Plant Pathology Society of Alberta – 30th Annual Meeting Proceedings

October 26-28, 2009, Best Western Pocaterra Inn, 1725 Mountain Avenue, Canmore, Alberta

Plant Pathology Society of Alberta – 30th Annual Meeting

AGENDA

October 26-28, 2009, Best Western Pocaterra Inn, 1725 Mountain Avenue, Canmore, Alberta

Date & Time	Event	Location
Monday, October 26th		
6:00 pm – 8:00 pm	Registration	Sunrise Room
6:00 pm – 9:00 pm	Wine and cheese reception	Sunrise Room
6:00 pm – 8:00 pm	Poster set-up	Bryant Room
Tuesday, October 27thth		
8:15 am – 10:00 am	Registration	Conference Room Lobby
8:15 am - 8:30 am	Poster set-up	Bryant Room
8:30 am – 8:40 am	Welcome and opening remarks	Dawson/Wheeler Room
8:40 am – 10:00 am	Paper session I	Dawson/Wheeler Room
8:40 am – 9:00 am	Stripe rust resistance and susceptibility in Canadian wheat cultivars, B. Puchalski, AAFC Lethbridge	
9:00 am – 9:20 am	Genetic diversity of *Puccinia striiformis* in central Alberta, M. Holtz, AARD Lacombe	
9:20 am – 9:40am	Low temperature plant-microbe interactions, M. Frick, AAFC Lethbridge	
9:40 am – 10:00 am	Proteins associated with sclerotial development and exudates of *Sclerotinia sclerotiorum*, Y. Liang, University of Alberta	

10:00 am – 10:30 am	Refreshment break	
10:30 am – 12:00 pm	Paper session II	Dawson/Wheeler Room
10:30 am – 10:50 am	Transcriptional responses in host- and non-host interactions between wheat and barley and the barley smut pathogen *Ustilago hordei*, Y. Wang, AAFC Lethbridge	
10:50 am – 11:10 am	Virulence of *Puccinia striiformis*, cause of stripe rust of Cereals in Central Alberta, K. Kumar, AARD Lacombe	
11:10 am – 11:30 am	The Yr10 stripe rust resistance in wheat and its silencing using the barley stripe mosaic virus system, A. Laroche, AAFC Lethbridge	
11:30 am – 11:50 am	Responses including hypersensitive cell death, oxidative burst, and defense gene expression in Moro wheat infected with *Puccinia striiformis*, D. Gaudet, AAFC Lethbridge	
11:50 am – 12:00 pm	Morning wrap-up and announcements	
12:00 pm – 1:30 pm	Lunch	Sunrise Room
1:30 pm – 3:00 pm	Paper session III	Dawson/Wheeler Room
1:30 pm – 1:50 pm	Molecular characterization of a serine protease Pro1 from the clubroot pathogen *Plasmodiophora brassicae*, J. Feng, AARD Edmonton	
1:50 pm – 2:10 pm	Occurrence, identification, and control of Alternaria disease in *Saponaria vaccaria*, R. Lange, ARC Vegreville	
2:10 pm – 2:30 pm	Biological control of aflatoxin contamination of corn in Texas using Aflaguard, a commercial atoxigenic strain of *Aspergillus flavus*, T. Isakeit, Texas A&M University	
2:30 pm – 2:40 pm	Afternoon wrap-up and announcements	
2:40 pm – 4:30 pm	Refreshment break and poster session	Bryant Room

6:00 pm – 9:30 pm	Banquet	Chez François Restaurant

Wednesday, October 28th

9:00 am – 10:00 am	Paper Session IV	Dawson/Wheeler Room
9:00 am – 9:20 am	Integrated Pest Management for controlling bacterial blights in dry edible bean, M. Harding, Innovotech, Brooks	
9:20 am – 9:40 am	The impact of fungicide and herbicide timing on barley leaf disease severity, weed management and crop productivity, T.K. Turkington, AAFC Lacombe	
9:40 am – 9:50am	Closing comments	
9:50 am – 10:15 am	Refreshment break	
10:15 am – 12:00 pm	PPSA Business Meeting	Dawson/Wheeler room

Plant Pathology Society of Alberta – 30th Annual Meeting

Sponsors

The organizing committee for the 2009 PPSA annual meeting would like to graciously acknowledge the support of the following companies and organizations for their generous support, which has certainly helped to ensure the success of our annual meeting.

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Paper and Poster Abstracts, Plant Pathology Society of Alberta – 30th Annual Meeting, October 26-28, 2009, Best Western Pocaterra Inn, 1725 Mountain Avenue, Canmore, Alberta

Stripe Rust; Sources of Resitance and Susceptibility in Canadian Wheat Cultivars

B.J. Puchalski, D.A. Gaudet, A. Laroche, R. Graf and H. Randhawa
Agriculture and Agri-food Canada, Lethbridge Research Centre,P.O Box 3000
5430 1st Ave. South, Lethbridge Alberta T1J-4B1. Stripe rust *(Puccinia striformis)* is an important plant pathogen to western Canadian cereal producers. Outbreaks, particularly in Alberta are common where yield losses can reach 30%. Ninety-two spring and ten winter cultivars of wheat and triticale were evaluated in 2009 for their reaction to naturally occurring stripe rust. Only the adult reaction of plants was evaluated as rust did not infect the plots until late June. Plants were rated for percent disease incidence and percent area of flag leaves infected.

All varieties of triticale, durum, spelt and all but Bluesky of the Canadian extra strong class are resistant. Susceptible varieties were common amongst the Canadian prairie spring red and white classes with all but PR-5701 and HY-682 being resistant. Of the soft white spring varieties only Sadash and Bhishaj are resistant. The rust resistance genes, *Yr-10, Yr-17* and *Yr 18* provide good resistance in the Canadian hard red spring and winter classes. Lesser genes will result in an intermediate to susceptible reaction.

Increases in the production of the resistant winter variety Radiant at the expense of the susceptible cultivar Bellatrix should reduce losses from this disease. The resistant spring wheat variety Lillian is replacing the susceptible varieties of AC Barrie and McKenzie and losses due to stripe rust in spring wheat should decrease. Producers that elect to grow varieties with an intermediate rust reaction should expect some yield and quality losses. Many susceptible cultivars exist but wheat growers have stripe rust resistant varieties in all classes.

Genetic diversity of *Puccinia striiformis* in central Alberta. M.D. Holtz, K. Kumar, K. Xi, and J. Zantinge. Field Crop Development Centre, Alberta Agriculture and Rural Development, 6000 C & E Trail, Lacombe, AB T4L 1W1. Stripe rust of wheat and barley, caused by *Puccinia striiformis* Westend. f. sp. *tritici* Eriks. (PST) and *Puccinia striiformis* Westend. f. sp. *hordei* Eriks (PSH) respectively, have recently become increasingly severe in recent years in Alberta. Molecular studies have shown extremely limited diversity within PST throughout most of the world, whereas PSH has been rarely examined. Fifty-five isolates of *P. striiformis* were collected from different locations and molecular variability was examined by inter-simple sequence repeat (ISSR), and simple sequence repeat (SSR) markers. Both types of markers separated PST and PSH into distinct groups and revealed greater diversity within PSH than PST. This separation of PST and PSH concurs with the identification of forma specialis determined by urediniospore inoculation onto host differentials. The frequent occurrence of repeated genotypes, heterozygous excess, and the lack of relationship between genotype and geographic

location suggest a widespread clonal population within the forma specialis. Comparison of genetic variability to pathogenic variability within the forma specialis resulted in low correlation coefficients indicating that little relationship exists between molecular and pathogenic variation.

Low temperature plant-microbe interactions. M. Frick, D.A. Gaudet, C. Penniket, B. Puchalski, D. Nilsson, and A. Laroche. *Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, Alberta, Canada***.** Snow mould fungi attack living tissues under the snow at temperatures near or below 0°C that are physiologically limiting for the plant. To survive the plant mobilizes reserves accumulated during the autumn and early winter when winter wheat is exposed to low-temperature hardening conditions. Transcript profiling during cold acclimation identified a wide range of differentially regulated genes that include specific PR-proteins, defence-related transcription factors, and abiotic stress-related genes in winter wheat. Snow mould resistant cultivars develop higher total carbohydrate reserves, mainly in the form of soluble fructans, in plant leaves and crowns and maintain their reserves for a longer period during the winter and early spring. Expression of a large subset of defence-related transcripts gradually decreases during the course of snow mould infection. Insufficient autumn growth and inadequate hardening reduce the level of expression of these stress-related and metabolic genes, fructan content and snow mould resistance. The transcriptome results provide a direction in identifying key genes involved in winter survival under snow mould conditions, and for developing a strategy for improving snow mould resistance in winter wheat.

Proteins associated with sclerotial development and exudates of *Sclerotinia sclerotiorum*. Y. Liang, S. E. Strelkov, and N. N.V. Kav. *Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G2P5, Canada*

Sclerotinia sclerotiorum is a necrotrophic phytopathogen that is capable of infecting over 400 plant species. The sclerotia produced by this fungus are long-term survival structures that serve as the primary source of inoculum in the disease cycle. Sclerotial development is associated with morphological changes and the exudation of liquid droplets, but little is known regarding the proteins associated with this process. Therefore, we conducted a proteomic analysis of the exudates and sclerotial tissues at different stages in sclerotial development. A total of 88 and 56 proteins were identified from three developmental stages and the exudates of sclerotia, respectively. These proteins were classified into several functional categories including metabolism, energy, transcription, protein fate, signal transduction, cell defense, differentiation and those with as of yet unknown functions. This study may enable a more comprehensive understanding of sclerotial development. Such knowledge may also lead to the formulation of alternative strategies for management of *S. sclerotiorum*.

Transcriptional responses in host- and non-host interactions between wheat and barley and the barley smut pathogen *Ustilago hordei*. *Y. Wang[1], D.A. Gaudet[1], C. Penniket[1], M. Frick[1], G. Bakkeren[2], and A. Laroche[1]. 1Agriculture and Agri-Food Canada, Lethbridge Research Centre, 5403-1st Avenue, South, Lethbridge, Alberta, T1J 4B1 Canada; 2Agriculture and Agri-Food Canada, Summerland Research Centre, Summerland, B.C., V0H 1Z0.* Barley (Hordeum vulgare), wheat (Triticum aestivum) and the seed-borne barley smut pathogen (*Ustilago hordei*) provide an ideal system for comparing molecular mechanisms involved in host compatible and incompatible, and non-host interactions between plants and pathogens. We used the Affymetrix GeneChip® Wheat Genome Array to compare transcriptional changes occurring on the coleoptiles of two barley cultivars in a compatible interaction, an incompatible reaction conferred by the resistance gene Ruh1, and in the non-host wheat cultivar with U. hordei. Some defense genes known to be responsive to some defense-related signal molecules are represented on the arrays. qRT-PCR was used to confirm that the induced expression of some of these genes was more rapid and stronger during early stages of pathogenesis in the RUh1 incompatible interaction than in the compatible interaction in barley. In contrast, a strong overexpression of most of these genes was observed at both early and late stages in the non-host wheat interaction. Furthermore, some typical down stream PR-proteins genes were induced by salicylic acid, jasmonic acid and ethylene while the upstream regulatory genes were not. In most cases, all 3 hormones had similar effects in both wheat and barley. The plant hormones SA, JA and ET may play crucial roles in the signaling network that regulates induced defense responses against U. hordei.

Virulence of *Puccinia striiformis* of cereals in central Alberta. *K. Kumar, K. Xi, M. Holtz, T.K. Turkington, X. M. Chen, J. Helm, D. Salmon, H. Booker and D. Spaner. Field Crop Development Centre, Alberta Agriculture and Rural Development, 6000 C & E Trail, Lacombe, AB, T4L 1W1; (T.K.T.) Agriculture and Agri-Food Canada, Lacombe Research Centre, Lacombe, 6000 C & E Trail, Lacombe, AB, T4L 1W1; (X.M.C.) U.S. Department of Agriculture, Agricultural Research Service, Washington State University, Pullman, WA, 99164-6430, USA; (J.H. & D.S.) Field Crop Development, Alberta Agriculture and Rural Development, 5030 50 Street, Lacombe, AB, T4L 1W8; (H.B. & D.S.) Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5.* Stripe rust of cereals has become increasingly important in central Alberta since the late 1990s. For virulence determination, 57 isolates were collected from wheat and barley primarily from central Alberta during 2007 – 2009 and used for growth chamber inoculation. Preliminary results showed that 36 of 57 isolates were identified as *Puccinia striiformis* f. sp. *tritici* (PST) and 21 were *Puccinia striiformis* f. sp. *hordei* (PSH) based on seedling reactions of 21 wheat and 12 barley differentials. All isolates collected from wheat were identified to be PST in classification. The majority isolates collected from barley were identified as PSH and two were identified as PST. This classification agreed with a PCR based identification. The isolates in the PST group were further identified to be 30 races using wheat differentials. Only two PST races that may not have originated from central Alberta were found to be virulent on *Yr10* in addition to many other wheat differentials. None of the PST races were virulent on *Yr1, Yr5, Yr15* or *YrSP*. The isolates in the PSH group were identified to be 17 races based on the barley differentials. Four PSH races had the virulence spectra that were previously reported in the USA. The remaining races were generally virulent on fewer barley differentials than typical American races. Both populations of PST and PSH

identified in central Alberta appear to be virulent on most differentials and aviulent on a few differentials with specific resistance genes.

Silencing the *Yr10* stripe rust resistance in wheat using the barley stripe mosaic virus system. Wei Liu[a,b], André Laroche[a], Michele Frick[a], R. Huel[a], C.L. Nykiforuk[a], F. Eudes[a], R. L. Conner[a], Zhen-Sheng Kang[b], Denis A. Gaudet[a] [a]*Agriculture and Agri-Food Canada, Lethbridge Research Centre, P. O. Box 3000, 5403-1st Avenue, South, Lethbridge, Alberta, T1J 4B1 Canada* [b]*College of Plant Protection and Shaanxi Key Laboratory of Molecular Biology for Agriculture, Northwestern A&F University, Yangling, Shaanxi 712100, PR China.* Wheat stripe rust, caused by *Puccinia striiformis* Westend. f. sp. *tritici*, is a destructive disease of wheat worldwide and the development of resistant cultivars is the most economical control method. The *Yr10* gene, that encodes a cytoplasmic protein containing a nucleotide-binding site (NBS) and leucine-rich repeats (LRR), imparts seedling resistance in Moro wheat to stripe rust. Virus-induced gene silencing (VIGS) is a rapid and powerful tool to analyze the function of plant genes. We have taken advantage of the barley stripe mosaic virus (BSMV) system which is a mild pathogen of cereals to silence the *Yr10* gene. Moro wheat transfected with different functional domains of the *Yr10* gene, was inoculated with an avirulent stripe rust strain, 44E14 (SRC84) and evaluated for resistance reaction. In parallel, the transcript profiling of *Yr10* under compatible and incompatible reactions was also evaluated. Results demonstrated that silencing of the *Yr10* resistance reaction in Moro was achieved in different sectors of transfected leaves. A corresponding reduction in *Yr10* transcript abundance was also observed with each of the different functional domains used in the transfection. These silencing results independently confirm the identity of genomic and cDNA sequences previously associated to *Yr10.*

Defense responses including hypersensitive cell death, oxidative burst and defense gene expression in Moro wheat infected with *Puccinia striiformis.* X. Wang[1,2], D. A. Gaudet[1,], Z. Kang[2], F. Leggett[1], and A. Laroche[1]. [1] *Agriculture and Agri-Food Canada, Lethbridge Research Centre, P. O. Box 3000, 5430-1st Avenue, South, Lethbridge, Alberta, T1J 4B1;* [2]*College of Plant Protection and Shaanxi Key Laboratory of Molecular Biology for Agriculture, Northwestern A&F University, Yangling, Shaanxi 712100, PR China.* The oxidative burst (OB) and hypersensitive response (HR) are known to be associated in plant defense responses to pathogens. These factors were studied in the interactions between *Puccinia striiformis* f. sp. *tritici* and susceptible wheat cultivar Fielder and Moro, which possesses *Yr10*. Both varieties were inoculated with *P. striiformis* strain 44E14 (SRC 84) which is avirulent on *Yr10* and virulent on Fielder. A morphological study of compatible and incompatible interactions in 'Fielder' and 'Moro' demonstrated that the hypersensitive response (HR) occurs between 10 and 14 days after inoculation (dai), following the formation of the haustorium. A first OB (OB1) was detected at 6 dai followed by a second burst (OB2) at 14 dai. Profiling of numerous plant defense-related genes from 0-14 dai demonstrated that transcripts of the key regulatory genes *Enhanced Disease Susceptibility* (*EDS1*), *Phytoalexin Deficient* (*PAD4*), and *Allene Oxide Synthase* (*AOS*) and the PR-proteins *chitinase 3*, and non-specific Lipid Transfer Protein (ns-LTP), were differentially upregulated in the inoculated compared to the uninoculated control treatments, at very early stages of infection between 2 to 4 dai and at later stages of infection between 10 and 14 dai. The PR-proteins PR-1.1, *β-1, 3-glucanase*, and thaumatin, and *phenylalanine ammonium lyase* (*PAL*), were differentially upregulated at later stages of

infection, between 10 and 14 dai. These results demonstrate that specific stages consisting of transcriptional changes indicative of recognition responses in host occur early in the host-parasite interaction but that key defense responses that terminate pathogen development and response occur later. These results will be discussed in terms of current models of host-parasite interactions.

Molecular characterization of a serine protease Pro1 from the clubroot pathogen *Plasmodiophora brassicae.* J. Feng, R. Hwang, S.F. Hwang, S.E. Strelkov, B.D. Gossen, and G. Peng. Crop Diversification Centre North, Alberta Agriculture and Rural Development, Edmonton, AB, T5Y 6H3, Canada; (R.H. and S.E.S.) Department of Agriculture, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5, Canada; and (B.D.G. and G.P.) Agriculture and Agri-Food Canada, Saskatoon, SK, S7N 0X2, Canada.

To better understand the pathogenesis of clubroot on canola (*Brassica napus*), a serine protease gene (*PRO1*) was cloned from *Plasmodiophora brassicae* and its molecular characteristics were investigated. Southern analysis and specific PCR amplification indicated that *PRO1* is a single-copy gene and present in a broad range of *P. brassicae* pathotypes. Northern analysis identified expression of *PRO1* during plant infection, as well as in dormant and germinating resting spores. Analysis of the amino acid sequence suggested that the encoded protein (Pro1) belongs to the S28 family of proteases, with a predicted signal peptide. The open reading frame of *PRO1* was transferred into *Pichia pastoris* cells and heterologously expressed. Pro1 showed proteolytic activity on skim milk and the synthetic substrate Suc-AAF-AMC, and the activity could be inhibited by serine protease inhibitors and the chelating agent EDTA. The optimal temperature of Pro1 was 25°C and it exhibited maximum activity at pH 6.2-6.4 and minimal activity at pH 6.8 and 7.6, which is consistent with the temperature and pH conditions favorable for *P. brassicae* resting spore germination in the field. When Pro1 was used to treat canola root exudates, it significantly enhanced the stimulating effect of the root exudates on *P. brassicae* resting spore germination, suggesting that Pro1 plays a role during clubroot pathogenesis.

Occurrence, identification and control of Alternaria disease in *Saponaria vaccaria*. J. Yang, R.M. Lange, and P.R. Watson. *Alberta Research Council, HWY 16A & 75th Street, Vegreville, AB T9C 1T4, Canada*. *Saponaria vaccaria* L., a member of the family Caryophyllaceae, is being developed as a crop species for production of starches, saponins and antibiotic peptides for the cosmetic, veterinary and medical use. Diseases affecting *S. vaccaria* were investigated as part of the crop development process. Diseased plant samples were collected from field plots in Manitoba (Red River Valley), Saskatchewan (Saskatoon) and Alberta (Vegreville and Taber), and fungi were isolated and identified. The most frequently-observed disease was Alternaria blight. Symptoms included circular, yellow to brown or necrotic spots on leaves, stems, capsules and seeds. Lesion edges were chlorotic, sometimes with concentric zones, darker in the centre and lighter outside. At high moisture, hyphae and conidia were visible in the lesion. The pathogen was identified as *Alternaria saponariae* (Peck) Neergaard and confirmed by using DNA sequencing analysis. Pathogenicity of *A. saponariae* on *S. vaccaria* was confirmed. *A. saponariae* was also found on *Thlaspi arvense* and *Polygonum persicaria* and other smartweeds, but did not cause symptoms when theses hosts were artificially

inoculated. Application of foliar fungicides at pre- and mid-flowering stages significantly reduced the Alternaria blight severity.

Biological control of aflatoxin contamination of corn in Texas using Afla-Guard®, a commercial atoxigenic strain of *Aspergillus flavus*. T. Isakeit, K. Mayfield, S. Murray, R. Minzenmayer, and J. Ripple. *Department of Plant Pathology and Microbiology, 2132 TAMU, Texas A&M University, College Station, TX 77843 USA; (K.M., S.M.) Department of Soil and Crop Sciences, 2474 TAMU, Texas A&M University, College Station, TX 77843 USA; (R.M.) Texas AgriLIFE Extension Service, 613 Hutchins Avenue, Suite 302, Ballinger, TX 76821 USA; and (J.R.) Texas AgriLIFE Extension Service, 3151 SE Inner Loop, Suite A, Georgetown, TX 78626 USA.* Aflatoxin, a carcinogenic mycotoxin produced by *Aspergillus flavus* Link:Fr., is a problem of corn (*Zea mays* L.) grown in tropical and sub-tropical areas, causing annual losses in Texas exceeding $10 million. We evaluated a commercial biocontrol agent, Afla-Guard®, for control of aflatoxin of corn at three Texas locations. Afla-Guard® consists of conidia of an atoxigenic isolate of *A. flavus* (NRRL 21882) coating non-viable wheat seed that is scattered over corn during flowering. In one experiment with furrow-irrigated corn, the application of Afla-Guard® (11.2 kg/ha) was followed five days later with infestation of plots with a toxigenic strain of *A. flavus* (NRRL 3357) colonized autoclaved corn kernels. The mean aflatoxin concentration with the Afla-Guard® treatment was 88 ng/g, which was less than that of the control, 152 ng/g. In a drip-irrigated field, aflatoxin was not reduced with Afla-Guard® treatment (47 ng/g), in comparison with the control (36 ng/g). In a dryland field under drought stress, aflatoxin was lower in hand-harvested ears of the Afla-Guard® treatment, in comparison with the control, but no differences were seen with combine-harvested corn. In this field, 9% of *A. flavus* isolates from visibly-colonized, Afla-Guard® treated ears were toxigenic, compared with 48% for visibly-colonized control ears. Additional research is needed to optimize efficacy of Afla-Guard®.

Integrated pest management for controlling bacterial blights in dry edible bean. *M.W. Harding, P.M. Balasubramanian, D.A. Sowa, R.J. Howard and M.E. Olson. Innovotech Inc. Suite 101 -- 2011 94 St., Edmonton, AB T6N 1H1 Canada; (PMB) Agriculture and Agri-Food Canada, 5403 - 1 Avenue South, PO Box 3000, Lethbridge, Alberta T1J 4B1 Canada; (RJH.) Alberta Agriculture and Rural Development, Crop Diversification Centre South, 301 Horticultural Station Rd. E., Brooks, AB T1R 1E6 Canada.* Bacterial blights occur each year in dry edible bean fields in southern Alberta. Complete genetic resistance to bacterial blight is not available in any early-maturing pinto bean cultivars grown in Alberta. However, the cultivar AC Island had been reported to have reduced disease severity in producer fields. In this study, we desired to compare the effect(s) of genetic differences, seed treatments and foliar-applied bactericides in controlling bacterial blights in dry edible bean in southern Alberta. Genetic mechanisms in the pinto cultivar AC Island were best able to reduce bacterial blight disease incidence, followed by seed treatments, and foliar applied bactericide sprays respectively. Integrating multiple management options, such as selecting tolerant varieties, using good quality disease-free seed, and applying a bactericidal seed treatment (Agress™), was necessary to optimize control of bacterial blight on beans in 2009.

The impact of fungicide and herbicide timing on barley leaf disease severity, weed management and crop productivity. T.K. Turkington, K. Xi, 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, Alberta Agriculture and Rural Development, 6000 C & E Trial, Lacombe, AB, T4L 1W1.* Interest in tank mixing herbicides and half rates of fungicides for weed and disease management in barley has been increasing. However, little published scientific information exists regarding the impact of this practice on weed and disease management, and crop productivity. A ten treatment experiment was set up at Lacombe, AB using a four-replicate RCBD. Treatments included various combinations (herbicide alone or herbicide + fungicide) and timings (2-3 leaf stage, 5-6 leaf stage, flag leaf stage) of herbicide (Axial®) and fungicide (Tilt®). Prior to seeding, the plot area was cross-seeded with tame oat as a model weed. Penultimate and flag leaf – 2 samples were collected for assessment of leaf disease severity, while crop and model weed emergence and biomass were assessed. Plots were harvested and grain yield and kernel quality assessed. Dry conditions limited crop emergence and disease development. Scald was the main disease with generally low severities, but was significantly higher for the no fungicide treatments and the 2-3 leaf stage combination herbicide and half rate fungicide treatment compared to all other treatments. Yields tended to be highest for those treatments with early herbicide application and/or where the fungicide treatment included a flag leaf stage application. Weed biomass was very low and not influenced by the treatments due to poor emergence and effective control following herbicide application.

Cereal resistance to stripe rust caused by *Puccinia striiformis* and potential sources of inoculum. K. Xi, K. Kumar, M. Holtz, L. Vandermaar, L. Langford, M. Wilson, X. M. Chen, H. Booker, D. Spaner, T.K. Turkington, J. Nyachiro and D. Salmon. Field Crop Development Centre, Alberta Agriculture and Rural Development, 6000 C & E Trail, Lacombe, AB, T4L 1W1; (X.M.C.) U.S. Department of Agriculture, Agricultural Research Service, Washington State University, Pullman, WA, 99164-6430, USA; (H.B. & D.S.) Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5; (T.K.T.) Agriculture and Agri-Food Canada, Lacombe Research Centre, Lacombe, 6000 C & E Trail, Lacombe, AB, T4L 1W1; (J.N. & D. S.) Field Crop Development Centre, Alberta Agriculture and Rural Development, 5030 50 Street, Lacombe, AB, T4L 1W8. Stripe rust of cereals caused by *Puccinia striiformis* Westend. has become increasingly important in central Alberta since the late 1990's. To breed for disease resistance, triticale, wheat and barley genotypes from central Alberta were screened in stripe rust nurseries at Pullman and Mt. Vernon, Washington State, USA. The majority of spring triticale germplasm and lines being screened were resistant. All barley cultivars were susceptible except for cv. 'Seebe', which consistently showed an intermediate reaction based on the severity rating scale used. Barley germplasm and breeding lines showed significant differential reactions to stripe rust in the Mt. Vernon nursery, indicating that screening for and identification of barley with stripe rust resistance was effective. Twenty-seven spring wheat cultivars were found to have similar rankings in the stripe rust reactions when screened at nurseries in Pullman and Mt. Vernon compared to those screened internationally. Resistance genes *Yr1, Yr5, Yr8, Yr15, YrCV* and *YrSP* as evidenced by the wheat differentials grown in the nurseries appeared to contribute to the resistance in the wheat cultivars

tested. Spring cereals planted in a winter wheat field showed higher levels of stripe rust than those planted in a spring wheat field in Lacombe, AB. These observations suggest that stripe rust may build up on winter wheat crops which then act as a source of inoculum for spring-seeded cereals in central Alberta.

Characterization of a differentially abundant exo-glucanase from *Pyrenophora tritici-repentis* H.T. Fu, T. Cao and S.E. Strelkov. Department of Agricultural, Food and Nutritional Science, 410 Agriculture/Forestry Centre, University of Alberta, Edmonton, AB T6G 2P5, Canada.

The fungus *Pyrenophora tritici-repentis* is the causal agent of tan spot, an important foliar disease of wheat. In a previous study, analysis by 2-dimensional gel electrophoresis revealed that the enzyme exo-β-1,3-glucanase was five times more abundant in the secretome of a virulent race 5 isolate of the fungus versus that of an avirulent race 4 isolate. Glucanase breaks down glucan, which is not only a major component of the cell walls of many phytopathogenic fungi, but is also widely present as a cell wall component in plants. To learn more about the relationship of exo-glucanase and the virulence of *P. tritici-repentis*, glucanase activity in the culture filtrates of virulent and avirulent isolates was assayed using laminarin as the substrate. Total glucanase activity in the secretome of race 5 was more than two-fold greater than in race 4, a finding consistent with the earlier study. The gene encoding exo-glucanase was also cloned and characterized from both races; the 1,266 bp exo-glucanase gene encodes a protein 421 amino acids in length with a predicted signal peptide between amino acid residues 18 and 19. In order to facilitate further studies into the role of exo-glucanase in pathogen virulence, the gene was heterologously expressed in *Escherichia coli* and the enzyme purified by affinity chromatography.

Developing a Method to Assess Insensitivity to Pyraclostrobin Fungicide in *Ascochyta rabiei*. N.H. Thaher, B.D. Gossen, and M.R. McDonald. *Department of Plant Agriculture, Crop Science Building, University of Guelph, 50 Stone Road East, Guelph, ON N1G 2W1, Canada; and (B.D.G.) Saskatoon Research Centre, Agriculture and Agri-Food Canada, 107 Science Place, Saskatoon, SK S7N 0X2, Canada.* The sensitivity to pyraclostrobin (a strobilurin fungicide) of isolates of *Ascochyta rabiei* (Pass.) Labr. collected from chickpea crops in Saskatchewan in 2007 was assessed based on reduction in radial growth at 5 µg mL^{-1} compared to the untreated check. Three sensitive (>70% reduction), four intermediate (40-69%), and three insensitive isolates (<40%) were selected for further testing. Our objectives were to determine if isolates of *A. rabiei* showed the same pattern of sensitivity to strobilurins in assessments 1) of radial growth and conidial germination, 2) using the alternative oxidase inhibitor, salicylhydroxamic acid (SHAM), and 3) of formulated product or technical grade active ingredient (a.i.). Isolates were grown on media amended with formulated product (0.1 – 1000 µg a.i. mL^{-1} as Headline® for radial growth, 0.0001 – 10 µg for conidial germination) with and without SHAM at 100 µg mL^{-1}. SHAM reduced EC_{50} values for both growth and germination, but did not affect differentiation of sensitive isolates for either assessment. In a second trial, radial growth on agar amended with 5 µg a.i. mL^{-1} was compared using Headline® and technical grade active with SHAM. There was no difference in response between the two sources of a.i.

Both studies were repeated, with the same results. Sensitive isolates were readily separated from intermediate and insensitive in all of the assessments, but there were no consistent differences among intermediate and insensitive isolates. We conclude that the intermediate isolates should be characterized as insensitive, and that a discriminatory dose of 5 µg a.i. mL^{-1} (as Headline®, without SHAM) for radial growth assessments could be used to determine sensitivity to strobilurin fungicides.

Effect of host and non-host bait crops on the severity of clubroot [*Plasmodiophora brassicae*] on canola. Q. Xiao, S.F. Hwang, S.E. Strelkov, H. Ahmed, J. Feng and B.D. Gossen. *Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada; (H.A, S.F.H. and J.F) Alberta Agriculture and Rural Development, Crop diversification centre north, AB T5Y 6H3, Canada and (B.D.G.) Agriculture and Agri-Food Canada, 107 Science Place, SK S7N 0X2, Canada.* In recent years clubroot, caused by the obligate parasite *Plasmodiophora brassicae* Woronin, has emerged as an important disease of canola in Alberta, Canada. One of the major challenges associated with managing this disease is the production, by the pathogen, of resting spores that can remain viable in the soil for many years. The cropping of host and non-host bait plants, which can induce germination of resting spores and thereby decrease the soil inoculum load, has been suggested as a tool in clubroot management. Therefore, we assessed two bait crops, Polish canola (*Brassica rapa* L.) and perennial ryegrass (*Lolium perenne* L.), for their effectiveness in reducing clubroot symptom severity in Argentine canola (*B. napus* L.) under greenhouse conditions. Rotations included Polish canola (PC)-ryegrass (R)-Argentine canola (AC), R-PC-AC, PC-PC-AC, R-R-AC, and fallow-AC. Inclusion of a bait crop reduced clubroot severity in the subsequent Argentine canola crop, relative to a fallow treatment, but the effectiveness of individual treatments fluctuated. Additional greenhouse and field studies are planned to examine the effectiveness of bait crops further.

Effect of seedling age and inoculum density on clubroot severity and seed yield of canola. S.F. Hwang, H.U. Ahmed, S.E. Strelkov, G.D. Turnbull and B.D. Gossen. *Crop Diversification Centre North, Alberta Agriculture and Rural Development, Edmonton, AB, T5Y 6H3, Canada; (S.E.S) Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, Alberta T6G 2P5, Canada; (B.D.G.) Agriculture and Agri-Food Canada Research Centre, Saskatoon, SK S7N 0X2, Canada*
Clubroot, caused by *Plasmodiophora brassicae* Woronin, is a grave threat to canola (*Brassica napus* L., *B. rapa* L.) production in Alberta because of its long-lived resting spores, its ability to rapidly build up spore populations, and its detrimental effects on canola yields in fields with high spore populations. An understanding of the effect of seedling age and inoculum density on clubroot and yield of canola is a prerequisite for designing any disease management strategy. Therefore, experiments were conducted to evaluate the influence of seedling age and inoculum density on clubroot severity and yield in canola under greenhouse conditions. The results indicated a significant effect of seedling age and inoculum density ($P \leq 0.01$) on clubroot, plant height and seed yield. The younger seedlings were more vulnerable compared to the older seedlings, which suggests that seed treatments that have a long residual period (four weeks or more) may be useful for the management of clubroot. Clubroot severity significantly increased,

while plant height and seed yield decreased, with increasing inoculum density. Management strategies such as cropping of bait plants or rotation with non-host crops may reduce resting spore concentrations in the soil, minimizing disease severity and increasing seed yield of canola.

Efficacy of selected biofungicides for control of clubroot on canola. G. Peng, B.D. Gossen, S.E. Strelkov, S.F. Hwang and M.R. McDonald. *Agriculture and Agri-Food Canada, Saskatoon, SK S7N 0X2, Canada; (S.E.S.) 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 Food, 17507 Fort Road, Edmonton, AB T5Y 6H3, Canada; (M.R.M.) Department of Plant Agriculture, University of Guelph, Guelph ON N1G 2W1, Canada.* Clubroot of canola, caused by the fungal pathogen *Plasmodiophora brassicae*, is an emerging threat to the canola industry in western Canada. Since its discovery near Edmonton in 2003, the disease has been found in more than 250 canola fields in Alberta. All commercial cultivars are susceptible, and currently there is a lack of effective/practical control options. In this study, biofungicides registered in Canada and the USA including Serenade, Pre-stop, Mycostop, Actinovate, SoilGard, Root Shield and Taegro, were tested initially at 5× label rates for control of the disease. Conidial suspensions (10^6 spores/ml) of the fungal endophyte *Heteroconium chaetospira*, reported to control clubroot on Chinese cabbage in Japan, and two chemical fungicides, Allegro and Ranman (at label rates), were also evaluated. All treatments were applied as a soil drench at 50 ml/plant in a 4 cm × 20 cm root-trainer 72 h prior to (for microbial products/agent) or 1 h after (fungicides) pathogen inoculation. Control plants were drenched with water. Treated canola plants were kept in growth cabinets set at 23/18ºC (day/night, 14 h photoperiod) in a containment facility. Clubroot severity was assessed using a 0–3 scale based on the portion of root diseased and gall size. At the lower pathogen inoculum dose (10^5 spores/ml), Serenade, Pre-stop, *H. chaetospira*, Allegro and Ranman were highly effective, reducing disease severity by 77–100% three weeks after pathogen inoculation. At the higher pathogen dose (10^6 spores/ml), *H. chaetospira* was less effective while the other four treatments reduced disease severity by 56–100% when compared to pathogen controls. Serenade, Allegro, and Ranman consistently provided 85–100 % reduction of disease severity in repeated trials.

Manipulating seeding date to minimize clubroot (*Plasmodiophora brassicae*) damage in canola and vegetable brassicas. B.D. Gossen (1), M.R. McDonald (2), S.F. Hwang (3) and K.C. Kalpana (2)**.** (1) Agriculture and Agri-Food Canada, Saskatoon, SK S7N 0X2; (2) University of Guelph, Guelph, ON, N1G 2W1, Canada; and (3) Alberta Agriculture and Rural Development, Edmonton, AB, T5Y 6H3, Canada. Clubroot caused by *Plasmodiophora brassicae* (Woronin) is endemic on vegetable Brassicas in many parts of eastern Canada, and threatens canola (*Brassica napus* L. and *B. rapa* L.) production across large areas of the Canadian prairies. Options for control, such as durable sources of resistance, are limited. A recent study on short-season Brassica vegetables indicated that timing plantings to avoid warm conditions in the 10 days before harvest reduced symptom severity. Studies were initiated to examine the impact of seeding date on clubroot incidence and severity. Trials on *B. napus* were seeded in early, mid and late May 2008 at two sites near Edmonton, Alberta. Also, a field trial on Shanghai pak choy (*B. rapa* subsp. *chinensis* var. *communis*) was seeded near Bradford, Ontario,

Canada in May, June, July, August and September of 2007 and 2008. Early seeding reduced symptom severity on canola by 10-50% and increased yield by 30-58%. Plantings of pak choy in June and July had 64–87% clubroot incidence. Seeding in May, August or September resulted in harvests during cool conditions and little or no clubroot (0–15% incidence). Clubroot severity showed a similar pattern of response. Repetitions of these trials were conducted in 2009, but dry conditions in Alberta inhibited seed germination in May and the canola field trials were abandoned.

Molecular detection of *Puccinia striiformis* using conventional and real-time PCR. M.D. Holtz, K. Xi, K. Kumar, and J. Zantinge. Field Crop Development Centre, Alberta Agriculture and Rural Development, 6000 C & E Trail, Lacombe, AB T4L 1W1.
Puccinia striiformis Westend., the causal agent of stripe rust of wheat and barley, has become more common in Alberta in recent years. Early detection of presymptomatic infections in cereals is needed in pathogen monitoring and disease forecasting. Previously published conventional PCR primers were tested for the detection of *P. striiformis* f. sp. *tritici* and *hordei* DNA. The primer pair YRNT1-YRNT2 that reliably amplified a *P. striiformis* specific fragment of the β-tubulin gene with a sensitivity of 10 pg of target DNA was selected for use. Analysis of a limited number of asymptomatic wheat plants from commercial fields found stripe rust infections to be rare. Comparison of spring cereals planted in winter wheat fields to spring cereals planted in spring wheat fields revealed higher infection rates within winter wheat fields. Real time quantitative PCR was also tested for *P. striiformis* detection using a previously developed Taqman probe and new primers based on the internal transcribed spacer 1 region. The detection limit was found to be 0.1 pg of *P. striiformis* DNA. Specificity of the assays were demonstrated using DNA from *P. striiformis*, other cereal leaf pathogens, as well as healthy wheat and barley leaves. The real-time PCR assay could be used in detecting latent infection and monitoring disease development in addition to conventional PCR.

Occurrence of downy mildew (*Peronospora viciae* f. sp. *pisi*) of pea in central Alberta. J.F. Liu, K.F. Chang, T. Cao, S.F. Hwang, and S.E. Strelkov. Department of Agricultural, Food and Nutritional Science, 410 Agriculture/Forestry Centre, University of Alberta, Edmonton, AB T6G 2P5, Canada; (K.F.C.) Agriculture Research Division, Alberta Agriculture and Rural Development, 6000 C & E Trail, Lacombe, AB T4L 1W1, Canada. *Peronospora viciae* f. sp. *pisi* is an obligate parasite that causes downy mildew of pea, which is an important field crop in Alberta, Canada. In July 2009, a survey for downy mildew was conducted in 37 commercial pea fields, located near Fort Saskatchewan, Vermillion and Mannville, Alberta. Disease incidence in the surveyed fields was 100%, although the severity of downy mildew infection varied significantly between fields and estimated yield losses ranged from 0 to 26%. The greatest yield loss (26%) was observed for a field near Fort Saskatchewan, with another two fields near Vermillion each estimated to have suffered a 13% yield loss. Yield losses in a group of four fields in the Mannville area exceeded 5%, while losses in the remaining fields ranged from 0 to less than 5%. Infected tissue samples were collected from the infested fields and will be used to characterize *P. viciae* populations from central Alberta. It appears that downy mildew is a major disease of pea in this province.

Ranman® 400 SC (cyazofamid) fungicide has potential for management of clubroot on a vegetable Brassica. K.C. Kalpana, M.R. McDonald, B.D. Gossen and S.M. Westerveld. *Department of Plant Agriculture, Crop Science Building, University of Guelph, 50 Stone Road East Guelph, ON N1G 2W1; (B.D.G.) Saskatoon Research Centre, Agriculture and Agri-Food Canada, 107 Science Place, Saskatoon, SK S7N 0X2, Canada, and (S.M.W.) Ontario Ministry of Agriculture, Food and Rural Affairs, Simcoe Resource Centre, 1283 Blueline Road, P.O. Box 587, Simcoe, ON N3Y 4N5.*

Clubroot, caused by the soil-borne biotroph *Plasmodiophora brassicae* (Woronin), is one of the most economically important diseases of Brassica crops. Studies were conducted to determine the efficacy of Ranman® (a.i. cyazofamid) against clubroot in controlled environment and field trials in 2008 and 2009. In growth cabinet trials, Shanghai pak choy (*Brassica rapa* L. subsp. *chinensis* (Rupr.) var. *communis* Tsen and Lee) was grown in plastic pots (conetainers) and Ranman® was applied as a drench (46 g a.i./100L water and 50 mL/conetainer) shortly after inoculation with the pathogen. Field studies were established in organic soil naturally infested with *P. brassicae.* The crop was seeded at five dates from May to September in both years and treated with a drench application of Ranman® (46 g a.i./100L water and 300 mL/m of row) in a 15-cm-wide band over the seed row within 3 days of seeding. In 2009, approximately 7 mm of irrigation water was applied onto the field trial within 24 hr of the Ranman treatment. Fungicide application provided 100% disease control in the growth cabinet experiments. In field studies, Ranman reduced disease severity in relation to the untreated control during the July seeding in 2008 and for the May, June, July and August seedings in 2009. We conclude that Ranman® has potential to be part of an IPM program to manage clubroot in vegetable Brassica crops.

Plant Pathology Society of Alberta – 30th Annual Business Meeting

Canmore, AB -- October 28, 2009

Minutes

Present:

Kan-Fa Chang	Sheau-Fang Hwang	Byron Puchalski
Michele Frick	André Laroche	George Turnbull
Denis Gaudet	Jackie Busaan	Kim Kenward
Bruce Gossen	Noryne Rauhala	Deb Clark
Michael Harding	Carol Pugh	Ralph Lange
Ron Howard	Sherry Lisowski	Jie Feng

1. Adoption of Agenda
   Motion to accept: Mike Harding, Denis Gaudet. Carried.

2. Adoption of Minutes of the Annual Meeting 2008 with year change and correction of minor typographical errors
   Motion to accept: Deb Clark, Jackie Busaan. Carried.

3. Financial Report – Noryne Rauhala
   Every year, the annual meeting has been making a profit and the bank balance is growing. There is $5100.00 in the chequing account at present, plus the investments.
   Motion to accept: Noryne Rauhala, André Laroche. Carried.
   There was a discussion regarding investing more of the money in the chequing account. A motion was made to leave a balance of $2000.00 in chequing (after paying the expenses of this meeting) and to transfer the rest to an investment instrument.
   Motion to accept: Deb Clark, Denis Gaudet. Carried.

4. Disease Survey Committee – Kelly Turkington - No report.
   Kim Kenward from BioVision reported that *Fusarium graminearum* on wheat was up to 6% in some cases and that it had been found on barley as well. HRS and Durham wheat had higher levels this year, especially on irrigated land. Higher levels of *F. graminearum* are being found even though environmental conditions this year were not favorable for disease

development in some areas because of dry conditions. The CGC is down grading grain quality also. Ron Howard will contact Paul Laflamme regarding future plans for coordinated *F. graminearum* field surveys in the province.

5. Historical Committee Report – Denis Gaudet
   The archives of the PPSA are held at University of Alberta, C/O Dr. J.P. Tewari. Past Presidents and other officers of the PPSA should submit important records such as PPSA Minutes, meeting programs, etc., to be stored in the archive when they complete their term of office, or as possible during their term. There is a new book being published on Plant Pathology in Canada. Denis handed out a pre-publication order form in order to get an expression of interest from PPSA members.

6. Terry Swanson Scholarship - Ron Howard
   A written report was handed out. The 2009 Dr. Terry Swanson Memorial Scholarship will be awarded to a student at the University of British Columbia. There is about $11,500 in the Scholarship Fund account.
   Motion to accept: Ron Howard, Ralph Lange. Carried.

   The 5-year GIC will mature in August 2010 and the interest rates are very low, so short term investments were recommended until the interest rates improve.
   Motion to accept: Ralph Lange, Denis Gaudet. Carried.

   In regards to renaming of Scholarship, there is a trend in the CPS to remove the person's name for whom the award was established and to state the actual purpose of the scholarship. The awards committee needs suggestions for a new name and there needs to be a clear differentiation from the Alberta Graduate Student Scholarship Award. The Scholarship will still rotate between the three universities (UBC, UA and UCR) and the terms of reference will remain the same. Member feedback favours hybridization with the memorial name and the descriptive title. One suggestion was: Swanson Award for Plant Pathology and Nematology. The awards committee will submit the suggestions at the next meeting for the members to ratify.

7. The Alberta Graduate Student Scholarship Award – Ron Howard
   The terms of reference have been changed to read all universities and because there are two new university designations (Mount Royal, Calgary, and Grant McEwen, Edmonton) with no Biology studies there may be a need to change to a list of accepted universities. There is some preliminary screening of applicants done by the universities themselves and the names are then forwarded to the awards committee. The consensus was to keep all universities listed and they can opt in or not. No names were forwarded for the 2009 award.
   There is still confusion with the PPSA and Terry Swanson award.

   There was a motion to increase the Best Student and Technician Awards for each meeting to $100 each. Discussion was also had on adding a post doc award, with the consensus being no.
   Motion to accept: Noryne Rauhala, Bruce Gossen. Carried.

8. Honorary Life Members
   No nominations for this year. A volunteer is needed to compile a list of Honorary Life Members for next year. Ralph Lange volunteered.

9. CPS Report – Sheau-Fang Hwang and Bruce Gossen.
   The CPS annual meeting was held in Winnipeg MB on June 21-25, 2009. The disease symposiums and tour made the meeting very successful. The Canadian Journal of Plant Pathology will have a new publisher. The CPS Board approved the new book on Plant Pathology in Canada, but recommended a professionally designed cover and the need for an index. The next meeting of the CPS will be at the University of British Columbia on June 20-23, 2010.

10. Western Forum on Pest Management – Bruce Gossen and Ron Howard.
    About 80 people attended the meeting in mid-October in Winnipeg, MB. There is a problem getting volunteers to compile disease situation reports and to sit as subcommittee chairs, etc. The canola chapter will not be updated every year now, but it does have links to other sites that are updated more often. The Western Committee on Plant Diseases is a good networking opportunity for practical pathologists. This year was relatively quiet on the disease front in Alberta and Saskatchewan, but Manitoba had higher levels of disease. There were interesting presentations for disease situation reports. Several crop disease slide sets are available to order on the Western Forum web site (www.westernforum.ca).

11. Future Meetings
    The Western Forum will be held in Lethbridge next year and we were invited to tie our annual meeting in with it. Some discussion was had in regards to a symposium in Lethbridge.
    a) 2010 – Lethbridge
    b) 2011 - Edmonton
    c) 2012 - Lloydminster
    Motion to accept: Bruce Gossen, André Laroche. Carried.

12. Election of Officers
    Nominations from the floor were as follows:
    André Laroche – President
    Michele Frick – Secretary
    Sheau-Fang Hwang – Vice-President
    Directors: Michael Harding, Ralph Lange, Peter Walsh
    Motion to accept: Denis Gaudet, Deb Clark. Carried.

13. Other Business
    Thanks to the local arrangements committee: Kelly Turkington, Noryne Rauhala, Deb Clark, and Jackie Busaan.

Thanks to the sponsors: BASF, Syngenta, 20/20 Seed Labs, BioVision, Pioneer, and Canadian Phytopathological Society.

14. Adjournment

Moved: Denis Gaudet.