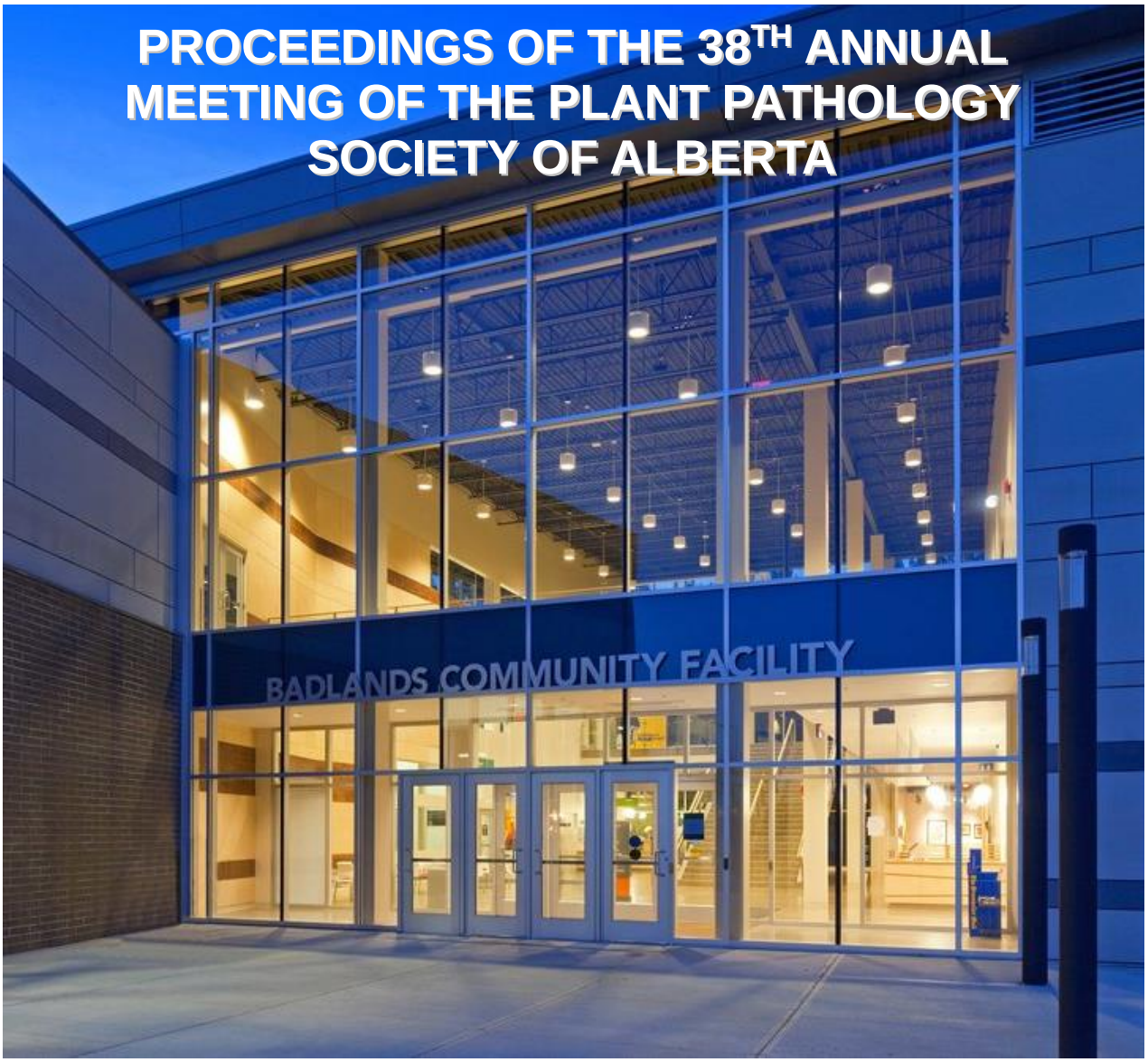
**38TH PPSA MEETING Drumheller, AB**
**November 6-8, 2017**

# PROCEEDINGS OF THE 38TH ANNUAL MEETING OF THE PLANT PATHOLOGY SOCIETY OF ALBERTA





**Sponsors** ..... **Page 1**
**Program** ..... **Page 2**
**Poster Presentations** ..... **Page 3**
**Abstracts** ..... **Pages 4-14**
**Business Meeting**

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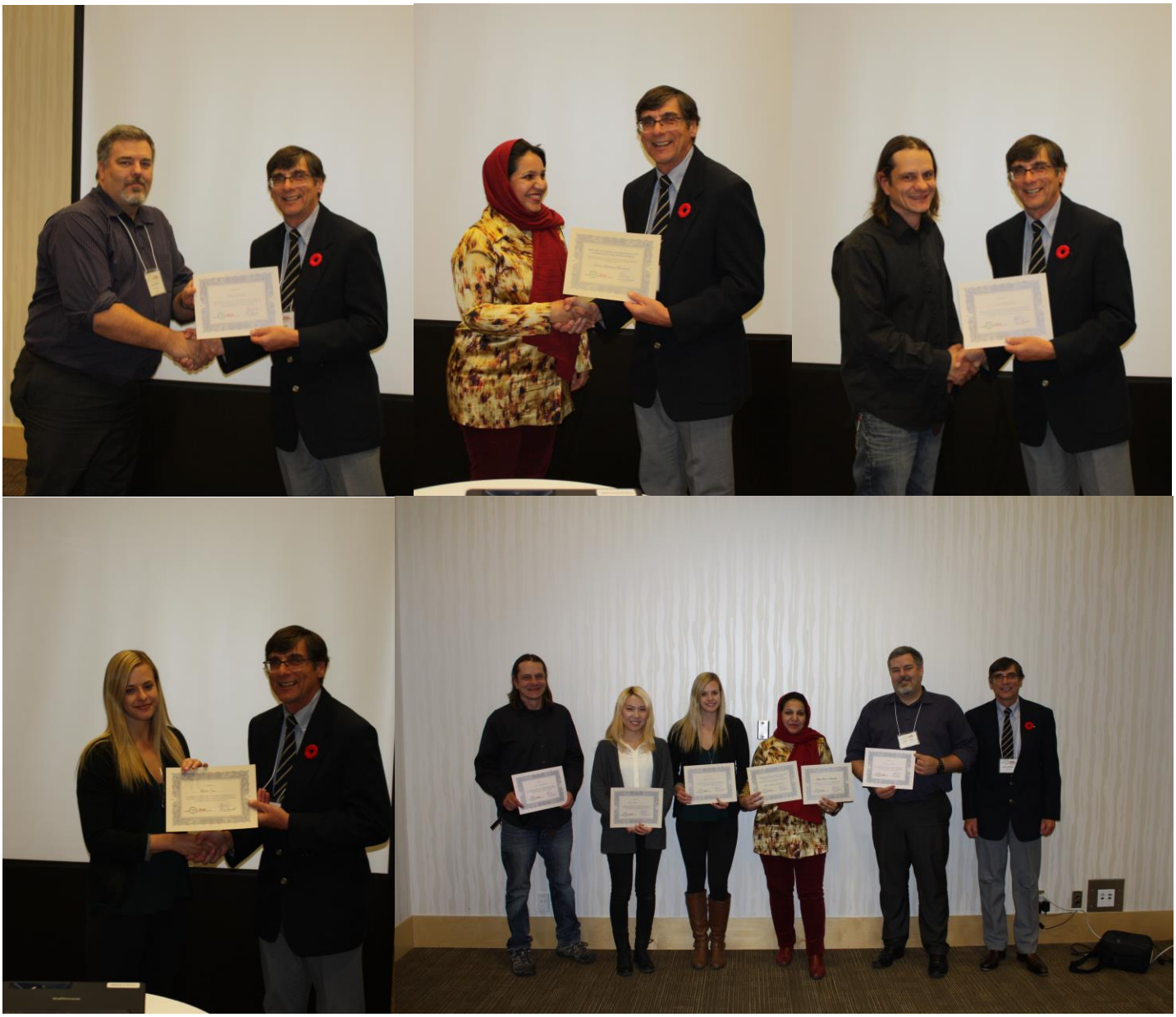


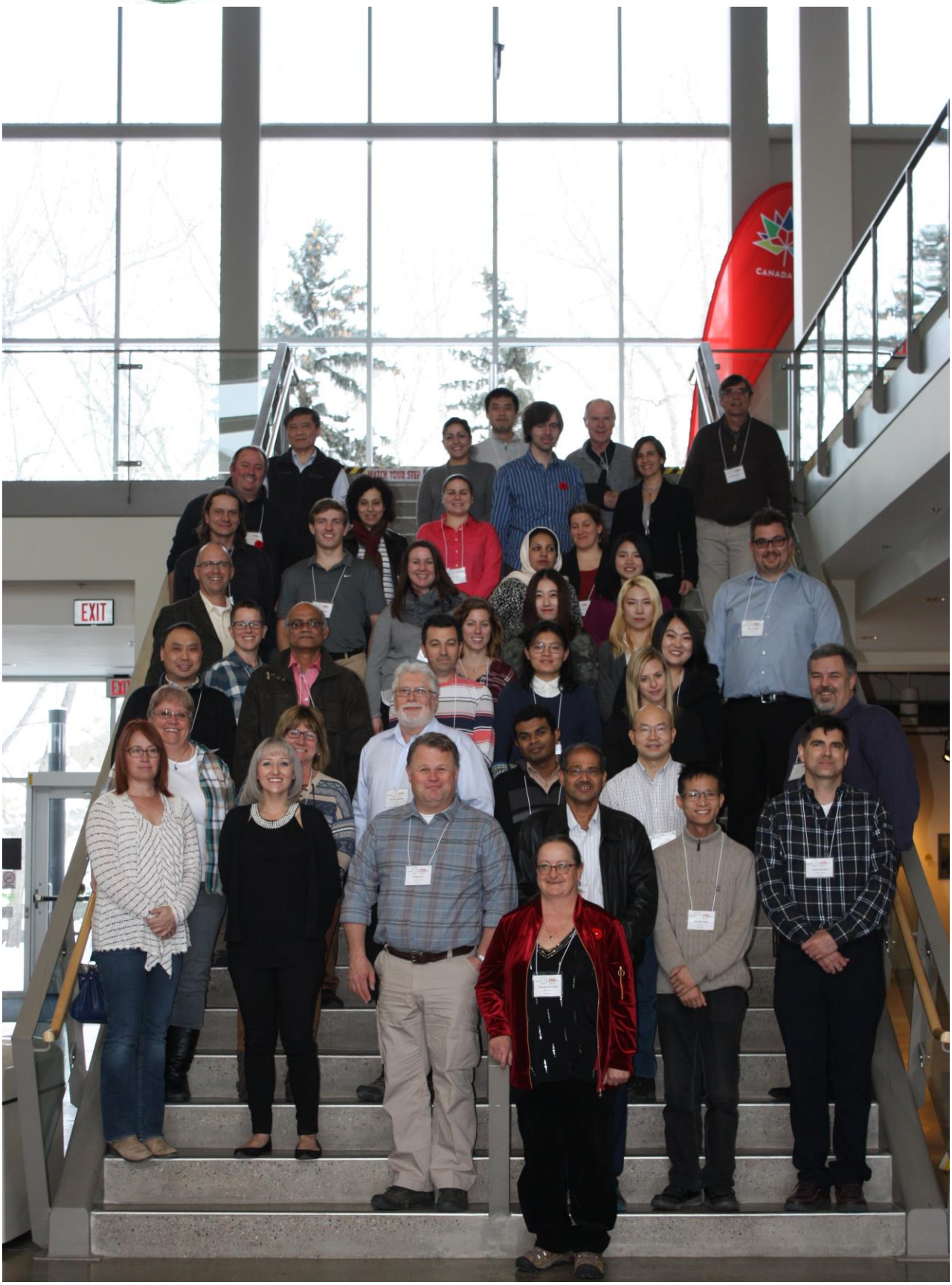
Upper left: Best technician presentation, Greg Daniels (Evaluation of species composition and fungicide resistance in Fusarium populations causing dry rot in Alberta potato storages).

Upper middle: Swanson Award and PPSA Scholarship Homa Askarian.working on clubroot at the University of Alberta supervised by Dr. Stephen Strelkov

Upper right: Best technician poster, Eric Amundsen (Wheat stripe rust in S. Alberta in 2017).

Lower left: Best student presentation, Nicole Fox (The evaluation of lime products as a clubroot management tool in canola.)

Best student poster:Xinyi Ma (Comparative study of the growth and colonization of host tissues by Ptr ToxA- and Ptr ToxB-producing isolates of *Pyrenophora tritici-repentis* (tan spot of wheat)).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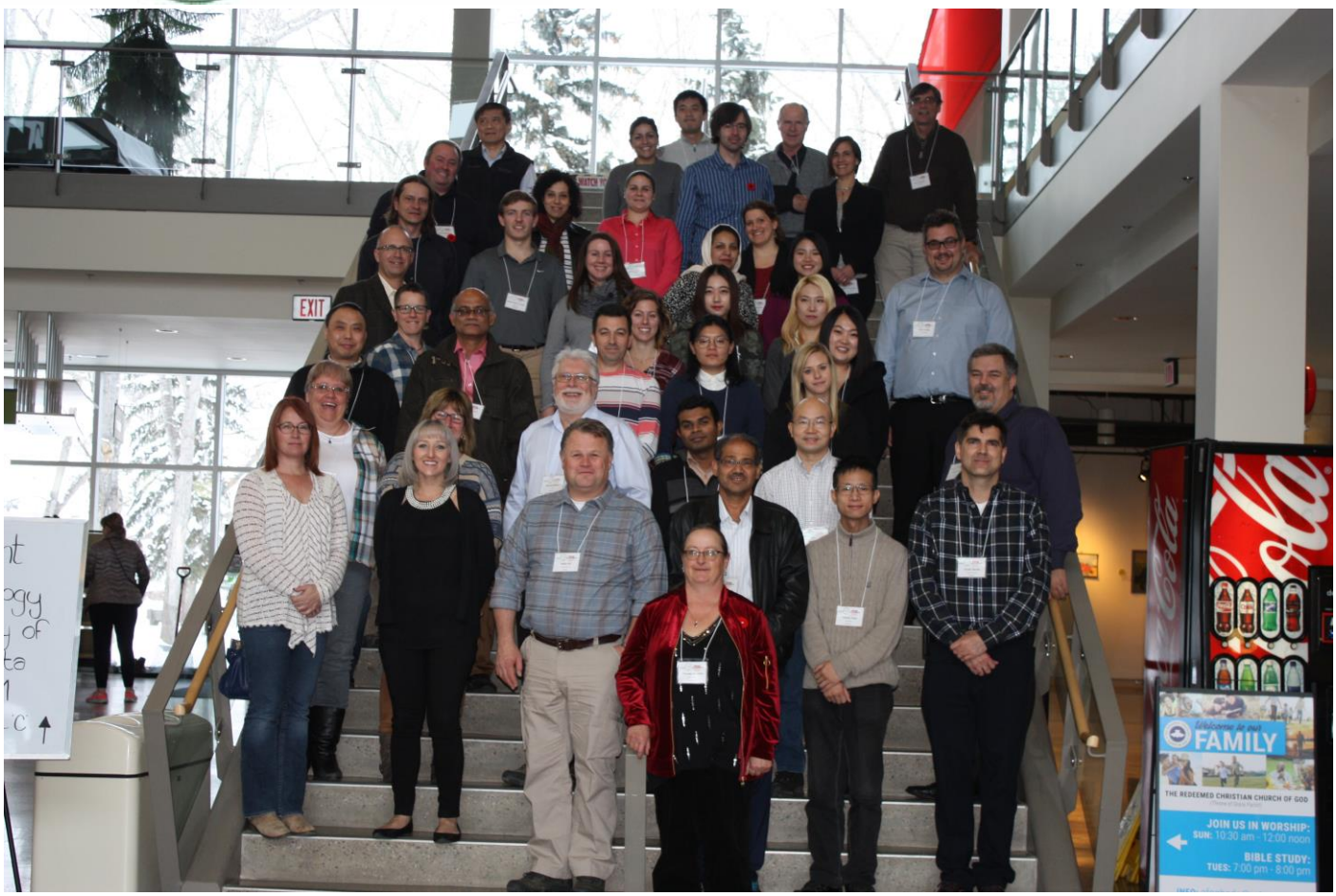
CANADA




**In attendance:** Andrea Botero, Blake Hill, Bohan Wei, Bruce Gossen, Carol Pugh, Charitha Jayasingehege, Cindy McConnell, Denis Gaudet, Dustin Burke, Enid Perez-Lara, Eric Amundsen, Gabriella Toscano de Araujo, Greg Daniels, Haitan Yu, Homa Askarian, Jackie Busaan, Jie Feng, Jim Calpas, Kequan Xi, Kher Zahr, Kieran McCormack, Krishan Kumar, Krista Zuzak, Kurt Anaka, Michael Harding, Michael Holtz, Nicole Calliou, Nicole Fox, Noryne Rauhala, Nora Foroud, Qinqin Zhou, Zuixing Zhou, Reem Aboukhaddour, Ron Howard, Sasha Waterman, Therese Despins, Vachaspati Mishra, Xinyi Ma, Yalong Yang, Yixiao Wang, Zhiyu Yu,

## PPSA 2017 MEETING PROGRAM

### Monday, November 6th

| | | |
|---|---|---|
| 18:00 – 20:00 | Registration & Poster Set Up | Pre-function area (2nd Level) |
| 18:30 – 21:30 | Informal welcome mixer | Pre-function area (2nd Level) |

### Tuesday, November 7th

| | | | |
|---|---|---|---|
| 08:30 – 09:00 | | Registration & Poster Set Up | Pre-function area (2nd Level) |
| 08:30 – 09:00 | | Poster set-up | 1/3 Ballroom (2nd Level) |
| 09:00 – 09:15 | | Welcome & Introductions | 1/3 Ballroom (2nd Level) |
| | | Paper session I | 1/3 Ballroom (2nd Level) |
| 09:20 – 09:45 | A1 | **FEATURED SPEAKER** B. Gossen *et al.* | Rapid decline in the sensitivity to strobilurin fungicides in *Mycosphaerella pinodes* |
| 09:45 – 10:00 | A2 | **STUDENTSPEAKER** N. Fox *et al.* | The evaluation of lime products as a clubroot management tool |
| 10:00 – 10:15 | A3 | **STUDENTSPEAKER** G.T. de Araujo *et al.* | Assessment of powdery mildew dose-response in a compatible interaction in wheat |
| 10:15 – 10:45 | | Refreshment break | 1/3 Ballroom (2nd Level) |
| | | Paper session II | 1/3 Ballroom (2nd Level) |
| 10:45 – 11:10 | A4 | **FEATURED SPEAKER** N. Foroud (Ryabova *et al*) | Ethylene mediated resistance to Fusarium head blight and seedling blight of wheat |
| 11:10 – 11:25 | A5 | **TECHNICIAN SPEAKER** T. Despins | Common bunt: a priority disease in Canada |
| 11:25 – 11:40 | A6 | **TECHNICIAN SPEAKER** D. Burke *et al.* | Efficacy of chemical fungicides against white mold of dry edible bean in southern Alberta |
| 11:40 – 11:55 | A7 | **TECHNICIAN SPEAKER** G. Daniels *et al.* | Evaluation of species composition and fungicide resistance in *Fusarium* populations causing dry rot in Alberta potato storages. |
| 12:00 – 13:30 | | Lunch buffet (provided) | 1/3 Ballroom (2nd Level) |
| | | Paper session III | 1/3 Ballroom (2nd Level) |
| 13:35 – 14:00 | A8 | **FEATURED SPEAKER** R. Aboukhaddour *et al.* | Prevalence and virulence of stripe rust in southern Alberta |
| 14:00 – 14:15 | A9 | M. Harding *et al.* | Fusarium head blight in Alberta: looking back 20 years |
| 14:15 – 14:30 | A10 | J. Calpas *et al.* | Review of research priority and capacity within Alberta Agriculture and Forestry |
| 14:30 – 14:45 | A11 | M. Harding *et al.* | Diseases of field pea in Alberta in 2017 |
| 14:45 – 15:00 | | Refreshment break | 1/3 Ballroom (2nd Level) |
| 15:00 – 16:30 | | Poster session | 1/3 Ballroom (2nd Level) |
| 18:00 – 18:30 | | Cocktails | Pre-function area (2nd Level) |
| 18:30 – 21:00 | | Banquet & Awards Program | 1/3 Ballroom (2nd Level) |

### Wednesday, November 8th

| | | |
|---|---|---|
| 08:30 – 10:00 | Business meeting | 1/3 Ballroom (2nd Level) |
| 10:00 – 10:30 | Refreshment break | 1/3 Ballroom (2nd Level) |
| 10:30 – 13:00 | Check out and lunch on your own | |
| 13:00 – 16:00 | Royal Tyrell Museum (admission = $18) | Meet at Museum Lobby |

## Poster Presentations (green shading = student; red shading = technician)

| ID# | Presenter | Title |
|---|---|---|
| A12 | H. ASKARIAN | The identification of new pathotypes among single-spore isolates of *Plasmodiophora brassicae* derived from field populations that can overcome resistance in canola (*Brassica napus*) |
| A13 | N. FOROUD (D. GONZÁLEZ-PEÑA FUNDORA) | Establishment of a *Brachypodium distachyon* cell suspension culture: a molecular plant pathology tool. |
| A14 | M.D. HOLTZ | Historical distribution of populations of *Plasmodiophora brassicae* in Alberta |
| A15 | M.D. HOLTZ (S. Xue) | Three SNPs in a CCHC-type zinc finger protein gene are linked to a net form net blotch resistance 3H QTL in Shyri |
| A16 | C.P. JAYASINGHEGE | Understanding the role of auxin in clubroot of crucifers |
| A17 | K. KUMAR | Stripe Rust management in winter wheat using cultivar resistance and fungicide |
| A18 | X. MA | Comparative study of the growth and colonization of host tissues by Ptr ToxA- and Ptr ToxB- producing isolates of *Pyrenophora tritici-repentis* (tan spot of wheat) |
| A19 | V. MISHRA (O. ELLOUZ) | Evaluation of two reactive gas-based systems for CGMMV management in commercial greenhouse cucumber production |
| A20 | E. PEREZ-LARA | Development of an optimized next-generation DNA sequencing approach for fungal plant pathogens using the Illumina MiSeq |
| A21 | Y. WANG | Baseline sensitivity of *Leptosphaeria maculans* isolates from Alberta to pyraclostrobin |
| A22 | K. XI | Stripe rust on wheat and barley in central Alberta during 2015 and 2016 |
| A23 | Y. YANG | Using the dimorphic sequences in *Plasmodiophora brassicae* genes as markers for pathotype differentiation |
| A24 | H.T. YU | Virulence of *Rhizoctonia solani* isolates from field pea and other crops in Alberta, Canada |
| A25 | Q. ZHOU | A molecular marker for specific detection of new pathotype 5-like strains of *Plasmodiophora brassicae* in canola |
| A26 | K.A. ZUZAK | Evaluation of qPCR primers for clubroot diagnosis |
| A27 | B.D. GOSSEN (F. YU) | Genotyping-by-sequencing reveals three QTL for clubroot resistance to six pathotypes of *Plasmodiophora brassicae* in *Brassica rapa*. |
| A28 | B.D. GOSSEN (F. AL-DAOUD) | A shift in the pathotype of *Plasmodiophora brassicae* at a site in Ontario. |
| A29 | B.D. GOSSEN | Breakdown of clubroot resistance in Quebec provides an inference for resistance in Alberta. |
| A30 | B.D. GOSSEN | Distribution of root rot on pea and lentil crops on the Canadian prairies, 2016. |
| A31 | E. AMUNDSEN | Prevalence and virulence of stripe rust in southern Alberta. |
| A32 | K. McCORMACK | *Tsn1* in Canadian winter and durum wheat germplasm. |
| A33 | T.B. HILL | Survey for blackleg on canola in southern Alberta in 2017. |
| A34 | J. FENG | Summary of Samples Submitted to the Alberta Plant Health Lab |

# Oral Paper Abstracts

A1 – **Rapid decline in the sensitivity to pyraclostrobin fungicide in *Mycosphaerella pinodes*.** B. D. GOSSEN AND M. R. MCDONALD. *Agriculture and Agri-Food Canada, Saskatoon Research and Development Centre, 107 Science Place, Saskatoon, SK, S7N OX2, Canada; (M.R.M.) Department of Plant Agriculture, University of Guelph, Guelph, ON, N1G 2W1, Canada;*

Mycosphaerella blight, caused by *Mycosphaerella pinodes* (Berk. & Blox.) Vestergr., is a destructive disease of field pea on the Canadian prairies that occurs in almost every field in most years. Genetic resistance is not available, so severity is managed primarily with application of foliar fungicides. Strobilurin fungicides have been used for management of mycosphaerella blight since their introduction to western Canada in 2003. Sensitivity of baseline isolates to pyraclostrobin (a widely used strobilurin) has been assessed previously, with $EC_{50}$ values for mycelial growth ranging from 0.03 to 0.3 mg $L^{-1}$ and a discriminatory dose of 5 mg $L^{-1}$. Of the 324 isolates collected in Canada and the northern USA in 2010 and 2011, 8% (all from Alberta or Saskatchewan) were insensitive to pyraclostrobin using that discriminatory concentration. In isolates of *M. pinodes* collected in 2013-2016 from sites across the field pea production region of Saskatchewan, 72% (46 of 64) were insensitive. This observation, taken together with concurrent studies that demonstrated a high degree of cross-sensitivity between pyraclostrobin and azoxystrobin, indicated that effective management of mycosphaerella blight with solo applications of these two widely used fungicides is likely no longer possible in Saskatchewan.

Reviewers: F. Al-Daoud (University of Guelph) and L. Buchwaldt (AAFC, Saskatoon)

A2 – **The evaluation of lime products as a clubroot management tool in canola.** N.M. Fox, S.F Hwang, V.P. Manolii, G. Turnbull, and S.E. Strelkov. *Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5, Canada; (S.F.H., G.T) Crop Diversification Centre North, Alberta Agriculture and Forestry, Edmonton, AB, T5Y 6H3, Canada.*

Clubroot (*Plasmodiophora brassicae* Wor.) is a soil-borne disease that has become a constraint to canola (*Brassica napus* L.) production in Alberta, Canada. The disease is managed primarily by the planting of clubroot resistant cultivars, but this resistance already has been overcome in over 60 fields in the province. Disease development is known to favour acidic soils; therefore, increasing soil pH could reduce clubroot severity in infested soils and serve as another management tool. The efficacy of hydrated lime products in reducing clubroot severity was assessed in replicated field plot experiments in central Alberta in 2017. The addition of moderate to high rates of hydrated lime significantly reduced clubroot severity and increased above-ground biomass in a susceptible canola cultivar at 8 weeks after planting. At the highest application rate, lime treatment reduced the clubroot disease severity index by 35-91%, while increasing above-ground plant biomass by 58-116%. A greenhouse study currently is underway to assess the efficacy of hydrated lime in reducing clubroot severity in susceptible and moderately resistant canola cultivars, under different application rates and concentrations of inoculum.

Reviewers: Dr. Tiesen Cao and Dr. Alireza Akhavan

A3 – **Assessment of powdery mildew dose-response in a compatible interaction in wheat.** G.T. ARAUJO, E. AMUNDSEN, M. FRICK, R. ABOUKHADDOUR, D.A. GAUDET, B.L. SELINGER, AND A. LAROCHE. *Agriculture and Agri-Food Canada, Lethbridge Research and Development Centre, Lethbridge, AB, T1J 4B1 Canada; (B.L.S.) University of Lethbridge, Department of Biological Sciences,*

*Lethbridge, AB, T1K 3M4 Canada.* In Western Canada, wheat is one of the most important cultivated crops. However, it can be infected by a common fungal disease called powdery mildew, which is caused by *Blumeria graminis f. sp. tritici* (Bgt). Powdery mildew pathogen can cause significant yield losses and decrease of grain quality by reducing photosynthetic area. This study has for objective to determine the minimum number of spores required to cause an infestation of powdery mildew in a susceptible wheat variety under controlled growth chamber conditions by rating the disease severity. The wheat plants were inoculated with different concentrations (0, $10^3$, $10^4$, $10^5$, $10^6$, and $10^7$ spores/ ml) of powdery mildew spores, and disease severity was rated after 9, 16, and 21 days. The disease severity caused by Bgt pathogen varies mainly with the host susceptibility and weather conditions, but also, the quantity of inoculum seems to be really important. The optimal weather conditions for powdery mildew are moderate to warm temperatures and high humidity. The disease severity was clearly progressing with time, being relatively high (25-80%) for the concentrations $10^5$, $10^6$, and $10^7$ spores/ ml on the last rating date. The assessment of the powdery mildew disease and the environmental conditions are two important components to predict potential epidemics.

A4 – **Ethylene mediated resistance to fusarium seedling and head blight of wheat.** N.A. FOROUD, R.K. GOYAL, D. RYABOVA, R. PORDEL, A. ERANTHODI, Y.T. YAO, I. KOVALCHUK AND S. CHATTERTON. *Lethbridge Research and Development Centre, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada; (I.K.) Department of Biological Sciences, University of Lethbridge, Lethbridge, AB, Canada.* Ethylene is a gaseous plant hormone involved in both plant defence and development. Often ethylene-mediated plant defence responses to necrotrophic fungi involve synergistic interactions with the jasmonate signalling pathway. On the other hand, ethylene is also an inducer of senescence and cell death, which could be beneficial for some invading necrotrophic pathogens. *Fusarium graminearum* is a hemibiotrophic pathogen, with both biotrophic and necrotrophic phases, that can infect wheat seedlings and inflorescence and cause fusarium seedling blight (FSB) and head blight (FHB), respectively. Interestingly, the role of ethylene signalling in the host-response to *Fusarium* species is unclear: some studies indicate that ethylene mediates resistance, while others have shown that it is associated with susceptibility. In an effort to understand the discrepancies in the literature, a series of FHB and FSB experiments involving exogenous hormone applications were carried out. The effects of ethylene-inhibitor or -enhancer treatments on the FHB responses suggest that ethylene signalling promotes resistance: ethylene inhibition broke down resistance in three resistant wheat genotypes, whereas enhancer treatments resulted in reduced susceptibility in three susceptible genotypes. A similar trend was observed in an FSB assay where one resistant and one susceptible genotype were screened. Additional work is underway to study the effect of timing in this interaction.

A5 – **Common bunt: a priority disease in Canada.** T. DESPINS, R. GRAF AND R. ABOUKHADDOUR. *Agriculture and Agri-Food Canada, Research Centre, Lethbridge, AB, T1J 4B1, Canada.* Common bunt of wheat, caused by *Tilletia spp,* once was a destructive disease of wheat in Canada, and today is controlled by fungicides as seed treatments. Common bunt is still one of the top priority diseases to which Canadian government invests to breed resistance against. The disease if present or unmanaged causes extreme losses in wheat; infection levels of 1% or less can cause grain to be downgraded to feed class, or rendering yield unmarketable. Lethbridge is a unique place where winter and spring wheat nurseries are established every year since 1980 to evaluate thousands of breeding material for their reaction to this disease. In this presentation the aim is to give an overview the disease and the several factors involved in establishing a successful bunt nursery. As a result of this effort recently registered bunt resistant cultivars will be highlighted.

A6 – **Efficacy of chemical fungicides against white mold of dry edible bean in southern Alberta.** D.A. Burke, M.W. Harding G.C. Daniels, C.A. Pugh and T.B. Hill. *Alberta Agriculture and Forestry, Crop Diversification Centre South, 301 Horticultural Station Road East, Brooks, AB T1R 1E6, Canada.*

Relative efficacy of foliar fungicide treatments against white mold (Sclerotinia rot) caused by *Sclerotinia sclerotiorum* (Lib.) de Bary in dry edible bean (*Phaseolus vulgaris* L.) were evaluated in replicated field experiments in southern Alberta from 2014-16. Fungicide was applied at 50% bloom. White mold incidence and severity were determined on subplots prior to senescence and seed yield was subsequently determined. Disease levels varied with each site-year, but based on the incidence and severity of disease, as well as seed yield, a number of registered products performed equal to or better than the industry standard fungicides. A cost per hectare analysis based on current retail prices, indicated a relatively significant price difference between some products.

Reviewers: Mr. Ted Harms and Dr. Darcy Dreidger

A7 – **Evaluation of species composition and fungicide resistance in *Fusarium* populations causing dry rot in Alberta potato storages.** G.C. Daniels, D. Johnson, K. Haile, D.A. Burke, C.A. Pugh, and M.W. Harding. *Alberta Agriculture and Forestry, Crop Diversification Centre South, 301 Horticultural Station Road East, Brooks, AB T1R 1E6, Canada; (D.J., K.H.) Department of Biological Sciences, University of Lethbridge, 4401 University Drive, Lethbridge, AB T1K 3M4, Canada.*

Dry rot on potato (*Solanum tuberosum* L.) tubers, caused by *Fusarium spp.* is a common problem in stored potatoes. At least 10 species of *Fusarium* can cause dry rot on wounded tubers, and many of them vary in their sensitivity to post-harvest fungicides. This project was initiated to characterize the species causing dry rot that are common to Alberta potato storages, and to evaluate their fungicide sensitivities. Over 320 *Fusarium* isolates were collected between 2011 and 2015 and have been identified to species, and evaluated for their sensitivities to thiabendazole, fludioxonil and difenoconazole. Results from a subset of the most recently collected 15 isolates are presented here. *Fusarium sambucinum* Fuckel remained the most commonly occurring species causing dry rot in Alberta. Based on $IC_{50}$ values, insensitivity to thiabendazole was more common in the 15 isolates while most or all were sensitive to fludioxonil and difenoconazole.

Reviewers: Ms. Shelley Barkley and Dr. Oualid Ellouz

A8 – ***Prevalence and virulence of stripe rust in southern Alberta.*** E. Amundsen, K. McCormack, H. Randhawa and R. Aboukhaddour. *Agriculture and Agri-Food Canada, Lethbridge Research & Development Centre, Lethbridge, Alberta T1J 4B1, Canada*

Stripe rust, caused by *Puccinia striiformis f. sp. tritici Erikss.*, is a destructive wheat disease worldwide. Disease incidence and severity was assessed in commercial wheat fields in southern Alberta in November 2016 through August 2017. In total, 74 commercial wheat fields were surveyed in 2016-2017 growing seasons. The pathogen overwintered in Alberta over that time. In November 2016, 7 fields out of 10 were rated severe or moderate, but during 2017, only one field out of 64 was reported to have severe infection, and 75% of the surveyed fields were reported symptomless. The hot dry weather throughout the summer coupled with fungicide applications may have resulted in low levels of stripe rust in 2017. A set of wheat differentials included 20 near isogenic lines in the Avocet background with various stripe rust resistance genes, including the null, were seeded in two locations in southern Alberta

and in one location in British Columbia. Under natural infection it was determined that Yr5, and Yr15 were still effective against existing races, however Yr17 and YrSP were partially defeated in Lethbridge and Yr18 was defeated in Creston. Genetic resistance to stripe rust is precarious and the need for genetic resistance in new wheat cultivars depends on reliable knowledge of the pathogen populations.

Reviewers: Dr. Michael Harding and Mr. Greg Daniels

A9 – **Monitoring *Fusarium graminearum* in Alberta: Looking back 20 years.** M.W. Harding, R.J. Howard, J. Feng, P. Laflamme, T.K. Turkington, T. Gräfenhan and G.C Daniels. *Alberta Agriculture and Forestry, Crop Diversification Centre South, 301 Horticultural Station Road East, Brooks, AB T1R 1E6, Canada; (R.J.H.) RJH Research Solutions, P.O Box 1456, Brooks, AB T1R 1C3, Canada; (J.F.) Alberta Agriculture and Forestry, Crop Diversification Centre North, 17507 Fort Road NW, Edmonton, Alberta, T5Y 6H3, Canada; (T.K.T.) Agriculture and Agri-Food Canada, Lacombe Research and Development Centre, 6000 C and E Trail, Lacombe, AB T4L 1W1, Canada; (T.G.) Canadian Grain Commission, Grain Research Laboratory, 196 Innovation Drive, Richardson Centre, Winnipeg, Manitoba R3T 6C5, Canada.*

*Fusarium graminearum* (Schwabe) is a major pathogen of small grain cereals and corn. Infections causing head blight in cereals reduce yield, grade and market acceptance. The pathogen was first reported in Alberta in 1989 and in 1999 it was added to Alberta's *Agricultural Pests Act*. Efforts to monitor its presence and spread in Alberta have been conducted every three to five years since 1995. A total of six surveys for *F. graminearum* have been conducted over the past 20 years. The pathogen was not reported in a 1995-97 survey, and only in five or six contiguous counties in southern Alberta in 2001-03 and again in 2006. After 2006, changes in *F. graminearum* prevalence, incidence and distribution were documented in 2010 and 2015 surveys, and by 2016 the pathogen was present in over 45% of counties and over 25% of fields sampled. Additionally, the pathogen was detected in central and northern Alberta in 2015 and 2016. These survey data show that over this 20 year period the risk and threat of *F. graminearum* progressed from non-detectable, to a southern Alberta problem, to a widely distributed issue for Alberta cereal and corn producers.

Reviewers: Dr. Manjula Bandara and Dr. Xiangfeng Meng

A10 – **Review of research priority and capacity within Alberta Agriculture and Forestry.** J. CALPAS. *Alberta Agriculture and Forestry, 5030 – 50 Street, Lacombe, AB T4L 1W8, Canada.* In January 2017, Alberta Agriculture and Forestry initiated a research review to establish strategic direction. The review aimed to address the following two questions: Are we doing the right things? Are we doing the right things in the right way? The review helped identify opportunities become more focused, relevant, and aligned with the priorities of the Government of Alberta and stakeholders. The four areas were identified for improvement were prioritization, exposure and publicity of results, nature of collaborations, and sustainability of resources and internal processes. Implementation of the recommendations through leadership and performance measures will help Alberta Agriculture and Forestry researchers prioritize, focus and collaborate in a sustainable framework with minimal barriers.

A11 – **Diseases of field pea in Alberta in 2017.** S. Chatterton, M.W. Harding, R. Bowness, C. Vucurevich, T. Dubitz and J. Nielson. *Alberta Agriculture and Forestry, Crop Diversification Centre South, 301 Horticultural Station Road East, Brooks, AB T1R 1E6, Canada; (S.C., C.V) Agriculture and Agri-Food Canada, Lethbridge Research and Development Centre, 5403 1st Avenue South, Lethbridge AB T1J 4B1, Canada; (R.B., T.D.) Alberta Agriculture and Forestry, Lacombe Research Centre, 6000 C. E. Trail, Lacombe, AB T4L 1W1, Canada.*

Diseases of field pea were evaluated in 169 fields across Alberta in 2017. Mycosphaerella blight and bacterial blight were rated in 1 m of row at each location. Root rot ratings were performed on five plants at each location. Mycosphaerella blight, bacterial blight and root rot were present in 67%, 60% and 95% of fields respectively. Incidence and severity of blights were approximately 45% and 0.4, while root rot incidence and severity were 75% and 3 respectively. When compared to 2016, a nominal 3% increase in root rot prevalence was observed in 2017 while incidence and severity each increased by 13%. One encouraging statistic was that a 25% drop in roots with high disease severity (>3) has occurred since 2014. Therefore, while prevalence and incidence may not be dropping, the number of fields with severe economic loss appears to be on the decline.

Reviewers: Dr. Manjula Bandara and Dr. Xiangfeng Meng

# Poster Abstracts

A12 – **The identification of new pathotypes among single-spore isolates of *Plasmodiophora brassicae* derived from field populations that can overcome resistance in canola (*Brassica napus*).** H. Askarian, S.F. Hwang, A. Akhavan, V.P. Manolii, T. Cao 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 Forestry, Edmonton, AB T5Y 6H3, Canada.*

Clubroot, caused by *Plasmodiophora brassicae* Wor., is an important soil-borne disease of canola (*Brassica napus* L.) in Canada. Field populations of *P. brassicae* can be a mixture of pathotypes, making assessments of the genetics of host-pathogen interactions challenging. Thirty-four single-spore isolates were purified from nine populations of the pathogen collected from clubroot resistant (CR) canola cultivars. The virulence patterns of these isolates were assessed on the 13 host genotypes of the Canadian Clubroot Differential (CCD) Set, which includes the differentials of Williams and Somé et al. Eleven pathotypes were identified on the CCD Set, while the hosts of Williams and Somé et al. enabled identification of seven or three pathotypes, respectively. In some cases, pathogen populations were mixtures of isolates virulent or avirulent on CR canola. Pathotype H, as defined on the CCD Set, was predominant. This pathotype cannot overcome resistance and corresponded to the original pathotypes $P_2$ and 3, respectively, as per Somé et al. and Williams. In contrast, the CCD pathotypes A, D, Q, R, S, T, U, and X all were virulent on CR canola. Various new pathotypes, not reported in Canada previously, were identified among the isolates tested. The results suggest that genetically homogeneous single-spore isolates provide a more complete picture of the *P. brassicae* pathotype structure.

Reviewers: Leonardo Miguel Galindo González and Charitha Pramod Jayashege

A13 – **Establishment of a *Brachypodium distachyon* cell suspension culture: a molecular plant pathology tool.** D. GONZÁLEZ-PEÑA FUNDORA, D. RYABOVA, A. ERANTHODI., P. MAHESHWARI, N. THAKOR AND N.A. FOROUD. *Lethbridge Research and Development Centre, Agriculture and Agri-Food Canada, Lethbridge, AB, Canada; (N.T.) Department of Biological Sciences, University of Lethbridge, Lethbridge, AB, Canada.* *Brachypodium distachyon* (Bd21) has emerged in the last 2 decades as a plant model for wheat and other monocot. *B. distachyon* is a diploid plant with small and sequenced genome which allows a feasible tool for genomic and proteomic studies. Some molecular pathology experiments can be challenging in wheat plants due to the life cycle and genomic complexity

of this crop. Furthermore, many variables can be difficult to control in greenhouse experiments. In order to overcome some of these challenges we have recently established a Bd21 cell suspension culture using calli derived from immature embryos using a previously reported method. Our objective is to establish high-throughput, reproducible protocols to investigate the cellular/molecular response of the Bd21 cells to different pathogen-associated molecular patterns and effector proteins. Information collected from these experiments could be later validated in the plant and in related cereal crops.

A14 – **Historical distribution of populations of *Plasmodiophora brassicae* able to overcome clubroot resistance in Alberta**. M.D. Holtz, S.F. Hwang, V. Manolii, and S.E. Strelkov. *Field Crop Development Centre, Alberta Agriculture and Forestry, 5030-50 Street, Lacombe, AB T4L 1W8, Canada; (S.F.H.) Alberta Agriculture and Forestry, Crop Diversification Centre North, 17507 Fort Road, Edmonton, AB, T5Y 6H3, Canada; (V.M, S.E.S.) University of Alberta, Department of Agricultural, Food and Nutritional Science, 116 St. and 85 Ave, Edmonton, AB, T6G 2P5, Canada.*

Clubroot, caused by *Plasmodiophora brassicae* Wor., was first identified as a disease of canola *(Brassica napus* L.) in Alberta in 2003. Initially, clubroot was localized around the Edmonton region, but has since spread to more than 30 counties in the province. Clubroot resistant (CR) canola varieties were first released in 2009. Highly virulent *P. brassicae* strains able to overcome this resistance, however, were found in 2013 in Westlock County, northwest of Edmonton. Initial analysis of these strains indicated that they belonged to a population that was genetically distinct from other *P. brassicae* strains. Using molecular markers developed to distinguish members of the pathogen population virulent on CR canola from the more common population, samples of *P. brassicae* collected in Alberta from 2005-2016 were examined to determine the historical occurrence and distribution of these virulent strains. Root galls from 219 samples were examined. Ten samples were found to have been infected with members of the population virulent on CR canola. These samples were found in Flagstaff County starting in 2008, Westlock County starting in 2009, the County of Vermillion River in 2011, and Red Deer County in 2014. Although relatively uncommon, members of this population were relatively widespread, occurring at locations 170 km apart prior to the release of CR canola. This widespread distribution may have helped hasten the breakdown of CR canola varieties.

Reviewers: Shiming Xue and Erinn Smith

A15 – **Three SNPs in a CCHC-type zinc finger protein gene are linked to a net form net blotch resistance 3H QTL in Shyri**. S. Xue, M.D. Holtz, J. Busaan, T.K. Turkington, and J. Zantinge. *Field Crop Development Centre, Alberta Agriculture and Forestry, 5030-50 Street, Lacombe, AB T4L 1W8, Canada; (J.B., T.K.T) Agriculture and Agri-food Canada, Lacombe Research and Development Centre, Lacombe, AB T4L 1W1, Canada.*

Net form net blotch (NFNB), caused by *Pyrenophora teres* f. *teres* (Ptt), is one of the major barley leaf diseases in North America. Identifying diagnostic molecular markers linked to NFNB resistance QTLs/genes is necessary for improving popular barley varieties which contain insufficient resistance to NFNB. Through genotyping by sequencing (GBS), we found three SNPs in one CCHC-type zinc finger (zinc knuckle) family protein gene that are linked to a QTL for adult plant NFNB resistance on chromosome 3H in ‘Shyri’. Physical mapping indicated that this shyri_QRptt3 QTL is different from the 3H QTLs previously reported. The QTL shyri_QRptt3 accounted for up to 20.6% of phenotypic variations in NFNB severity, and the lines containing this QTL showed an average of 51% less NFNB than the lines without this QTL. This QTL is an additional major QTL for adult plant NFNB resistance after the two adult plant resistance 6H QTLs reported previously by two research groups. Whether the

CCHC-type zinc finger (zinc knuckle) family protein gene is involved in the resistance remains a question for investigation.

Reviewers: Lori Oatway and Erinn Smith

A16 – **Understanding the role of auxin in clubroot of crucifers**. C.P. Jayasinghege, V.P. Manolii, J.A. Ozga, 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; (S.F.H.) Alberta Agriculture and Forestry, Crop Diversification Centre North, 17507 Fort Road, Edmonton, AB T5Y 6H3, Canada.*

Infection by the obligate parasite *Plasmodiophora brassicae* Wor., the causal agent of clubroot disease of crucifers, results in the development of root galls. These galls reduce water and nutrient uptake by the affected plants, stunting above-ground growth. The plant hormone auxin is believed to be among the hormones utilized by this pathogen in gall development. Therefore, it may be possible to suppress gall development by modulating auxin signaling in the plant host. Members of the TIR1/AFB family of F-box proteins act as plant auxin receptors. Of a total of six TIR1/AFB family members in *Arabidopsis thaliana* (L.) Heynh. (TIR1 and AFB1 to AFB5), only TIR1 and AFB2 are primarily responsible for auxin sensitivity in roots. A previous report indicated that the mutants *tir1, afb1-3*, and *afb1-3afb2-3* have increased clubroot susceptibility. In this study, clubroot susceptibility was tested in *tir1-10, afb2-3*, and *afb4-8* mutants of Arabidopsis. The *tir1-10* and *afb2-3* mutants exhibited reduced auxin sensitivity in root-growth assays with the synthetic auxin 2,4-D. All three of the mutants, however, developed levels of clubroot similar to the wild-type following inoculation with $6 \times 10^4$, $6 \times 10^5$ or $6 \times 10^6$ *P. brassicae* resting spores/ml. Accordingly, the inactivation of single auxin receptors does not appear to be sufficient to suppress root gall development in *P. brassicae*-infected plants, possibly as a result of the complementary action of other auxin receptors.

Reviewers: Leonardo Miguel Galindo González and Tiesen Cao

A17 – **Stripe Rust management in winter wheat using cultivar resistance and fungicide.** K. Kumar, K. Xi, T. K. Turkington, M. Aljarrah and F. Capettini. *Field Crop Development Centre, Alberta Agriculture and Forestry, 5030-50 Street, Lacombe, AB T4L 1W8, Canada; (K.T.) Agriculture and Agri-Food Canada, Lacombe Research and Development Centre, 6000 C&E Trail, Lacombe, AB T4L 1W1, Canada.*

Under natural infection conditions in central Alberta during two winter wheat seasons (years), field tests were conducted to determine the effect of winter wheat cultivars with different levels of resistance, seed treatment and foliar fungicide application on management of stripe rust (*Puccinia striiformis f. sp. tritici Erikss.).* In the check plots containing susceptible AC Bellatrix and CDC Buteo, relatively high levels of stripe rust developed, while lower stripe rust severity was observed on the resistant cultivar AC Emerson. Similar levels of powdery mildew (*Blumeria graminis* (DC.) Speer *f. sp. tritici )* developed on all cultivars in check plots evaluated at Olds in 2015-16. Foliar application of the fungicide Caramba (metconazole) at the early flowering stage reduced severity of both diseases. Reduction in disease severity by the fungicide treatments resulted in significant yield increases for the susceptible cultivars. There was a limited yield response to the same fungicide treatments for the resistant cultivar AC Emerson due to low levels of stripe rust observed on this cultivar. Seed treatment alone had a limited effect on stripe rust severity and no yield increases were observed for all cultivars. Similar trends were observed for other yield components such as thousand kernel weight (TKW) and test weight (kg/hL) in

response to fungicide treatments. Combination of seed treatment and foliar treatment yielded the same effect as the application of Caramba.

Reviewers: Shiming Xue and Noryne Rauhala

A18 – **Comparative study of the growth and colonization of host tissues by Ptr ToxA- and Ptr ToxB-producing isolates of *Pyrenophora tritici-repentis* (tan spot of wheat).** X. MA, R. ABOUKHADDOUR, I.S. STRELKOV, A. AKHAVAN, 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 Forestry, Edmonton, AB T5Y 6H3, Canada. Pyrenophora tritici-repentis* (Died.) Drechs. (*Ptr*) is a necrotrophic fungal pathogen which causes tan spot disease of wheat worldwide. *Ptr* produces several necrotrophic effectors, including Ptr ToxA and Ptr ToxB, encoded by the *ToxA* and *ToxB* genes, respectively. Although both Ptr ToxA- and ToxB-producing isolates are found in Canada, Ptr ToxB-producing isolates are extremely rare. The objective of this study was to determine whether or not Ptr ToxA- producing isolates have a competitive advantage over Ptr ToxB-producing isolates. The percent leaf area diseased was measured on wheat leaves following inoculation with *Ptr* race 2 (Ptr ToxA- producing isolate), race 5 (Ptr ToxB-producing isolate), or both races together. Inoculation with race 2 resulted in greater lesion sizes than inoculation with race 5 alone or races 2 and 5 in combination. Colonization of the host tissues by the fungus was examined microscopically in leaves by fluorescent staining. The results indicated greater fungal growth and spread following inoculation with race 2. Quantification of fungal biomass and *ToxA* and *ToxB* gene abundance via real time PCR analysis showed similar trends. Collectively, these results suggest a selective advantage for Ptr ToxA-producing isolates of *Ptr*.

A19 – **Evaluation of two reactive gas-based systems for CGMMV management in commercial greenhouse cucumber production.** W. ELLOUZE AND V. MISHRA. *Alberta Agriculture and Forestry, Crop Diversification Centre South, 301 Horticultural Station Rd. E., Brooks, Alberta T1R 1E6, Canada. Cucumber Green Mottle Mosaic Virus* (CGMMV) is an extremely stable Tobamovirus that can cause extensive yield losses in greenhouse cucumbers. The management of this disease is a difficult task because the virus is very persistent on greenhouse hard surfaces. Control strategies are mainly aimed at reducing or eliminating existing sources of infection and prevention of virus survival and transmission from contaminated tools, fixtures and equipment. The objective of this study was to evaluate the relative effectiveness of two systems that produce a group of patented oxidant gases for CGMMV management in commercial greenhouse cucumber production. Oxidant gases are very effective at destroying harmful microbes, including viruses. They are approved for use as an antimicrobial agents for the treatment, storage and processing of foods and food products. These processes could be an environmentally safe means of CGMMV disease management. Replicated ELISA analysis revealed dissimilarities in the efficacies of the hydroperoxide and other patent pending oxidant that they produced against CGMMV on plants and virus-infested surfaces consisting of concrete, metal, wood and plastic. One of the oxidant treatments was able to significantly reduce the concentration of CGMMV on a wooden surface. However, none of the treatments was able to completely eliminate CGMMV contamination from the surfaces used in our studies. More fine-tuning is needed to improve the efficiency of the currently studied oxidation systems for CGMMV management in commercial greenhouse conditions.

A20 – **Development of an optimized next-generation DNA sequencing approach for fungal plant pathogens using the Illumina MiSeq.** E. PEREZ-LARA, M. HOLTZ, S.-F. HWANG AND S. E. STRELKOV. *Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5, Canada; (M.H.) Field Crop Development Centre, Agriculture Building, 5030-*

*50 Street, Lacombe, AB, T4L 1W8, Canada; (S.-F. H) Crop Diversification Center North, Alberta Agriculture and Forestry, Edmonton, AB, T5Y 6H3, Canada.* The development of high-throughput sequencing technologies has enabled exploration of the genomes of large populations of organisms at a lower-cost than with PCR-based methods, including the discovery and characterization of molecular polymorphisms at a higher rate than ever before. The MiSeq bench-top sequencer enables target genes and whole microbial genome sequencing. This makes it suitable for the study of fungal plant pathogen populations. Different library preparation methods are accessible on the market but also can be developed or optimized for a variety of applications, including genotyping by sequencing. We are testing two different protocols using one and two restriction enzymes, respectively. These protocols can be multiplexed up to 384 samples for those projects requiring greater throughput. The pathogens tested in this work include *Leptosphaeria maculans, Fusarium oxysporum*, *Pyrenophora teres*, *Pyrenophora tritici-repentis*, *Sclerotinia* spp., *Rhizoctonia solani*, *Aphanomyces* spp. We will discuss which library preparation method is more suitable for each pathogen and the amount of polymorphisms generated by each library preparation method.

A21 – **Baseline sensitivity of *Leptosphaeria maculans* isolates from Alberta to pyraclostrobin.** Y. WANG, A. AKHAVAN, 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 Forestry, Edmonton, AB T5Y 6H3, Canada.* Blackleg of canola (*Brassica napus*L.), caused by *Leptosphaeria maculans* (Desm.)Ces.& de Not.,is an important disease in Alberta. The strobilurin fungicide pyraclostrobin is commonly applied as a foliar and seed treatment to manage blackleg and other diseases across the province. Up-to-date information on the sensitivity of local isolates of *L. maculans* to pyraclostrobin is helpful in the formulation of integrated blackleg management strategies. In this study, 11 and 18 isolates, collected in 2011and 2016, respectively, were used to determine the half-maximal effective concentration ($EC_{50}$) of pyraclostrobin. The isolates were grown on pyraclostrobin-amended agar plates, with 10concentrations, and growth inhibition was assessed relative to non-amended controls and presented as a percentage. For each isolate, the $EC_{50}$ value was independently estimated by probit analysis. The results revealed that the mean $EC_{50}$ value was significantly higher for the 2016 isolates relative to the 2011 isolates. This suggests an increased insensitivity among the *L. maculans* isolates over time, and highlights the need for increased fungicide stewardship in Alberta. Screening of a large population of *L. maculans* isolates is presently underway to detect any potential cases of qualitative pyraclostrobin insensitivity in the province.

A22 – **Stripe rust on wheat and barley in central Alberta during 2015 and 2016.** K. Xi, K. Kumar, T.K. Turkington and F. Capettini. *Field Crop Development Centre, Alberta Agriculture and Forestry, Lacombe, AB T4L 1W8, Canada; (K.T.) Lacombe Research and Development Centre, Agriculture and Agri-Food Canada, 6000 C and E Trail, Lacombe, AB T4L 1W1, Canada.*

Wheat stripe rust caused by *Puccinia striiformis f. sp. tritici Erikss*. (Pst) is widespread, while barley stripe rust resulting from *P. striiformis f.sp. hordei* (Psh) has regularly been observed in central Alberta. Cross infection between wheat and barley by the two pathogens has been observed. The objective of this study was to differentiate the two pathogens and identify virulence in each pathogen. Sixty-four isolates were purified from diseased leaf samples that had been collected from wheat, barley, foxtail barley and triticale in central Alberta during 2015 and 2016. Based on phenotyping on barley and wheat differentials, 21 of the 23 isolates sampled from barley and foxtail barley were classified to be Psh and two were Pst; all 41 isolates from wheat and triticale were classified to be Pst. Temporal changes in virulence frequency were apparent when Psh and Pst collected during 2015 to 2016 were compared with those collected during 2009 to 2011. Current Psh and Pst pathotypes from the 2015 to 2016 collection exhibited substantial increases in virulence frequency on a number of wheat differentials when inoculated at the seedling stage, compared with previous isolates from the 2009 to 2011 collection.

Current Psh pathotypes showed substantial decreases in virulence frequency on 7 of the 12 barley differentials, while current Pst pathotypes exhibited similar virulence frequency on 12 barley differentials compared with those collected from 2009 - 2011.

Reviewers: Noryne Rauhala and Sasha Waterman

A23 – **Using the dimorphic sequences in *Plasmodiophora brassicae* genes as markers for pathotype differentiation.** Y. Yang, K. Zahr, K. Zuzak, M. Harding, S.F. Hwang, S.E. Strelkov, D. Feindel and J. Feng. *Crop Diversification Centre North, 17507 Fort Road NW, Edmonton, AB T5Y 6H3, Canada; (M.H.) Crop Diversification Centre South, 301 Horticultural Station Road East, Brooks, AB T1R 1E6, Canada; (S.E.S.) Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada.*

Genetic markers for *Plasmodiophora brassicae* Wor. pathotype differentiation would be extremely useful, but are not currently available. An attempt to discover pathotype markers was undertaken by screening sequence polymorphisms on 85 *P. brassicae* protein coding genes. Sequences from 85 expressed sequence tag (EST) of a New Zealand strain were compared to their corresponding sequences in the two released whole genomes. Of the identified differences in all genes, approximately 80% were dimorphisms falling into two distinct groups: Group 1 was formed by the New Zealand strain and Group 2 included the two whole genome sequenced strains. Two genes with a high density of dimorphism were selected and their partial sequences were PCR amplified from the original Alberta pathotypes 2, 3, 5, 6 and 8 (based on the Williams' differential set) and the new virulent pathotypes 3x and 5x. For each of the two genes, the sequences of the original pathotypes were identical to those of Group 2 and the sequences of the new virulent pathotypes were identical to those of Group 1. Based on the dimorphisms on the sequences of these two genes, an RNase H-dependent PCR protocol was developed. This protocol was demonstrated to be useful for virulent pathotype identification and may also be used to study the population dynamics of *P. brassicae.*

Reviewers: Tiesen Cao and Victor Manolii

A24 – **Pathogenicity and genetic diversity of *Rhizoctonia solani* isolates from field pea and other crops in Alberta, Canada.** H.T.Yu, Q.Zhou, H.T.Fu, K.F.Chang, S.F.Hwang and S.E.Strelkov. *Institute of Food Crops, Yunnan Academy of Agricultural Science, Kunming, Yunnan, 650205 China; (Q.Z., H.T.F., K.F.C., S.F.H.) 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, AB T6G 2P5, Canada.*

The root rot is a major constraint to the production of field peas (*Pisum sativum* L.) and other pulse crops around the world. In Western Canada, *Rhizoctonia solani* Kuhn was identified as one of the major pathogens of the root rot complex that causes the disease. In the summer of 2016 and 2017, a total of 66 isolates of *Rhizoctonia solani* were isolated from diseased pea and soybean plants and soil samples in central Alberta. The isolates could be classified based on their anastomosis behavior against tester isolates (AG grouping). When tested on the field pea cv. Midas, five isolates showed no aggressiveness (disease severity of 0.00) while nine isolates were highly aggressive to pea with (disease severity ranged from 3.0-3.7).The remaining 52 isolates resulted in disease severity ratings between 0.03 and 2.50. A phylogenetic analysis based on the rDNA ITS sequences among the isolates were also carried out. The

differential pathogenicity of the identified isolates showed the existence of a wide spectrum of *Rhizoctonia solani* in Alberta.

Reviewers: Rudolph Feduda-Agyeman and George Turnbull

A25 – **A molecular marker for specific detection of new pathotype 5-like strains of *Plasmodiophora brassicae* in canola.** Q. Zhou, S. F. Hwang, S. E. Strelkov, R. Fredua-Agyeman and V.P. Manolii. *Crop Diversification Centre North, Alberta Agriculture and Forestry, Edmonton, AB T5Y 6H3, Canada; (S.E.S, V.P.M.) Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada*

Clubroot of canola (*Brassica napus* L.), caused by *Plasmodiophora brassicae* Wor., is primarily managed by the deployment of resistant cultivars in Alberta, Canada. Recently, however, new strains of *P. brassicae* have been detected, which can overcome this resistance. Some of these strains are classified as pathotype 5 based on the differential system of Williams, but are distinguished by their ability to overcome resistance, which were previously resistant to pathotype 5. In order to expedite the identification of these new pathotype 5-like strains, three primer sets were developed based on the 18S-ITS region of the pathogen. With one of the primer sets (P5XF3 and P5XR3), a 127-bp product was amplified from all new pathotype 5-like strains following optimized PCR analysis. Together with a TaqMan probe (P5XP3) and primer set (P5XF3 / P5XR3), a quantitative assay also was developed. Host infection could be detected as early as 4 days after inoculation. Samples containing ≤ 500 fg of *P. brassicae* DNA, and as few as $1 \times 10^4$/mL pathogen resting spores could be consistently detected using these primers and PCR protocol. The PCR and qPCR assays described in this study represent useful tools for the rapid and reliable diagnosis and quantification of new pathotype 5-like strains of *P. brassicae*.

Reviewers: Hafiz Ahmed and George Turnbull

A26 – **Evaluation of qPCR primers for clubroot diagnosis.** K.A. Zuzak, D.C. Rennie, Y.Yang, M.W. Harding, D. Feindel, and J. Feng. *Crop Diversification Centre North, Alberta Agriculture and Forestry, 17507 Fort Rd NW, Edmonton, AB T5Y 6H3, Canada; (M.H) Crop Diversification Centre South, Alberta Agriculture and Forestry, 301 Horticultural Station Road East, Brooks, AB T1R 1E6, Canada.*

To select a quantitative PCR (qPCR) protocol for routine diagnosis of the clubroot pathogen *Plasmodiophora brassicae* Wor. in the Alberta Plant Health Lab, 12 primer sets were evaluated for their specificity and sensitivity. Ten of these primer sets were developed in this study based on the sequences of the ribosomal DNA (rDNA) region or single-copy protein coding genes of *P. brassicae*, while the other two primer sets were selected from literature. Sensitivity was tested using serial dilutions of the *P. brassicae* DNA. Specificity was tested against the DNA extracted from organisms commonly associated with canola roots in the field conditions, including fungi, bacteria and other protists. The data indicated an inverse relationship between the sensitivity and the specificity of the primers. In general, primers targeting a single-copy gene have higher specificity but lower sensitivity than the primers targeting the rDNA region (multiple copies). Based on these data, we recommend using at least one pair of the single-copy gene primers to confirm the results from rDNA-based primers in the diagnosis of clubroot.

Reviewers: Tiesen Cao and Rudolph Fredua-Agyeman

A27 – **Genotyping-by-sequencing reveals three QTL for clubroot resistance to six pathotypes of *Plasmodiophora brassicae* in *Brassica rapa*.** F. YU, X. ZHANG, G. PENG, K. C. FALK, S. E. STRELKOV, and B. D. GOSSEN. *Agriculture and Agri-Food Canada, Saskatoon Research and Development Centre, 107 Science Place, Saskatoon, SK, S7N OX2, Canada; (SES) Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada.* Clubroot, caused by *Plasmodiophora brassicae*, poses a serious threat to canola and Brassica vegetable production worldwide. A *B. rapa* canola breeding line T19 was found to be highly resistant to six pathotypes (Williams' system pathotypes 2 (P2), 3 (P3), 5 (P5), 6 (P6), 8 (P8) and a highly virulent variant of P5 (P5x) of *P. brassicae* identified from canola in Canada. Crosses of T19 with a susceptible double-haploid line ACDC were made and the resulting $F_1$ was backcrossed with ACDC to produce a $BC_1$ population. The 92 $BC_1$ plants were self-pollinated to produce 92 $BC_1S_1$ lines, which were evaluated for resistance to clubroot. Genotyping-by-sequencing (GBS) was performed on the parental lines and 92 plants in the $BC_1$. Short-read sequences were aligned into the chromosomes of the reference genome and genome-wide DNA variants were identified in the population and the parental lines. After filtering for false heterozygous, monomorphic and un-linked SNP loci, 1178 high quality SNP loci distributed on 10 chromosomes of *B. rapa* were obtained. A single co-localized QTL designated as *Rcr4* on chromosome A03 conferred resistance to P2, P3, P5, P6 and P8. Two QTL designated as *Rcr8* on chromosomes A02 and *Rcr9* on A08 were detected for resistance to pathotype 5x. DNA variants in the respective QTL target regions were examined through bulked segregant DNA sequencing to identify possible candidate genes. Our results demonstrated the power of GBS-based QTL mapping for rapid and efficient QTL detection and provided reliable QTL regions for fine mapping.

A28 – **A shift in the pathotype of *Plasmodiophora brassicae* at a site in Ontario.** F. AL-DAOUD, B.D. GOSSEN, AND M.R. MCDONALD. *Department of Plant Agriculture, University of Guelph, Guelph, ON, N1G 2W1, Canada; (B.D.G.) Agriculture and Agri-Food Canada, Saskatoon Research and Development Centre, Saskatoon, SK, S7N 0X2, Canada. Plasmodiophora brassicae* Woronin causes clubroot disease on Brassica crops worldwide. Genetic resistance is the principal strategy for clubroot management, but resistance has often been overcome by the emergence of new pathotypes. Pathotype 6 is the predominant pathotype in Ontario. Changes over time in the pathotype at the Muck Crops Research Station in King, Ontario, were assessed following observation of changes in the disease reaction of previously resistant canola (*Brassica napus* L.) cultivars. Clubbed roots of the susceptible canola line ACS-N39 were collected from field trials in 2011 and 2014, and inoculum was increased on a susceptible host. The cultivars that comprise Williams' differential set were inoculated under controlled conditions at about one week after seeding (four replicates, 10-12 plants per experimental unit). Plants were rated for clubroot symptoms using a 0-3 scale at 6 weeks after inoculation, and a disease severity index (DSI) was calculated. A host was resistant if DSI ± 95% confidence interval < 50; otherwise it was susceptible. This assessment identified the collections as pathotype 6 in 2011 and pathotype 2 in 2014. This shift was associated with changes in the Brassica crops grown at this site. Prior to 2009, clubroot experiments at this site were performed exclusively on susceptible cultivars. After 2009, most studies included resistant or moderately resistant lines. Assessment of *P. brassicae* collections from this site in 2016 is underway to characterize any subsequent changes in pathotype.

A29 – **Breakdown of clubroot resistance in Quebec provides an inference for resistance in Alberta**. B. D. GOSSEN, D. PAGEAU, J. DALTON, F. YU, AND M. R. MCDONALD. *Agriculture and Agri-Food Canada (AAFC), Saskatoon Research and Development Centre, Saskatoon, SK, S7N 0X2, Canada; (D.P.) AAFC Research Farm, 1468 St-Cyrille Street, Normandin, QC G8M 4K3, Canada; (J.D., M.R.M.) Department of Plant Agriculture, University of Guelph, Guelph, ON, N1G 2W1, Canada.* Genetic resistance to *Plasmodiophora brassicae* Wor. (cause of clubroot of brassicas) has been the cornerstone of clubroot management on canola (*Brassica napus* L.) in Canada since the release of the first clubroot-resistant cultivar in 2009. Erosion of this resistance was observed in several heavily infested fields in

Alberta, Canada in 2013 and confirmed under controlled conditions. Several genotypes of this new and virulent pathotype have since been identified that differ in their clubroot reaction on lines in the European Clubroot Differential system. Outside of Alberta, clubroot is still found only infrequently on canola in Canada. However, it has been present at high levels in a field at Normandin, Quebec for several years. Pathotype 2 (William's system) predominates at this site, rather than pathotype 3 (predominant in Alberta) or pathotype 6 (on vegetables in Ontario). Studies using clubroot-resistant cultivars were conducted at the Normandin site each year from 2013 to 2015. Limited clubbing was noted on a previously resistant cultivar in 2014, and severe clubbing developed in 2015, accompanied by a substantial increase in the concentration of resting spores in the soil (estimated using qPCR). Replicated and repeated inoculation with spores from clubs collected at Normandin onto the clubroot-resistant cv. 45H29 under controlled conditions resulted in moderate levels of clubbing on most plants. This demonstrates that a change to a virulent pathotype has also occurred at Normandin, which is separated from the sites in Alberta by > 2000 km. This provides strong support for the conclusion that the multiple new pathotypes observed in Alberta have developed independently, rather than being variants of a single change that has spread from an initial site.

A30 – **Distribution of root rot on pea and lentil crops on the Canadian prairies, 2016.** B. D. GOSSEN, S. CHATTERTON, AND D. L. MCLAREN. *Agriculture and Agri-Food Canada (AAFC), Saskatoon Research and Development Centre, 107 Science Place, Saskatoon, SK, S7N 0X2, Canada; AAFC, Lethbridge Research and Development Centre, 5403 1st Ave S, Lethbridge, AB T1J 4B1, Canada; AAFC, Brandon Research and Development Centre, 2701 Grand Valley Road, Brandon, MB R7A 5Y3, Canada.* Wetter-than-normal spring seasons across large portions of the Canadian prairies in recent years have been associated with the emergence of root rot as a major constraint to production of field pea and lentil. Also, use of molecular diagnostic tools indicate that *Aphanomyces euteiches* Drechs. May be a more important component of the root rot complex across the northern Great Plains than previously thought. Therefore, a survey was conducted to assess root rot etiology, incidence and severity on pea and lentil across the Canadian prairies in 2016. Root samples were collected at 5-10 sites from 187 pea and 94 lentil fields across the region during flowering and sent to a central laboratory for assessment of visible symptoms (1-7 scale, 7 = dead) and DNA tests to determine the causal agent. On field pea, root rot symptoms were present in almost 90% of fields, with mean severity per field (3.2) slightly below yield-limiting levels. On lentil, incidence was >90% but mean severity was slightly lower (2.9). Differences among soil zones were generally small. *Fusarium* spp. and *Rhizoctonia solani* Kühn were detected in about 90% of fields, *A. euteiches* in >60% and *Pythium* spp. in about 50% of fields. However, *A. euteiches* was present at high levels in fields in every soil zone and was commonly associated with the most severe root rot symptoms. This study demonstrated that *A. euteiches* is a widespread and important root pathogen of field pea and lentil across the region.

A31 – ***Prevalence and virulence of stripe rust in southern Alberta.*** E. Amundsen, K. McCormack, H. Randhawa and R. Aboukhaddour. *Agriculture and Agri-Food Canada, Lethbridge Research & Development Centre, Lethbridge, Alberta T1J 4B1, Canada*

Stripe rust, caused by *Puccinia striiformis f. sp. tritici Erikss.*, is a destructive wheat disease worldwide. Disease incidence and severity was assessed in commercial wheat fields in southern Alberta in November 2016 through August 2017. In total, 74 commercial wheat fields were surveyed in 2016-2017 growing seasons. The pathogen overwintered in Alberta over that time. In November 2016, 7 fields out of 10 were rated severe or moderate, but during 2017, only one field out of 64 was reported to have severe infection, and 75% of the surveyed fields were reported symptomless. The hot dry weather throughout the summer coupled with fungicide applications may have resulted in low levels of stripe rust in 2017. A set of wheat differentials included 20 near isogenic lines in the Avocet background with various stripe rust resistance genes, including the null, were seeded in two locations in southern Alberta

and in one location in British Columbia. Under natural infection it was determined that Yr5, and Yr15 were still effective against existing races, however Yr17 and YrSP were partially defeated in Lethbridge and Yr18 was defeated in Creston. Genetic resistance to stripe rust is precarious and the need for genetic resistance in new wheat cultivars depends on reliable knowledge of the pathogen populations.

Reviewers: Dr. Michael Harding and Mr. Greg Daniels

A32 – ***Tsn1 in Canadian winter and durum wheat germplasm.*** K. McCormack, T. Despins, E. Amundsen, R. Graf, Y. Ruan and R. Aboukhaddour**.** [1]*Agriculture and Agri-Food Canada, Lethbridge Research & Development Centre, Lethbridge, Alberta T1J 4B1, Canada; (Y.R.) Agriculture and Agri-Food Canada, Swift Current Research and Development Centre, Swift Current, Saskatchewan, S9H 3X2, Canada*

The wheat *Tsn1* gene on chromosome 5B confers sensitivity to the ToxA-producing wheat pathogens *Pyrenophora tritici-repentis* (Ptr) and *Stagonospora nodorum* that cause the diseases tan spot and Stagonospora nodorum blotch (SNB), respectively. Both are destructive foliar diseases of wheat worldwide and in Canada. ToxA is the necrosis inducing effector (protein) that contributes considerably to necrosis development in sensitive wheat genotypes carrying the *Tsn1* gene. In this study, Canadian durum and winter wheat germplasm were evaluated for their reaction to Ptr and its ToxA-producing isolate and for the presence of *Tsn1* and therefore sensitivity to ToxA. Bioassay with ToxA-producing isolate followed by PCR amplification of *Tsn1* different domains revealed that 65 and 67% of winter and durum wheat respectively amplified the *Tsn1* gene. While bioassay results need further confirmation, the high level of *Tsn1* amplification indicates the widespread of ToxA-sensitivity in the Canadian winter and durum wheat and is consistent with the prevalence of ToxA-producing Ptr isolates in Canada.

Reviewers: Dr. Jamie Larson and Dr. Nora Foroud

A33 – **Survey for blackleg on canola in southern Alberta in 2017.** T.B. Hill, G.C. Daniels, D.A. Burke, C.A. Pugh, J. Feng, K. Zuzak, D. Rennie, J. MacDonald, and M.W. Harding. *Alberta Agriculture and Forestry, Crop Diversification Centre South, 301 Horticultural Station Road East, Brooks, AB T1R 1E6, Canada; (J.F., K.Z., D.R.) Alberta Agriculture and Forestry, Crop Diversification Centre North, 17507 Fort Road NW, Edmonton, Alberta, T5Y 6H3, Canada; (J.M.) Agricultural Research and Extension Council of Alberta, #2 5304 50 St. Leduc, AB T9E 6Z6, Canada.*

A survey for blackleg disease on canola caused by *Leptosphaeria maculans* (Sowerby) P.Karst. was performed in Alberta in 2017 targeting 1% of canola fields in each county. A total of 421 canola fields in 65 counties were surveyed. Within each field surveyed, a total of 100 stems were collected from 5 locations. Disease was characterized visually based on discoloration within the stem at the crown and/or the presence of basal stem cankers or stem lesions. Disease severity was rated using a 0 to 5 scale where a plant was rated 0 when it had no symptoms through to 5 when the plant was dead due to infection. Blackleg symptoms were observed in 80% of fields at an average incidence of 14.1% and average severity of 0.05. The 2017 growing season was very dry across much of the province and blackleg prevalence, incidence and severity were reduced when compared to the survey results in 2016, a year which generally had higher rainfall than 2017.

Reviewers: Dr. Michele Konschuh and Mr. Ted Harms

A34 – **Summary of Samples Submitted to the Alberta Plant Health Lab**. J. FENG. *Crop Diversification Centre North, Alberta Agriculture and Forestry, Edmonton, AB T5Y 6H3, Canada.* No abstract submitted.

# BUSINESS MEETING OF THE 38TH ANNUAL MEETING OF THE PLANT PATHOLOGY SOCIETY OF ALBERTA

**Business Meeting Agenda**
**November 8, 2017, Badlands Community Facility Drumheller, Alberta, 8:30-10:00 AM**

**Introductions:** President – Greg Daniels; Vice President – Kequan Xi; Secretary – Rudolph Fredua-Agyeman; Treasurer – Noryne Rauhala; Directors – Robyne Bowness, Krista Zuzak, Reem Aboukhaddour, Jackie Busaan, CPS Representative, guests.

1. **Adoption of the Agenda**
2. **Adoption of the Minutes of the 2016 Business Meeting**
3. **In Memorium**
4. **Interim Financial Report –** Noryne Rauhala
5. **Update on CPS Activities –** Denis Gaudet
    a. CPS Publications
        i. DFCC – Bruce Gossen/Mike Harding
        ii. DPVCC – Ron Howard
        iii. CPDS – Janice Elmhirst
        iv. CJPP – ?
6. **Reports of Standing Committees**

    *Disease Survey Committee Report (Kelly Turkington):*

    *Historical Committee (Denis Gaudet):*

    *Awards Committee (Michael Harding):*
7. **Conference Reports**
8. **Reports on Unusual or Exceptional Disease Situations**
9. **Nomination of Honorary Life Members**
10. **Resolutions**
11. **Locations and Dates of Future Meetings**
    a. 2018 Lloydminster (Organized by Lacombe jointly with CPS-SK and in conjunction with WFPM)
    b. 2019 (Lethbridge)
    c. 2020 (Edmonton)
    d. 2021 (Brooks)
12. **Election of Officers for 2017-18**
    a. President: Kequan Xi
    b. Vice President:
13. **Other Business**
14. **Adjournment**

# BUSINESS MEETING OF THE 38TH ANNUAL MEETING OF THE PLANT PATHOLOGY SOCIETY OF ALBERTA

**Business Meeting Minutes**
**November 8, 2017, Badlands Community Facility Drumheller, Alberta, 8:30-10:00 AM**

Welcome and Introductions
There were 42 registrants attending the 38th annual meeting.

1- Adoption of Agenda: (moved by Bruce Gossen, Therese Despin second, carried).

2- Adoption of the minutes of the 2016 business meeting (moved by Ron Howard, Second Greg Daniels, carried).

3- Interim Financial report by Noryne Rauhala (Appendix 1). Noryne moved it, Reem Aboukhaddour second it, carried.

4- Update on CPS activities (Denis Gaudet the CPS president)
- Update on national CPS meeting, the best attendance meeting joint with agronomy society over 200 members, quality of meeting was high
- The video presentations by students were excellent and are on the website
- Next year meeting in June in QC joint between cps and QC society in plant protection
- Projects ongoing is to update the website (Mike Holtz, efforts recognized as the site manager)
- Potential to improve interaction with other international societies like APS or the Britsh Society
- Establish mentorship project (inputs are welcome)
- Increase the the value of students competition now it is $1000, $500, $300 for 1 st, 2ed and 3ed positions
- The support for regional society increased from to $750 to $1000
- Plant pathology and related students are given free membership in the society for any student in Canadian Univ or any citizen in other University
- New initiative for books, like writing book and getting support for that, the society will support member in this (could be books, videos etc..)contact board member for new ideas to improve outreach of plant pathology in Canada
- Taylor Francis relationship

5- Update on CPS publication

- In 2014, 1500 copies of Diseases of field crops in Canada, reprint of 2100 prints because of demand. There is desperate need to revise the book and update it and work is underway (Reported by Mike Harding and Bruce Gossen, see appendix 2).

- Disease and pest of vegetables diseases (Reported by Ron Howard): work is ongoing to update and build this, has greenhouse component with details for greenhouse industry. Hope to get first draft by the summer

- CPDS report prepared by Janice Elmhirst read by Mike Harding (appendix 3). Mike Holtz was recognized for his contributions as site editor

- Updates on CJPP by Denis Gaudet, mentioned the rising impact factor to 1.48, Zamir Punja the editor added international section editor to the journal. There is editor for reviews, if desired, contact CJPP

6- Reports from Committees:
- Survey Committee: Disease survey reports from Western Committee on Plant Disease are available from Mike Harding (on behalf of Kelly Turkington)

- Historical committee (Denis Gaudet) reported that archives are held at the Univ of AB archive (facilitated by Steve Strelkov) PPSA has a specific cite at the Univ of AB. All proceedings of meetings should be sent to Steve for archiving.

- Award committee (update by M. Harding)
    - Best student poster:Xinyi Ma (Comparative study of the growth and colonization of host tissues by Ptr ToxA- and Ptr ToxB- producing isolates of *Pyrenophora tritici-repentis* (tan spot of wheat)).
    - Best student presentation: Nicole Fox (The evaluation of lime products as a clubroot management tool in canola.)
    - Best technician poster: Eric Amundsen (Wheat stripe rust in S. Alberta in 2017).
    - Best technician presentation: Greg Daniels (Evaluation of species composition and fungicide resistance in Fusarium populations causing dry rot in Alberta potato storages).
    - The Swanson award for plant pathology this years awarded to Homa Askarian.working on clubroot at the Univ of AB supervised by Stephen Strelkov (see appendix 4)

7- Updates on conference reports: none

8- Reports on unusual or exceptional disease situations in 2017: clubroot pathotypes is still dynamics and symptoms in SK and Peace River region in AB

9- Nomination of Honorary life member: Mike asked for a list and Bruce asked Mike to get list, Ron and Mike and Steve will work together to get that list

10- Resolutions:

Adoption of Denis suggested resolutions thanking regional organizing committee and thanking student and sponsors

11- Future meeting in 2018 in Lloydminster in conjunction with WFPM (will be organized by CPS-SK)

2019 Lacombe
2020 Lethbridge

12- Elections of Officers:

President Bruce Gossen
Vice president: Kequan Xi
Secretary: Mike Holtz
Directors: Krista Zuzak, Reem Aboukhaddour, Robyne Bowness, Jackie Bussan
Treasure Noryne Rauhala

All by acclimation

13- other business

- Discussed the option of the society to get charge card (moved by Noryne, seconder Dustin Burke, carried)
- Do we need to increase fee on registration, Therese asked? Decided not necessary at this time.
- Giving option to make payment on website, but the issue we do not have PPSA website, Mike Holtz suggested using Eventbrite and therefore that no need for specific website
- Denis suggested linking the national site with regional site
- Local arrangement hopefully will decide on that

14- Adournment

## APPENDIX 1. Interim Financial Report

**Plant Pathology Society of Alberta**
**Financial Summary October 2017**

| | | | |
|---|---|---|---|
| **Opening Balance:** | | | $ 7,773.65 |
| **Revenues** | | | |
| Sponsorship | $6,150.00 | | |
| Registrations for 2016 meeting | $7,006.00 | | |
| Membership | $540.00 | | |
| Dr.Terry Swanson Memorial Scholarship Donations (2016) | $90.00 | | |
| Abstract Publication | $840.00 | | |
| **Total Revenue** | $14,626.00 | | $ 22,399.65 |
| **Expenses** | | | |
| Student Award 2016 meeting | | $100.00 | |
| Technician Award 2016 meeting | | $100.00 | |
| PPSA Graduate Student Scholarship 2016 | | $1,000.00 | |
| Abstract Publication | | $840.00 | |
| Meeting Expenses | | $12,601.34 | |
| Dr.Terry Swanson Memorial Scholarship (2016) | | $1,369.90 | |
| **Total Expenses** | | $16,011.24 | |
| **Balance** | | | $6,388.41 |

**PPSA Savings**

| | Interest Rate | Interest Earned | Amount |
|---|---|---|---|
| GIC - 18 month term | | | |
| Maturity Date November 8, 2018 | 1.40% | $ 120.42 | $21,652.56 |

## APPENDIX 2.

**Update on *Diseases of Field Crops in Canada* – 38th Annual Meeting of the PPSA**
**November 8, 2017, Badlands Community Facility Drumheller, Alberta, 8:30-10:00 AM**

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In 2014, 1,500 copies of *Diseases of Field Crops in Canada* were reprinted to meet short-term demand. At that time, the committee recommended to the CPS Board that after that 1,500 copy reprint, that the book not be reprinted in future, because it was becoming out-dated. However, in the spring of 2017, another reprint of 2,100 copies was approved because of demand, and lack of progress on revisions to the book. The 2100 copy reprint was done in June of 2017. Revision to DFCC is urgently required.

## APPENDIX 3.

**Report to the Plant Pathology Society of Alberta** November 8, 2017
**Canadian Plant Disease Survey Vol. 97 (March, 2017)**

57 reports were published for the 2016 crop year:

- 11 Diagnostic Labs
- 26 Cereals
- 18 Oilseeds, Pulses, Forages and Special Crops
- 2 Vegetables

This was similar to previous years, *i.e.*, 49-57 reports were published annually from 2000-2016.
**CPDS on the new CPS WEBSITE:** When Vol. 97 was uploaded to the CPS website in March 2017, we discovered that one previous year was completely missing and several volumes had individual reports, or pages, missing. Michael Holtz, the CPS website editor, used an automated program to scan for broken links and discovered more than 160. Thanks to Michael, these were promptly repaired in April. But, if anyone finds reports or data missing, please let me know.

**SECTION EDITORS:** Our Compiler, Deidre Wasyliw, and all of the Section Editors, did a fantastic job, as always. Special thanks to our new 2017 Section Editors Debra McLaren (Oilseeds) and Kelly Turkington (Cereals). These are our largest sections and require a lot of work.

**CHANGE: Vol. 98 (2018)**: Janice Elmhirst will take over as Section Editor for Fruits, Nuts and Berries, Ornamentals and Turf, replacing Mike Celetti who has held the post since 2014.
**FORMAT of REPORTS:** The format of reports has been somewhat inconsistent in previous years. Dr. Debra McLaren brought a few issues to my attention:

- Some cite references as (1), (2) etc. and then number them in the reference listing; others cite as Smith et al. (2012) within the text and then list in the reference by author name. I think either way is acceptable, if used correctly, that is, author names should be listed **alphabetically.**
- Some articles list affiliations on separate lines with a footnote; other articles have affiliations listed in a continuous manner. **Affiliations should be listed on separate lines with a footnote. Please follow Vol. 97 for spacing and punctuation.**
- Most articles have section headings in both French and English, but some have just one language. To be consistent, **put headings in both languages.** Please copy Vol. 97 for English/French formatting and spelling.

**DEADLINES:** I have kept the same deadlines as Robin Morrall, before me. This schedule allowed Deidre and me to post Vol. 97 on the website by end of March. Section Editors may change the dates, at their discretion, as long as the final reports reach me by **January 9/18.** This gives me time to review each report before sending to Deidre and follow-up with the author or Section Editor, if something is needed.

Respectfully,
Dr. Janice Elmhirst, National Editor, Canadian Plant Disease Survey

**APPENDIX 4.**

Report on the
**SWANSON AWARD FOR PLANT PATHOLOGY AND NEMATOLOGY**
November 8, 2017

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The 2016 Swanson Award was still being decided at the time of the 2016 meeting, so it is reported here along with the 2017 Swanson Award.

The 2016 Swanson Award for Plant Pathology and Nematology was gratefully received by Mr. Arsenio Ndeve, a fourth year Plant Pathology Graduate Student at the University of California Riverside (UCR). Mr. Ndeve is working at UCR on the genetics of resistance to Fusarium wilt (*Fusarium oxysporum* f.sp. *tracheiphilum*), root-knot nematodes, and charcoal rot (*Macrophomina phaseolina*) in the grain legume cowpea. It was special to note that Terry Swanson also worked on Fusarium wilt and root knot nematode interactions in cowpea when he was a graduate student at UCR.

The 2017 Swanson Award for Plant Pathology and Nematology was awarded to Homa Askarian Khanaman, from the University of Alberta. She is a student supervised by Drs. Stephen Strelkov and Sheau-Fang Hwang. Ms. Khanaman is working on the genetic and pathogenic structure of *Plasmodiophora brassicae* single-spore isolates and field populations on canola (*Brassica napus*) in Alberta, Canada
.

An updated financial statement for the Scholarship Fund for 2016-17 is given below.

**Guaranteed Investment Certificates (Community Savings, Lacombe)**

| | | |
|---|---|---|
| Donations from November 2016 meeting | | $ 90.00 |
| 12 month GIC (matures August 12, 2018) | Opening Balance | $13,020.03 |
| Interest 0.5% | | $ 8.74 |
| | Balance to date | $13,028.77 |

Respectfully submitted by D. Gaudet, R. Howard, and M. Harding (PPSA Awards Committee)