centre, Lacombe, AB, T4L 1W1, Canada; (A.T.) Agriculture and Agri-Food Canada, Cereal Research Centre, Winnipeg, MB, R3T 2M9, Canada, (K.X. and K.K.) Alberta Agriculture, Food and Rural Development, Field Crop Development Centre, Lacombe, AB, T4L 1W1, Canada; (R.K.) Crop Development Centre, University of Saskatchewan, Saskatoon, SK, S7N 5A8, Canada; (J.T.) Agriculture and Agri-Food Canada, Brandon Research Centre, Brandon, MB, R7A 5Y3, Canada; (C.K.) Agriculture and Agri-Food Canada, Melfort Research Farm, Melfort, SK, S0E 1A0, Canada*

Microsatellite DNA markers were employed to investigate genetic variation among 82 isolates of *Pyrenophora teres* Drechs. f. *maculata* Smedeg. (causal agent of the spot form of net blotch) collected from barley on the Canadian Prairies. A total of 35 alleles were detected among the isolates at 13 polymorphic simple sequence repeat loci, with an average of 2.7 alleles per locus and a range of 1 to 5. High levels of diversity were found

among the isolates with a clonal fraction of approximately 11%. Following clone-correction, both pairwise population PhiPT values and analysis of molecular variance showed no significant genetic differentiation (PhiPT = 0.010, P = 0.177) among populations collected from Alberta, Saskatchewan and Manitoba, with 99% of the total genetic diversity found within populations and only 1% between populations. Cluster analysis using the unweighted pair group method with arithmetic mean procedure and Jaccard's similarity coefficient also resulted in no obvious clustering based on geographical origin of the isolates. These results combined with a high level of gene flow among the provinces suggest the occurrence of one singular panmictic Prairies population. Furthermore, the high number of distinct haplotypes combined with an equal ratio of both pathogen mating types indicates extensive sexual recombination in the Prairie *P. teres* f. *maculata* population.

P11 (Student) – Evaluation of soil properties and *Plasmodiophora brassicae* spore concentrations in soils cropped to canola in Alberta, Canada. M. TABORI, T. CAO, D. RENNIE, S.F. HWANG, AND S.E. STRELKOV. *Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada; (S.F.H.) Crop Diversification Centre North, Alberta Agriculture and Rural Development, Edmonton, AB T5Y 6H3, Canada.*

Clubroot, caused by *Plasmodiophora brassicae* Wor., is an emerging disease of canola in Alberta. An experiment was conducted to evaluate the relationship between *P. brassicae* resting spore concentration and soil properties (pH, organic matter, and electrical conductivity). Soil samples were collected from three clubroot-infested fields located near Bassano, in southern Alberta (95 samples), and in Edmonton (98 samples) and Parkland County (100 samples) in central Alberta. The presence of *P. brassicae* DNA in each sample was first evaluated by conventional PCR analysis, followed by a quantitative PCR assay to measure resting spore concentration. Results indicated that 56% of the samples from Bassano, 8% of the samples from Parkland County, and 72% of the samples from Edmonton were positive for the presence of *P. brassicae* DNA and had quantifiable spore loads. When the data from all of the positive samples from the three fields were pooled together, spore concentration was found to be negatively correlated with soil pH (r^2=0.0948, p=0.0004) and soil conductivity (r^2=0.2309, p<0.0001), but positively correlated with soil organic matter (r^2=0.5130, p<0.0001). These correlations, while significant, were generally weak and suggest that other factors, such as cropping history, are influencing resting spore concentrations in the soil.

P12 (Student) – The impact on the invasive hawkweed *Pilosella caespitosa* of the leaf galling wasp *Aulacidea pilosellae* and the rust fungus *Puccinia hieracii*, and their potential for use as biological control agents G. D. HOLMES, R. A. LAIRD, S. CHATTERTON, R. A. DECLERCK-FLOATE. *Lethbridge Research Centre, Agriculture and Agri-Food Canada, 5403 1st Avenue South, Lethbridge, Alberta, Canada, T1K 4B1; (R.A.L.) University of Lethbridge, 4401 University Drive West, Lethbridge, Alberta, Canada, T1K 3M4.*

Invasive species that cannot be effectively controlled by chemical or mechanical means may be managed by classical biological control strategies. Invasive hawkweeds (*Pilosella* spp.) are a major concern in western North America as they form dense stands that out-compete native plants, and can also disperse with a very high number of seeds. Two potential agents, the leaf galling wasp, *Aulacidea pilosellae* Kieffer, and the rust fungus, *Puccinia hieracii* (Röhl) H. Mart, have been identified as natural enemies of hawkweed spp. (*Pilosella* spp) in central Europe. Therefore, the purpose of this study is to determine the effectiveness of *A. pilosellae* and *P. hieracii* as biological control agents in North America for the invasive weeds *P. caespitosa* Dumort (meadow hawkweed) and *P. glomerata* Froel. (yellowdevil hawkweed). To determine whether these agents will be effective in a biological control program, their impact on their hosts, meadow hawkweed (wasp and fungus) and yellowdevil hawkweed (wasp only) must first be determined. Agents will be tested on their host individually and together for impact, determined by measuring the effect of the agents on host reproduction, vegetative growth and leaf death. The factors affecting wasp fitness will also be explored by measuring the number of galls produced per female, the following generation's sex ratio and emergence success.

P13 (Student) – Tracking the development of *Botrytis cinerea* and *Sclerotinia sclerotiorum* in seed alfalfa fields of southern Alberta. J. REICH, D. JOHNSON, AND S. CHATTERTON. *University of Lethbridge, 4401 University Drive, Lethbridge, AB, T1K 3M4, Canada; (S.C.) Lethbridge Research Centre, Agriculture and Agri-Food Canada (AAFC), 5403–1 Avenue South, Lethbridge, AB, T1J 4B1, Canada.*

Blossom blight and stem rot of seed alfalfa, caused by the fungal pathogens *Botrytis cinerea* and *Sclerotinia sclerotiorum,* can result in reduced seed set and yield losses. Recently, growers in the Enchant and Rosemary regions of southern Alberta have reported reduced seed yields without obvious signs of disease. To track disease development, surveys were performed every 2-3 weeks in nineteen seed alfalfa fields in southern Alberta. Severity and incidence were rated in the field, and flower and/or pod samples were collected, surface sterilized, and plated on selective media. In the field, blossom blight and stem rot were observed at trace levels, but plating revealed a higher frequency of infection. *B. cinerea* infected 65% of florets at the beginning of July and the rate increased to almost 100% of pods at the end of August. *S. sclerotiorum* infected 10% of florets at the beginning of July, the rate peaked in pods at 20% at the end of July, and declined to <10% by the end of August. *B. cinerea* infected 15% of seeds, but no infection by *S. sclerotiorum* was observed. Future studies will use scanning electron microscopy to investigate whether pollen infected by *B. cinerea* impacts seed development and seed set.

P14 (Student) – The occurrence and severity of soybean root rot in southern Alberta, Canada in 2013. R. NYANDORO, K.F. CHANG, S.F. HWANG, S.E. STRELKOV, G.D. TURNBUL, R.J. HOWARD, AND M. HARDING. *Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada; Crop Diversification Centre North, (K.F.C., S.F.H., G.D.T.) Alberta Agriculture and Rural Development (AARD), Edmonton, AB T5Y 6H3, Canada; and (R.J.H., M.H.) AARD, Brooks, AB T1R 1E6, Canada*

Soybean (*Glycine max* (L.) Merr) has great potential as an alternative cash crop to canola in southern Alberta farming systems. A number of technological issues however, need to be addressed and among these is the challenges posed by root rot disease caused by fungi belonging to the genus *Fusarium.* A comprehensive survey was conducted in August 2013 across the southern Alberta region and soybean roots were collected from 28 fields in Brooks, Duchess, Tilley, Taber, Lacombe, Vauxhall, and Medicine Hat. The roots were placed in a 4^0C cooler soon after collection to avoid bio-degradation. They were then brought to the lab, washed to rid them of dirt, and then assigned a visual score for root rot and rated for nodulation. The mean root rot incidence ranged from 45% in Brooks to as high as 100% in some root samples in Duchess. Root rot severity ranged from as low as 0.5 to as high as 3.4 in some fields in Duchess on a scale of 0-4. The severity of the disease increased from the south to the north in the area covered by the survey. Root nodulation was highest in Taber and lowest in Tilley. There was no association between root rot and nodulation, probably because the root rot was not severe enough to hinder nodulation.

P15 – Evaluation of resistance to Canadian *Plasmodiophora brassicae* pathotypes in *Brassica rapa* and *B. juncea* varieties in China. H. ZHANG, R. F. SUN, S. F. HWANG, S. E. STRELKOV, S. J. ZHANG, S. F. ZHANG and F. LI. *Institute of Vegetables and Flowers, Chinese Academy of Agricultural Sciences, Beijing, 100081, China; (S.F.H.) Crop Diversification Centre North, Alberta Agriculture and Rural Development, Edmonton, AB T5Y 6H3, Canada; and (S.E.S.) Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada*

Clubroot disease, caused by the protist *Plasmodiophora brassicae*, has become a major problem in cruciferous vegetable crops around the world. Chinese cabbage, pak-choi (*Brassica rapa*) and mustard (*B. juncea*) are among the most important vegetable crops in China. Development of clubroot-resistant cultivars of these crops is urgently needed. The objective of this study was to screen and evaluate the resistance of 75 *B. rapa* and *B. juncea* genotypes (divided into 5 groups) to three *P. brassicae* pathotypes (pathotypes 3, 5 and 6). A highly significant interaction (P<0.001) was observed between *P. brassicae* pathotypes and Brassica genotypes. Pathotype 3, which is the most virulent pathotype on canola in Alberta, showed the weakest virulence among the pathotypes on all plant materials. On the other hand, pathotypes 5 and 6 were both highly virulent in regular lines. Nine out of thirteen of the resistant cultivars in group 1 were resistant to all three pathotypes, while four were resistant only to specific pathotype. Ten genotypes in group 2 derived from resistant cultivars, showed only partial resistance, especially to pathotypes 5 and 6; three turnip cultivars showed resistant to all pathotypes. Regular inbred lines of Chinese cabbage and Pak-choi, (groups 3, 26 and group 4, 11), were susceptible to all three pathotypes, but their susceptibility was lower to pathotype 3 and higher to pathotypes 5 and 6. No resistance was found in the regular mustard group 5 (12).

P16 – Characterization of *Apioplagiostoma populi* causing bronze leaf disease in poplar. C.P. WIJEKOON, M.L. KALISCHUK, R.C.J. SPENCER, R.J. HOWARD, AND L.M. KAWCHUK. *Agriculture and Agri-Food Canada, Lethbridge Research Centre, 5403, 1st Avenue South PO Box 3000, Lethbridge, AB, T1J 4B; (M.L.K.) Lethbridge College, 3000- College Drive S, Lethbridge, AB, T1K 1L6; (R.C.J.S.) Alberta Agriculture and Rural Development, Provincial Building, 4705 - 49 Avenue, Stettler, AB, T0C2L0; (R.J.H.) Alberta Agriculture and Rural Development, Crop Diversification Centre S, 301- Horticultural Station Rd E, Brooks, AB, T1R 1E6.*

Poplar (*Populus spp.*) is used as an ornamental tree, a wind break, and in the pulp and wood industry due to its rapid growth and hardiness. Bronze leaf disease (BLD) affects poplar and its hybrids and is characterized by the infected bronze colored leaves. An infected tree may die within 3-5 years of initial infection. Recently, the disease has been introduced to Alberta causing premature tree mortality in trees such as *Populus* × *canescens* Smith, *P. tremula* L., and *P. tremuloides* Michx. Symptoms become severe in late summer producing discolored leaves with a yellow petiole and veins. Perithecia, asci and ascospores have been used to classify the pathogen as *Apioplagiostoma populi* Barr. Although DNA extracted from the perithecia of the diseased leaves showed more than 90% identity to other *Apioplagiostoma spp*, the molecular characteristics of *A. populi* Barr remain elusive. Specific primers were designed to provide a stringent diagnostic based on the r-DNA internal transcribed spacer sequence (ITS) sequences of *A. populi*. Fungal morphology and the ITS sequence together indicate that *A. populi* is distinct but highly similar to other members of family Gnomoniaceae. Further analysis of BLD pathogen will help to determine the epidemiology of the disease and potential control measures.

Awards

Best Presentation by a Technician: Michele Frick (AAFC-Lethbridge); Best Oral Presentation by a Student: Barbara Ziesman (Univ. of Alberta); Best Poster Presentation by a Student: Alireza Akhavan (Univ. of Alberta); PPSA Scholarship: Barbara Ziesman (Univ. of Alberta)

Best Technician Presentation

Best Student Oral Presentation

Best Student Poster Presentation

PPSA Scholarship

L-R: Denis Gaudet (Chair of PPSA Awards Committee), Alireza Akhavan, Barbara Ziesman, Michele Frick, Janice Elmhirst (CPS President)

Minutes of the 34th Annual Business Meeting of the Plant Pathology Society of Alberta

November 6, 2013 Crop Diversification CentreSouth Brooks Alberta

8:30 – 9:30 am

President – Mike Harding
Secretary- Syama Chatterton
Treasurer- Noryne Rauhala
Directors: Ralph Lange (North), Robyne Bowness (Central), vacant (South)

Awards Committee: Stephen Strelkov, Denis Gaudet, Ron Howard
Historical Committee: Denis Gaudet
Disease Survey Committee: unknown

1. **Adoption of the Agenda.**
   There were no changes or amendments.
   - A motion to adopt the agenda was moved by Andre Laroche and seconded by Bruce Gossen. Approved.

2. **Adoption of the Minutes of the 2011 Business Meeting**
   There were no changes or amendments suggested.
   - A motion to adopt the agenda was moved by Kelly Turkington and seconded by Denis Gaudet. Approved.

3. **Memoriam** – Moment of silence in memoriam for Yasuyuki (Yasu) Hiratsuka. The memorial was distributed at the meeting and is attached.

4. **Interim Financial Report**
   A financial summary report for 2013 was provided by Noryne Rauhala, and is attached. Noryne recommended to roll GIC and investment accounts together in order to get better interest rates. Currently these are in short term investments due to low interest rates. Denis Gaudet suggested utilizing some funds to promote the society and science of plant pathology – encourage ideas to use excess funds to increase awareness of society. Noryne indicated that current amount in accounts does not include profit from this year's meeting, but at the time the final numbers on meeting finances was not finalized. Sherry provided an update that there is currently $6300 in chequing account, with another $1200 to be collected from sponsors, so this meeting was successful financially. AARD provided $1200 towards hosting the reception, which does not come from PPSA proceeds. Bruce Gossen noted that the joint meeting last year made $10,000, and was split into between CPS-Sk and PPSA.
   Noryne Rauhala made a motion to move some funds from the chequing account to the savings account, so that total amount in savings is account is at $20,000. This will leave $1,500 in chequing. Seconded byAndre Laroche. Approved.

5. **Update on CPS Activities**
   An updates on CPS activities was provided by Janice Elmhirst, current president of the CPS. She reminded everyone that there will be a Feb 1 deadline for abstracts for CPS/APS meeting in Minneapolis. If you have questions or comments for the CPS board, you can contact Janice Elmhirst, Larry Kawchuk or Ron Howard from PPSA also serve on the CPS board. Discussion on CPS' current plans for promoting plant pathology and improving education and public relations. For promoting education: science competitions, education packages on plant pathology to schools, list CPS meetings on large science websites and media releases on different issues. Larry Kawchuk pointed out that the website is being upgraded on CPS, and would be great if it could be linked to PPSA. Denis Gaudet requested if we can use funding from PPSA to develop a PPSA website that would be coordinated with CPS website upgrades? The CPS Website editor position is a volunteer position and is current open for CPS.

6. **Reports of standing committee**
   a. *Disease survey committee* – who's on it? Bruce Gossen questioned the function of the disease survey committee; maybe it's time to disband the committee? Ron Howard noted that the role used to be to coordinate survey work. A leader is identified at the PPSA meetings, in case something important happens, there is someone to report on it. Use it as a means of reporting diseases mentioned in the

WFPM meeting. Disband survey committee and move to disease situation reports under the meeting agenda, to describe the highlights and unusual disease situation. Ron Howard mentioned that with the new pest surveillance network there might be more opportunities to coordinate and discuss surveillance network. We need to do a better job at surveillance, as this is not always a priority activity for funding groups. **Kelly Turkington volunteered to put together a short report in terms of crops and who is doing surveys in AB, indication of activities and different groups working in the province to be aware of activities.** Motion to accept the report was moved by Ron Howard, seconded by Denis Gaudet. Approved.

b. *Historical committee* – Update by Denis Gaudet. There is a historical resource archiving system at U of A for PPSA, but there has been little activity on that portfolio. Material has been archived at the national archive (Archives Canada), but they're not accepting new material because of budget cuts. Need to discuss what to do with important documents, and best way to format, move to archiving of electronic material? Ron Howard indicated that the PPSA archives at U of A are still active; Steve Strelkov submits all the material into archive at the end of every meeting. If anyone comes across significant memorabilia opportunity exists to move to U of A.
Motion to accept the report was moved by Larry Kawchuk, seconded by Denis Gaudet. Approved.

c. *Awards committee* – Steve Strelkov is chair, Ron Howard provided the report in his stead. The Terry Swanson award rotates between UBC, U of A, UC Riverside. In 2012 the award was presented to a student at UBC ($1000). The account for the scholarship is maintained at Lacombe, Noryne Rauhala provided a report, which is attached. Anyone can donate to account. Terms of reference were revised last year, should be in the minutes of 2012 meeting.
Motion to accept the report was moved by Ron Howard, seconded by Kelly Turkington. Approved.
Denis Gaudet provided a list of 4 awards presented to graduate students at the 2013 PPSA meeting, as follows:
Barb Ziesman was awarded the PPSA student scholarship ($1000)
Michele Frick won the Technician oral presentation award for talk entitled 'Molecular characterization of *Pst* races from Alberta'
Alireza Akhavan won the student poster award for poster entitled 'Genetic diversity of the spot form of the net blotch pathogen of barley (*Pyrenophora teres* f. *maculata*) on the Canadian Prairies as revealed by simple sequence repeats analysis.'
Barb Ziesman won the student oral presentation award for talk entitled 'Initial validation of a quantitative PCR-based system for detection of *Sclerotinia sclerotiorum* on canola.'
Motion to accept these awardees were moved by Denis Gaudet, seconded by Ron Howard. Approved

7. **Conference reports** - Kelly Turkington presented on his trip to Australia 'A Canadian reckons: tales from my down under research adventure'.

8. **Reports of unusual disease situation** – none

9. **Nomination of honorary life members** – Denis Gaudet nominated Byron Puchalski as an honorary lifetime member. Denis noted that Byron started the co-op testing system for common bunt and for stripe rust, presented numerous times at PPSA, and served as president for two consecutive terms. Nomination seconded by Andre Laroche. Bruce Gossen nominated Ron Howard as an honorary lifetime member, in recognition of Ron's significant contribution to pathology in Western Canada. Nomination seconded by Larry Kawchuk. Mike Harding put out the call for any further nomination 3 times. No further nominations, therefore nominations cease.
Mike Harding moved that both nominees, Byron Puchalski and Ron Howard, be accepted as honorary life members in PPSA. Seconded by Kelly Turkington. Approved

10. **Resolutions** – Denis Gaudet presented a resolution to recognize the work of the organizing committee, and thank the LOC for wonderful job, hard work, and excellent activities.

11. Location and dates of future meetings

2014 – Kelly Turkington will be organizing, and meeting will be in Canmore, date around as the same time as 2013 meeting. Maybe held in conjunction with WFPM, but needs to be coordinated.
2015 – Lethbridge
2016 - TBD

12. Election of officers for 2014-2015

President – Kelly Turkington
Vice-President – Syama Chatterton nominated by Andre Laroche, Michele Frick seconded
Secretary – Jackie Bussan nominated by Kelly Turkington, Ron Howard seconded
Treasurer – Noryne Rauhala
2014 Directors (3 year term) – Robyne Bowness and Ralph Lange current directors, nomination for 3rd Director: Melanie Kalischuk nominated by Mike Harding.

Kelly Turkington moves that nomination cease, and election of the new officers (as listed above) be accepted by acclimation. Seconded by Andre Laroche. Approved

13. Other business – none

14. Adjournment

- Moved by Mike Harding, seconded by Denis Gaudet. Approved.

In Memorium: Yasuyuki (Yasu) Hiratsuka received his early training in Japan, obtaining a BS from the International Christian U, Tokyo (1957), and a MS from Hokkaido U, Sapporo (1959). He received a PhD from Purdue U under George Cummins (1962). Yasu's entire professional career has been with the Canadian Forest Service. He began as the mycologist attached to the Forest Insect and Disease Survey Unit in the Calgary Forest Pathology Laboratory in 1963, where his duties were the identification of disease specimens sent in from the field. Later, he was a Research Scientist conducting forest mycology research projects. He moved to Edmonton in 1970. His main research subjects were forest tree rusts, and aspen decay and stain. Yasu published two field guides of forest diseases and insects, *Illustrated Genera of Rust Fungi*, 3rd Edition (with G.B. Cummins) and Yasuyuki (Yasu) Hiratsuka received his early training in Japan, obtaining a BS from the International Christian U, Tokyo (1957), and a MS from Hokkaido U, Sapporo (1959). He received a PhD from Purdue U under George Cummins (1962). Yasu's entire professional career has been with the Canadian Forest Service. He began as the mycologist attached to the Forest Insect and Disease Survey Unit in the Calgary Forest Pathology Laboratory in 1963, where his duties were the identification of disease specimens sent in from the field. Later, he was a Research Scientist conducting forest mycology research projects. He moved to Edmonton in 1970. His main research subjects were forest tree rusts, and aspen decay and stain. Yasu published two field guides of forest diseases and insects, *Illustrated Genera of Rust Fungi*, 3rd Edition (with G.B. Cummins) and *Pine Stem Rusts of Canada* (with the late John M. Powell). His research included: life cycle and cytological studies of pine stem rusts, especially autoecious pine stem rusts, including western gall rust and the establishment of a new endocyclic genus *Endocronartium*; clarification of terminology and definitions of spore states of rust fungi; aspen decay and stain fungi investigation with the Province of Alberta and the U of Alberta; SEM investigation of Dutch elm disease with the late Sho Takai (GLFC); and fungi involved in mountain pine beetle with Y. Yamaoka, R. Swanson and K. Suzuki. His many awards and honours include: Distinguished National Award, Society of Technical Communication, 1988; Dr. and Mrs. D.L. Bailey Award, Canadian Phytopathological Society, 1988; Award of Excellence, International Technical Publications Competition, 1989; Forestry Canada Science and Technology Development Award, 1992; Canadian Forest Service Merit Award for Excellence in Science, 1994; Department of Natural Resources Merit Award, 1994; Canadian Forestry Scientific Achievement Award, 1994; Distinguished National Award, Society of Technical Communication, 1995; Award of Excellence, International Technical Publications Competition, 1995; and Mycological Society of Japan Award, 2003.

Plant Pathology Society of Alberta
Financial Summary October 2013

Opening Balance:			$ 4,001.09
Revenues			
Sponsorship	$4,633.68		
Registrations for 2012 meeting	$4,000.00		
Membership	$170.00		
Dr.Terry Swanson Memorial Scholarship Donations (2012)	$20.00		
Abstract Publication	$315.00		
Total Revenue	$9,138.68		
			$ 13,139.77
Expenses			
Student Award 2012 meeting		$100.00	
Technician Award 2012 meeting		$100.00	
PPSA Graduate Student Scholarship		$1,000.00	
Abstract Publication		$315.00	
Meeting Expenses		$3,171.32	
Dr.Terry Swanson Memorial Scholarship Donations (2012)		$20.00	
Dr.Terry Swanson Memorial Scholarship 2012		$918.22	
Total Expenses		$5,624.54	
Balance			$7,515.23

PPSA Savings	Interest Rate	Interest Earned	Amount
GIC - 16 month term Maturity Date December 22, 2013	1.50%	$ 17.29	$10,787.02
Business 3 Year Escalator Maturity Date December 23, 2013	3.00%	$110.74	$4,778.15

Prepared by: Noryne Rauhala _____

Auditted by: Robyne Bowness _____

Liabilities: 0

Assets: 0

Report on the

SWANSON AWARD FOR PLANT PATHOLOGY AND NEMATOLOGY

November 6, 2013

The 2013 Swanson Award for Plant Pathology and Nematology will be available to a graduate student from the University of California - Riverside. The University is in the process of selecting a suitable candidate and will notify the PPSA Awards Committee of their choice once the adjudication process has been completed. A nomination letter, along with a curriculum vitae and academic transcript, will be reviewed by the Awards Committee to confirm that they meet the eligibility criteria for the scholarship. Once approved, a cheque for $1,000 and diploma will be presented to the awardee at a special ceremony at UCR.

A financial statement for the Scholarship Fund for 2012-13 is given below.

Guaranteed Investment Certificates (Community Savings, Lacombe)

16-month GIC (matures August 12, 2014)	$ 12,359.42
Interest Earned (2012-13) 1.65%	$ 109.04
Closing Balance	$ 12,468.46

Daily Interest Savings Account (Community Savings, Lacombe)

Commercial Cash Anytime	$ 64.81
Interest 0.60%	$ 3.44
Donations received at PPSA 2012 annual meeting	$ 20.00
2012 Award (Ms. Kankana Ghoshal, UBC)	$ 81.78
Closing Balance (October 31, 2013)	$ 6.47

Respectfully submitted by D. Gaudet, S. Strelkov and R. Howard

Seated (L-R): Michele Frick, Sherry Lisowski, Melanie Kalischuk, Champa Wijekoon,Therese Despins, Syama Chatterton, Robyne Bowness, Janice Elmhirst, Barbara Ziesman, Krista Zuzak, Nicole Caillou

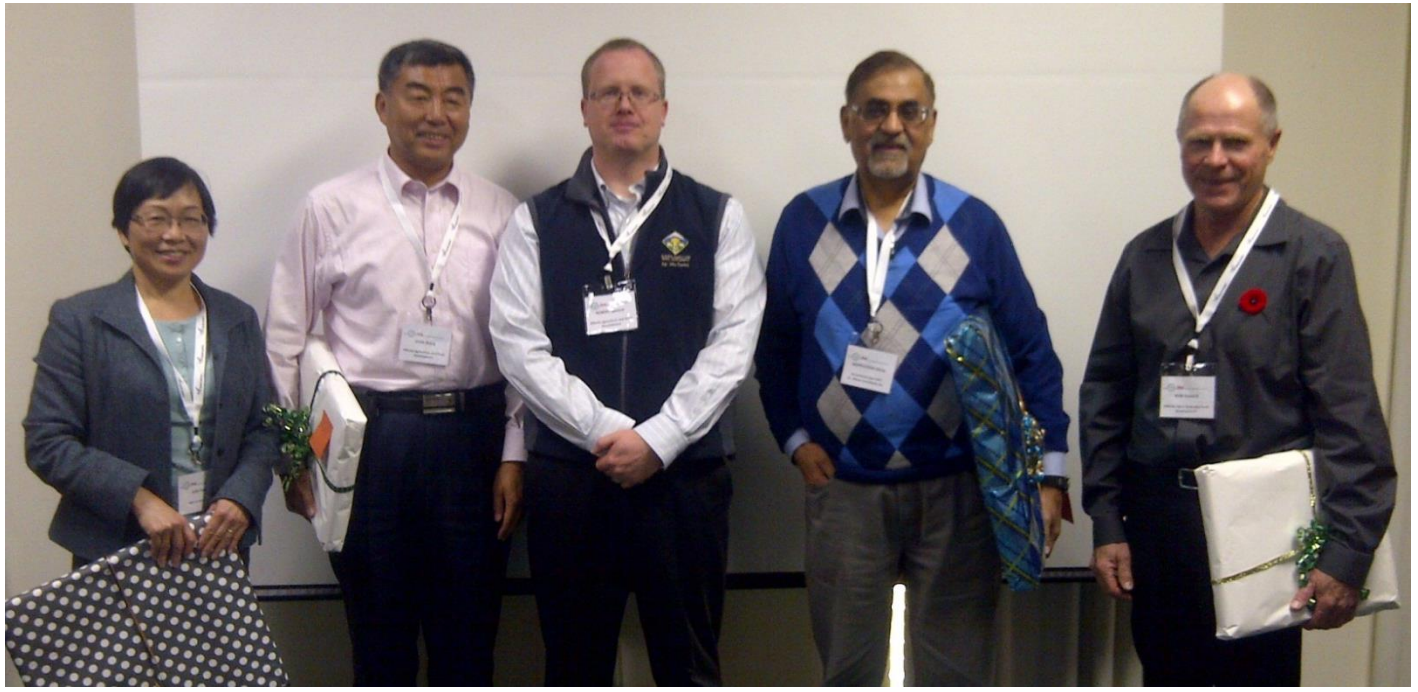
Standing (L-R): Krishan Kumar, Hui Zhang, Noryne Rauhala, Michelle Fraser, Ron Howard, Byron Puchalski, James Calpas, Andre Laroche, Greg Holmes, Kelly Turkington, Autumn Barnes, Larry Kawchuk, Michael Holtz, Carol Pugh, Jie Feng, Murray Hartman, Andrew Reid, Deb Clark, Jonathan Reich, Dustin Burke, Victor Manolii, Kevin Zaychuk, Michael Harding, Mirko Tabori, Jackie Busan, Eric Amundsen, Alireza Akhavan, Jian Yang, Kristen Steenbergen, Denis Gaudet, Bruce Gossen, Ronald Nyandoro.

Other attendees not in photo: Mohyuddin Mirza, Robert Spencer, Dustin Morton, John Zhang, Darcy Driedger,

Janice Elmhirst – CPS President

Paper Session 1

Networking at refreshment break



Greenhouse Diseases Mini-Symposium Speakers (L-R): Jian Yang, John Zhang, Robert Spencer, Mohyuddin Mirza, Ron Howard.