Plant Pathology Society of Alberta
43rd Annual Meeting

Heritage Inn & Convention Centre
Brooks, AB November 2-4, 2022

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Plant Pathology Society of Alberta – 43rd Annual Meeting Program
Heritage Inn & Convention Centre, Brooks, AB – November 2-4, 2022

Wednesday, November 2nd

6:30pm – 9:30pm	Registration, welcome reception, Poster set-up	Heritage Inn Meeting Room C

Thursday, November 3rd

7:00am – 8:00am	Breakfast buffet (provided)	Heritage Inn Meeting Room C/D
7:00am – 8:00am	Registration and poster set-up	Heritage Inn Meeting Room C
8:00am – 8:15am	Welcome & Introductions	Heritage Inn Meeting Room D
8:15am – 9:30am	Student presentations – Moderator: Kelly Turkington	

8:15 – 9:30	**Student session – Moderator: Kelly Turkington**		**Heritage Inn Meeting Room D**
8:15-8:30	S1	Zyre Aubrey-Hebert	Characterization of novel races of *Pyrenophora tritici-repentis* (tan spot of wheat) from durum wheat
8:30-8:45	S2	Atta Ur Rahman	Potato early dying disease comple: Identification of pathogen(s) and assessing disease severity in Alberta's commercial potato fields
8:45-9:00	S3	Brad Calder	Assessing the variability and fungicide resistance of *Sclerotinia sclerotiorum* isolates collected from different host crops across Canada
9:00-9:15	S4	Emilee Storfie	Evaluating the effect of foliar application of salicylic acid on clubroot development in *Brassica napus*
9:15-9:30	S5	Dilini Adihetty	Propiconazole, pyraclostrobin, and fluxapyroxad sensitivity of western Canadian *Cochliobolus sativus* population
9:30-9:45	S6	Kun Lou	Race characterization of *Puccinia striiformis* f.sp. *tritici* population in western Canada from 2017 to 2022

9:45-10:00 Break

10:00am – 12:00pm	**Paper session I – Moderator: James Calpas**		**Meeting Room D**
10:00-10:15	A1	Jorge Cordero Elvia	Clubroot-induced changes in the root and rhizosphere microbiome of susceptible and resistant canola
10:15-10:30	A2	Kelly Turkington	The impact of row spacing, seeding rate, and fungicide timing on severity of leaf disease, fusarium kernel damage, deoxynivalenol, and productivity of spring wheat
10:30-10:45	A3	Junye Jiang	Development of a LAMP method to detect the potato zebra chip pathogen and differentiate haplotypes A and B

10:45-11:00 Break

11:00 – 12:00	**Paper session I, continued**		
11:00-11:15	A4	Yoann Aigu	The evolution of clubroot spread in Alberta
11:15-11:30	A5	Jie Feng	Detection of *Xanthomonas translucens* pv. *translucens* and pv. *undulosa* by qPCR and duplex qPCR
11:30-11:45	A6	Nora Foroud	Characterization of mitogen-activated protein kinase mutants in *Fusarium graminearum*
11:45-12:00	A7	Sajid Rehman	Virulence of *Rhychosporium commune* isolates from Alberta on barley differential genotypes

12:00 – 1:15 **Lunch buffet (provided)** **Heritage Inn Room C/D**

1:15 – 1:25 **Welcome message from CPS President Sheau-Fang Hwang**

1:30 – 3:00 **Symposium – Moderator: Ron Howard**

Advances in plant pathology research using novel techniques **Room D**

1:30-1:50	Y1	Junye Jiang	Using rhqPCR for detection of plant pathogens
1:50-2:10	Y2	Syama Chatterton	Digital droplet PCR to assess root disease risk for peas/lentils
2:10-2:30	Y3	Liang Zhao	Analysis of contributing factors of blackleg disease with AI
2:30-2:50	Y4	Lipu Wang	Fast chromatography tandem mass spectrometry for DON quantification in wheat grain

3:00 – 3:30 **Group photo and Refreshment break**

3:30 – 5:30 **Poster session P1** **Heritage Room C**

6:00 – 6:30 **Cocktails** **Heritage Room C/D**

6:30 – 8:00 **Banquet and Awards Program** **Heritage Room C/D**

Friday, November 4th

7:00am – 8:00am **Breakfast buffet (provided)** **Heritage Room C/D**

08:00am – 9:30am **Business meeting – everyone please attend** **Heritage Room D**

9:30am – 10:30am **Poster take down/check out**

10:30 – 11:30 **Crop Disease Surveys – Roundtable Discussion (optional)** **Heritage Room D**

11:45 clean up, lunch on your own – and travel safely home

POSTER SESSIONS I, II, and III – 3:30pm – 5:30pm		
STUDENT POSTERS – SESSION I		
SP1	Yixiao Wang	Exploring resistance to *Verticiliium longisporum*in *Brassica* genotypes
SP2	Chunxiao Yang	Exploring resistance to Fusarium wilt in *Brassica* genotypes under hydroponic conditions
SP3	Sijan Pandit	Effect of phytohormones on disease progress of susceptible pea cultivar to *A. euteiches* and *F. avenaceum* infection
SP4	Haitan Yu	Effects *of Fusarium avenaceum, F. oxysporum* and *F. proliferatum* on seedling survival, growth, root rot severity and yield of canola
SP5	Zhiyu Yu	Evaluation of fall and spring lime applications for the management of clubroot of canola
SP6	Ryan Gourlie	Genome wide association study reveals possible SNPs associated with the ToxC phenoytpe in *Pyrenophora tritici-repentis* (tan spot of wheat)
SP7	Bohan Wei	Stripe rust in Alberta threatens the Canadian wheat
SP8	Danna Rotariu	Effects of fertilizer application on *Brassica* root architecture, clubroot severity and yield
TECHNICIAN POSTERS – SESSION II		
TP1	Albert Hannig	Evaluation of synthetic antimicrobial peptide expression and resistance to root rot in *Pisum sativum*.
TP2	Blake Hill	The effects of varying freeze/thaw cycles on *Plasmodiophora brassicae* resting spore mortality
TP3	Mouldi Zid	Identification of common bunt races from contaminated seed sources
REGULAR POSTER SESSION III		
P1	Bruce Gossen	Reduction of resting spores of *Plasmodiophora brassicae* with wheat and lime
P2	Bruce Gossen	Type of soilless mix influences the development of clubroot (*Plasmodiophora brassicae*).
P3	Bruce Gossen	The interaction of lime and boron to manage clubroot on canola, 2022.
P4	Maria Munawar	Rhizospheric Nematodes: *Filenchus* species from cultivated areas of Southern Alberta, Canada.
P5	Longfei Wu	Pathogenicity of *Fusarium spp.* associated with root rot and wilt of soybean and evaluation of cultivar resistance
P6	Mohammed Hafez	Mutations in the CYP51 and CYTB genes related to fungicide tolerance among septoria leaf and glume blotch causing pathogens in Canada
P7	Alejandra Oviedo Ludena	Effect of diverse crop sequences on Fusarium head blight of wheat in the Canadian Prairies
P8	Anas Erathodi	Aggressiveness of *Fusarium avenaceum* isolated from different hosts on pea and lentil

Abstracts

Regular Oral Presentations

A1 – Clubroot-induced changes in the root and rhizosphere microbiome of susceptible and resistant canola. J. CORDERO-ELVIA, L. GALINDO-GONZALEZ, R. FREDUA-AGYEMAN, S.F. HWANG & S.E. STRELKOV. *Department of Agricultural, Food and Nutritional Sciences, University of Alberta, Edmonton, AB T6G2P5, Canada; and (L.G.-G) Ottawa Plant Laboratory, Science Branch, Canadian Food Inspection Agency, 3851 Fallowfield Road, Ottawa, ON K2H 8P9, Canada*
Clubroot, caused by the soilborne parasite *Plasmodiophora brassicae*, is a major disease of canola (*Brassica napus* L.) in Alberta. The use of resistant cultivars is currently the main clubroot management practice, but the emergence of resistance-breaking *P. brassicae* pathotypes indicates that the disease poses a continued threat to canola production. Rhizosphere and root-associated microbiomes may have important implications for pathogen control and crop protection, yet have not been examined in the context of clubroot of canola. In this study, we characterized the root and rhizosphere related microbiomes of clubroot-resistant and clubroot-susceptible canola challenged with pathotype 3A. The experiment was conducted under greenhouse conditions with canola lines TR_0277 and TS_0244 as the resistant and susceptible hosts, respectively. Three biological replicates were included for each line and treatment (inoculated and non-inoculated), and samples were harvested at 7, 21 and 35 days after inoculation (dai) to determine microbial diversity and abundance. Clubroot development was assessed at 42 dai, and expressed as a disease severity index (DSI, 0-100%). On the resistant host TR_0277, the DSI was 50%, suggesting it was not fully resistant and/or that the high inoculum pressure resulted in some disease. Metabarcoding analysis indicated a shift of the bacterial communities in both canola lines, in response to inoculation treatments in the root and rhizosphere at 7dai and 35dai, respectively. Fungal communities associated with the rhizosphere exhibited significant differences between sampling times, whereas root communities differed among canola lines, sampling times and treatments.

A2 – The impact of row spacing, seeding rate, and fungicide timing on the severity of leaf disease, fusarium kernel damage, deoxynivalenol, and productivity of spring wheat. T.K. TURKINGTON, H. KLEIN-GEBBINCK, K. XI, S. REHMAN, B. BERES, R. ABOUKHADDOUR, PRABHATH LOKURUGE, A. MULENGA, G. PENG, W. MAY, R. MOHR, G. TELMOSSE, D. PAGEAU, A. FOSTER, B. BLACKWELL, H. KUBOTA, B. TIDEMANN, & G. SEMACH. *(TKT, HK, BT) Lacombe Research and Development Center, Agriculture and Agri-Food Canada, Lacombe, AB T4L 1W1, Canada; (HKG) Beaverlodge Research Farm, Agriculture and Agri-Food Canada, Beaverlodge, AB T0H 0C0, Canada; (KX, SR) Field Crop Development Centre, Olds College, Lacombe, AB T4L 1W8, Canada; (BB, RA) Lethbridge Research and Development Center, Agriculture and Agri-Food Canada, Lethbridge, AB T1J 4B1, Canada; (PL, AM) Scott Research Farm, Agriculture and Agri-Food Canada, Scott, SK S0K 4A0, Canada; (GP) Saskatoon Research and Development Centre, Agriculture and Agri-Food Canada, Saskatoon, SK S7N 0X2, Canada; (WM) Indian Head Research Farm, Agriculture and Agri-Food Canada, Indian Head, SK S0G 2K0, Canada; (RM) Brandon Research and Development Center, Agriculture and Agri-Food Canada, Brandon, MB R7A 5Y3, Canada; (DP, GT) Normandin Experimental Farm, Agriculture and Agri-Food Canada, Normandin, QC G8M 4K3, Canada; (AF) Crops and Livestock Research Centre, Agriculture and Agri-Food Canada, Charlottetown, PEI C1A 4N6, Canada; (BB) Ottawa Research and Development Centre, Agriculture and Agri-Food Canada, Ottawa, ON K1A 0C6, Canada*
The impact of row spacing, seeding rate, and fungicide timing were assessed at seven Canadian spring wheat sites in 2019 and 2021. Narrow and wide row spacings (RS) were only set up at four sites. Seeding rates (SR) of 200 and 400 seeds m^{-2} were used. Fungicide (Prosaro XTR) timings included: no

treatment (check); the start of anthesis (early); a late application 7-10 days after the start of anthesis (late); and a dual early and late application (dual). Leaf spot levels in 2019 were low at four sites, while low to moderate levels occurred at the remaining three sites. In 2021, leaf spot levels were low at all sites except for Charlottetown. Overall in 2019 and 2021, RS and its interaction with other factors generally had limited impacts on disease, crop productivity and kernel quality. At some sites in both years the higher SR had increased leaf spot severity. Leaf disease was lower than the check, but similar for all fungicide treatments, although at some sites the dual application had the lowest levels. In both years the highest yields tended to occur for the early and dual applications. In 2019, elevated deoxynivalenol (DON) levels at one site decreased with increased RS and SR, although there was an interaction whereby SR differences were only significant for the narrow RS. Overall in both years, DON levels were generally lowest for the dual or late treatment, intermediate for the early treatment, and highest for the check.

A3 – Development of a loop-mediated isothermal amplification (LAMP) method to detect the potato zebra chip pathogen '*Candidatus* Liberibacter solanacearum' (Lso) and differentiate haplotypes A and B. JUNYE JIANG[1, 2], WILL FEINDEL[1, 2], KYLIE SWISHER GRIMM[3], MICHAEL HARDING[4], DAVID FEINDEL[2], STACEY BAJEMA[1] & JIE FENG[2]. *[1]Potato Growers of Alberta, Edmonton, AB, T5Y 6H3, Canada; [2]Alberta Plant Health Lab, Alberta Agriculture, Forestry and Rural Economic Development (AAFRED), Edmonton, AB, T5Y 6H3, Canada; [3]USDA-ARS Temperate Tree Fruit and Vegetable Research Unit, Prosser, WA, 99350; [4]Crop Diversification Centre South, AAFRED, Brooks, AB, T1R 1E6, Canada.*
Candidatus Liberibacter solanacearum (Lso) is the causal agent of zebra chip of potato (*Solanum tuberosum*), which can significantly reduce potato yield. In this study, a loop-mediated isothermal amplification (LAMP) method for the detection of Lso haplotypes A and B was developed and evaluated. Two sets of LAMP primers named LAMP-A and LAMP-B were designed and tested for specificity and sensitivity. Both LAMP-A and LAMP-B were specific to Lso in *in silico* analysis using the Primer-Blast tool. The LAMP-A and LAMP-B could only produce positive signal from DNA mixtures of Lso-infected tomato but not from the genomic DNA of 37 non-target plant pathogens. The sensitivity of LAMP-A and LAMP-B on Lso haplotypes A and B were tested on gBlocks and genomic DNA from Lso-infected tomato. On the genomic DNA, for LAMP-A, the lowest amount of template DNA for a positive LAMP reaction was 2 to 20 ng on four haplotype A strains and 20 to 80 ng on four haplotype B strains; for LAMP-B, the lowest amount of template DNA for a positive LAMP reaction was 0.02 to 2 ng on four haplotype B strains and 20 ng to no amplification on four haplotype A strains. On gBlocks, for LAMP-A, the lowest number of copies for a positive LAMP reaction was 60 on haplotype A and 600 on haplotype B; for LAMP-B, the lowest number of copies for a positive LAMP reaction was 60 on haplotype B and 600 on haplotype A. Therefore, considering the convenience of the LAMP technique, as well as the high specificity and sensitivity, the LAMP-A and LAMP-B primers can be used together to test the probable Lso-infected plant or psyllid samples to rapidly, accurately and directly differentiate haplotypes A and B. We highly recommend this LAMP system to plant pathology practitioners and diagnostic labs for routine detection of Lso and confirmation of zebra chip disease on potato or tomato.

A4 – The evolution of clubroot spread in Alberta. Y. AIGU[1], V.P. MANOLII[1], F.M. HAMELIN[2] & S.E. STRELKOV[1]. *[1] Department of Agricultural, Food, and Nutritional Science, University of Alberta, Edmonton, T6G 2P5, Canada; [2] Institut de Génétique, Environnement et Protection des Plantes, INRAE, Rennes, 35000, France;*
Clubroot, caused by the obligate parasite *Plasmodiophora brassicae*, is a soilborne disease of canola and other cruciferous hosts. Infection by *P. brassicae* is associated with the formation of large galls on the roots of susceptible plants, leading to important yield losses. In Alberta, clubroot was first

identified on canola in 2003 and targeted surveys have been conducted annually since 2005. At present, the disease is managed mainly by planting clubroot-resistant cultivars, which initially became available in 2009. However, in 2013, resistance-breaking genotypes of *P. brassicae* were detected on canola in Alberta for the first time. This study had as its main objective to characterize the spread of the clubroot pathogen, including the patterns and rates of dissemination of wild-type (WT) and resistance-breaking (RB) genotypes of *P. brassicae*. Epidemiological approaches, including mathematical modeling in a context of mosaics of host genotypes (susceptible and resistant), have been applied to improve our understanding of *P. brassicae* dissemination, to evaluate the efficacy of efforts to limit clubroot spread, and to predict the evolution of this spread. By 2021, clubroot had been detected more than 4900 times in about 3600 different fields across Alberta. RB isolates had been confirmed in more than 250 *P. brassicae*-infested fields. Based on these data, a large variety of maps have been generated to illustrate clubroot spread clearly on a province-wide scale. In terms of spread, RB genotypes of *P. brassicae* appear to have a lower rate of field infestation than WT genotypes, suggesting a potential fitness cost associated with resistance-breaking capacity. However, due to their capacity to appear in any WT infested field by mutation, the area under RB pressure increases faster.

A5 – Diagnosis of bacterial leaf streak on wheat and barley by qPCR. J. FENG. *The Alberta Plant Health Lab, 17507 Fort RD NW, Edmonton, AB T5Y 6H3*
A probe-based quantitative PCR (qPCR) system was developed for detection of bacterial leaf streak (BLS) pathogens *Xanthomonas translucens* pathovar (pv.) *undulosa* on wheat and *X. translucens* pv. *translucens* on barley. The system can detect the bacteria from both infected grain and leaf tissues, and one qPCR reaction can test DNA from the surface of one wheat/barley grain. In addition, based on the candidate genes identified in the designing of the qPCR, a duplex qPCR system was developed, which can differentiate pv. *undulosa* and pv. *translucens*. The robustness of the duplex qPCR as a diagnostic tool for BLS will be further evaluated. A seed testing protocol using the qPCR and/or duplex qPCR will be developed and standardized.

A6 – Unravelling the cell wall integrity cascade in *Fusarium graminearum.* NORA A. FOROUD[1], DIANEVYS GONZÁLEZ-PEÑA FUNDORA[1], SUSAN STASIUK[1], ANAS ERANTHODI[1], DARIA RYABOVA[1], KRISTINA SHOSTAK[2], RAJAGOPAL SUBRAMANIAM[2], CHRISTOF RAMPITSCH[3], POOJA SRIDHAR[4], TANYA SHARMA[4], MICHELE LOEWEN[4] & NEHAL THAKOR[5]. *[1]Lethbridge Research and Development Centre, Agriculture and Agri-Food Canada, 5403 1st- Avenue South, Lethbridge AB, Canada, T1J 4B1; [2]Ottawa Research and Development Centre, Agriculture and Agri-Food Canada, 960 Carling Avenue, Ottawa, ON, Canada, K1Y 4X2; [3]Aquatic and Crop Resources Development Research Center, National Research Council of Canada, 100 Sussex Drive, Ottawa, ON, Canada, K1A 0R6; [4]Morden Research and Development Centre, Agriculture and Agri-Food Canada, 101 Rte 100 #100, Morden, MB R6M 1Y5; [5]Department of Chemistry and Biochemistry, University of Lethbridge, 4401 University Drive West, Lethbridge AB, Canada, T1K 3M4*
Fusarium graminearum is one of the main pathogens involved in Fusarium head blight (FHB) disease of cereals. The fungus produces harmful trichothecene mycotoxins, such as deoxynivalenol (DON), that accumulate in the grain of infected crops. Pathogen aggressiveness has been linked with the onset of DON biosynthesis, and a handful of effector proteins involved in aggressiveness have been identified in *F. graminearum*. The expression or activation of some effector proteins in different plant-pathogen interactions have been linked to mitogen-activated protein kinases (MAPKs). MAPKs are also involved in important regulatory process in, such as cell division, growth and development. MAPKs are activated by phosphorylation, and they themselves act through the phosphorylation of target proteins. By altering the sequence of some MAPKs, it is possible to mimic the phosphorylated form of the enzyme, and as a result the 'phosphomimic' will be constitutively active when the gene is

expressed. In the present study, disruption/knockout mutants, overexpression strains and phosphomimetics were generated targeting the *Fusarium graminearum* Mkk1 and Mgv1 MAPKs of cell wall integrity pathway (CWI). Characterization of the strains for growth and development, disease aggressiveness, as well as some molecular characterization will be presented.

A7 – Virulence of *Rhynchosporium commune* isolates from Alberta on barley differential genotypes. S. REHMAN, S. WATERMAN, K. XI & T.K. TURKINGTON. *Field Crop Development Centre, Olds College, Lacombe, AB T4L 1W8; (T.K.T.) Lacombe Research and Development Centre, Agriculture and Agri-Food Canada (AAFC), Lacombe AB, T4L 1W1*
Alberta is the largest producer of barley in Canada, and among various biotic stresses which limit its productivity, scald or leaf blotch (*Rhynchosporium commune*) is the most destructive disease. It can overcome genetic resistance in cultivars and can also develop fungicide resistance within a short period of time due to its high genetic diversity. Therefore, the identification and deployment of genetic resistance is the most economical and environmentally friendly strategy to combat this pathogen. For this purpose, knowledge of pathogen population structure and effective resistance genes is crucial for designing a resistance breeding strategy. In this study, the response of 28 *R. commune* isolates from central Alberta was studied on 11 barley differentials including genotypes with major resistance genes from Hudson (*Rh*), Atlas 46 (*Rrs1* (*Rh3*), *Rrs2*)), Kitchin (*Rrs3*), and Turk (*Rrs1*$_{Turk}$ *(Rh3), Rh5,*) under controlled conditions. Based on their infection responses, the 28 *R. commune* isolates were classified into 12 pathotypes. Two barley differentials, Harrington and Argyle, were susceptible to 27 and 25 *R.* commune isolates, respectively. Furthermore, two *R. commune* isolates from Edmonton (ED5 and ED6) had a wider virulence spectrum than the check isolate (40NROT01). The *R. commune* isolate ED5 was avirulent on Hudson, Atlas 46, Seebe, and Manny, whereas the *R. commune* isolate ED6 was virulent on all barley differentials except on Hudson and Kitchin. Barley differential genotypes including Hudson (*Rh*), Atlas 46 (*Rrs1* (*Rh3*), *Rrs2*), and Kitchin (*Rrs3*) were resistant to 28, 27, and 26 *R.commune* isolates, respectively. These resistant barley genotypes can be utilized in scald resistance breeding programs.

Regular Poster Presentations

P1 – Reduction of resting spores of *Plasmodiophora brassicae* with wheat and lime. SARAH DRURY, BRUCE D. GOSSEN, & MARY RUTH McDONALD, *University of Guelph, Guelph, ON, Canada, (B. D. G.) Agriculture & Agri-Food Canada, Saskatoon, SK, Canada.*
Plasmodiophora brassica, the cause of clubroot, survives as persistent resting spores in soil. Clubroot of canola is managed with genetic resistance in Canada, but resistance is not durable. Applying lime to soil to increase the pH can reduce clubroot severity, possibly by suppressing the germination of resting spores. Growing grasses and cereal crops can stimulate the germination of resting spores and reduce inoculum in soil. It was not clear if combining lime and a cereal crop would counteract each other or further decrease resting spore numbers in soil. Controlled environment studies were conducted with soil inoculated with resting spores of *P. brassicae*. The pH treatments were no lime (pH 6.4) and calcium hydroxide applied to achieve a pH of 7.0 and 7.6. Spring wheat cv. ACC Connery was seeded at 10 seeds per pot. There was a no plant (bare soil) control. There were six reps (pots) per treatment. The study was conducted over 8 weeks. The concentration of resting spores was determined using qPCR. The log of the spore concentration was analyzed as a factorial with crop and pH as main factors. There was no interaction between crop and pH. The spore concentration was slightly lower in wheat than in bare soil, 2.7×10^6 vs. 3.7×10^6, respectively, and slightly lower in soil at pH 7.6 than pH 6.4, 2.4×10^6 and 4.0×10^6, respectively. The greatest reduction in resting spore concentration was achieved with wheat at high soil pH.

P2 – Type of soilless mix influences the development of clubroot (*Plasmodiophora brassicae*). S. G. CHESNEY, B. D. GOSSEN, J. ROBSON & M. R. MCDONALD. *University of Guelph, 50 Stone Road East, Guelph, ON NIG 2W1, Canada and (B.D.G.) Saskatoon Research and Development Centre, Agriculture and Agri-Food Canada, 107 Science Place, Saskatoon, SK Z7N 0X2, Canada*
Clubroot is caused by the soil-borne pathogen *Plasmodiophora brassicae* Woronin which causes distinctive clubbing symptoms on infected roots of brassica crops. Soilless mixes are a common growth media used in controlled environment studies to assess pathogen biology and disease reaction to clubroot. A growth room study was conducted to assess clubroot severity that developed in two soilless mixes: LA4 (Sungro) and BM6 HP (Berger). These soilless mixes have similar characteristics, including percentage of peat moss (LA4: 63 –73%, BM6: 65 –73%) and perlite (LA4: 30%, BM6: 22%) and pH (LA4: 5.7, BM6: 5.8). However, BM6 has lower electrical conductivity (822 µS cm^{-1}) than LA4 (1148 µS cm^{-1}) based on lab testing. The effect of compaction of the growth medium was assessed by comparing dry soilless mix placed directly from the bag into tall plastic pots versus wet soilless mix saturated with water. Seedlings of canola (*Brassica napus* L.) cultivar 'L233P', 10 seedlings per experimental unit, were inoculated with 5 mL of 1×10^6 or 1×10^8 resting spores mL^{-1} of *P. brassicae* pathotype 2 (Williams' system). Clubroot severity was assessed 5 weeks after inoculation. Canola grown in LA4 exhibited above-ground symptoms within 3 weeks of inoculation while plants grown in BM6 did not develop above-ground symptoms. Across potting method and inoculum concentration, plants grown in LA4 developed high clubroot incidence and severity. Canola grown in BM6 developed few or no clubroot symptoms. These results demonstrate the importance of choosing a suitable soilless mix for studies on clubroot development.

P3 – The interaction of lime and boron to manage clubroot on canola, 2022. S. G. CHESNEY, B. D. GOSSEN & M. R. McDONALD. *University of Guelph, 50 Stone Road East, Guelph, ON NIG 2W1, Canada and (B. D. G.) Saskatoon Research and Development Centre, Agriculture and Agri-Food Canada, 107 Science Place, Saskatoon, SK Z7N 0X2, Canada*
Clubroot of canola (*Brassica napus*) is caused by the soil-borne pathogen *Plasmodiophora brassicae*. Raising soil pH with agricultural lime or applying moderate levels of boron have been used to reduce clubroot severity. Two field trials were conducted on high organic matter (muck) soil in 2022 to assess the interaction of lime and boron on clubroot severity. In one trial, standard lime (calcium carbonate) was applied in the fall and supplemented with hydrated lime (calcium hydroxide) in the spring to reach the target pH of 7.0 and 7.5 from a starting pH of 6.4. In a second trial, lime was applied in the spring as calcium hydroxide. Boron (Solubor) was applied at 16 kg B/ha to both trials, two weeks after calcium hydroxide application using a backpack sprayer. Both trials were seeded with clubroot susceptible canola and assessed for clubroot severity 6 weeks later using a 0-3 scale to calculate disease severity index. There was no interaction between lime and boron. Lime reduced clubroot severity in both trials (fall applied - pH 6.4 = 64%, 7.0 = 21%, 7.5 = 24%; spring applied – pH 6.4 = 73%, 7.0 = 40%, 7.5 = 41%). There was a significant negative correlation between pH and disease severity in both trials (fall applied: r^2 = -0.75; spring applied: r^2 = -0.57). Boron reduced clubroot severity slightly in the spring applied trial (58% vs 45%) but not in the fall trial. Lime can be used to manage clubroot but the use of clubroot requires further study.

P4 – Rhizospheric Nematodes: *Filenchus* species from cultivated areas of Southern Alberta, Canada. M. MUNAWAR, A.U. RAHMAN, P. CASTILLO & D.P. YEVTUSHENKO. *Department of Biological Sciences, University of Lethbridge, 4401 University Drive W, Lethbridge, AB T1K 3M4, Canada; (P.C) Institute for Sustainable Agriculture (IAS), Spanish National Research Council (CSIC), Campus de Excelencia Internacional Agrolimentario, ceiA3, Avenida Menendez Pidal S/N, 14004 Cordoba, Spain*

The soil is a vital component of the farming system where soil-inhabiting nematodes play several ecological roles. Most of these nematodes are completely harmless, whereas some pose a serious threat to crop production. Nematode diversity surveys allow researchers to identify dominant nematode species and assess their risk levels in cultivated areas. Therefore, the current study aims to present the characterization of five *Filenchus* (*F. cylindricus, F. hazenensis, F. sheri, F. thornei* and *F. vulgaris*) species detected in our recent soil surveys. Four of the recovered species are new records in Canada, while *F. hazenensis* is a native species that was previously described from the high arctic area. Morphologically the recovered species have slender bodies, four lateral lines, short delicate stylets (> 15µm) and filiform tails. Molecular characterization was carried out using 18S, D2-D3 region of 28S and ITS rDNA genes. *Filenchus* species are polyphagous, migratory nematodes, generally classified as fungal or plant root hair feeders. These nematodes are not considered pest species, their ecological significance rendered them a subject of higher interest in soil health and conservation studies. Moreover, their mycophagy has been tested against several phytopathogenic and saprophytic fungi. The photo-documentations and molecular data obtained during this study will facilitate accurate species identification and likely aid in decision-making on whether these eco-friendly nematode species qualify to become part of sustainable management programs.

P5 – Pathogenicity of *Fusarium spp.* associated with root rot and wilt of soybean and evaluation of cultivar resistance. LONGFEI WU[1], STEPHEN E. STRELKOV[1], YONG MIN KIM[2], OWEN WALLY[3] & SHEAU-FANG HWANG[1]. *[1]Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada; [2]Agriculture and Agri-Food Canada, Brandon Research and Development Centre, Brandon, MB R7C 1A1; [3]Agriculture and Agri-Food Canada, Harrow Research and Development Centre, Harrow, ON N0R 1G0*
Fusarium spp. can cause root and stem rot, wilt and sudden death of soybean (*Glycine max* L.). Surveys in Canada have often identified six species from diseased soybean root samples, including *F. oxysporum*, *F. redolens*, *F. graminearum*, *F. solani*, *F. avenaceum* and *F. acuminatum*. This study aimed to evaluate the pathogenicity of these species and assess host resistance in a selection of soybean cultivars. Pathogenicity was tested on two cultivars, 'Akras' (moderately resistant) and 'BISOYI' (susceptible) under greenhouse conditions. Twelve isolates (two per species) were inoculated separately into potting medium, and seedling emergence, plant height, root rot severity, and dry root and shoot weight were monitored. Symptoms caused by the different *Fusarium* spp. varied, and included rotting, girdling and the development of brown and sunken lesions. The virulence of the fungal isolates also varied, with root rot severities ranging from 1.5 to 3.3 on a 0-4 scale. The greatest reduction in emergence of either cultivar was caused by *F. avenaceum*. Plant height was reduced following inoculation with any of the species, with the exception of *F. oxysporum* and *F. redolens* on 'BISOYI'. The most virulent isolates of each species were used to screen 20 Canadian soybean cultivars for resistance in a greenhouse. Cluster and principal component analyses were conducted based on the same traits as for the pathogenicity study. Two cultivars clustered in the resistant group for *F. oxysporum*, *F. redolens*, *F. graminearum* and *F. solani*, while another two cultivars were most resistant to *F. avenaceum* or *F. acuminatum*.

P6 – Mutations in the *CYP51* and *CYTB* genes related to fungicide tolerance among septoria leaf and glume blotch causing pathogens in Canada. M. HAFEZ, K. TAN, N. SCHATZ, J. PEACOCK, M. ZID, D. GONZALEZPENAFUNDORA, T. K. TURKINGTON & R. ABOUKHADDOUR. *Agriculture and Agri-Food Canada, Lethbridge Research and Development Center, Lethbridge, T1J 4B1, AB, Canada; (T.K.T.) Agriculture and Agri-Food Canada, Lacombe Research and Development Center, Lacombe, T4L 1W1, AB, Canada.*

Sterol demethylation inhibitors (DMIs) and quinone outside inhibitors (QoIs) are widely used to manage agronomically important wheat fungal pathogens in Canada and worldwide. Several reports indicate the rise of DMI- and QoI-insensitive pathogens. The aim of this study was to investigate mutations in the cytochrome P51 (*CYP51*) and cytochrome b (*CYTB)* genes in a Canadian *Parastagonospora nodorum* and *Parastagonospora pseudonodorum* populations. The full length of *CYP51* and *CYTB* genes were sequenced in 89 isolates (71 *P. nodorum* and 18 *P. pseudonodorum*) recovered from wheat in Canada between 1976 and 2021. The coding sequence for *CYTB* gene (encodes the target protein of QoI fungicides) was found to be identical in all tested isolates, whereas the coding sequence for *CYP51* gene (encodes the target protein of DMI fungicides) showed many mutations. An updated global *CYP51* haplotype network was constructed, and a total of 16 *CYP51* haplotypes were obtained with 18 polymorphic sites, and translation of coding sequences to amino acids indicated the prevalence of synonymous (13) over nonsynonymous (5) substitutions. Two nonsynonymous mutations unique to *P. nodorum* isolates from Manitoba were observed. Among the *P. pseudonodorum* isolates, four *CYP51* haplotypes were identified with two nonsynonymous mutations at the positions R192Q and A343V. This is the first report on *CYP51* and *CYTB* gene polymorphism in Canadian *P. nodorum* populations, and the first report on genetic diversity in these genes in *P. pseudonodorum*. Further validation on the impact *CYP51* mutations on DMI fungicide tolerance will be conducted.

P7 – Effect of diverse crop sequences on Fusarium head blight of wheat in the Canadian Prairies.

M. A. OVIEDO-LUDENA[1], K. COLES[2], M. GRETZINGER[2], R. MOHR[3], D.L. MCLAREN[3], M. A. HENRIQUEZ[4] & H.R. KUTCHER[1]. *[1] Department of Plant Sciences / Crop Development Centre, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK, Canada, S7N 5A8; [2] Farming Smarter, 211034 AB-512 Lethbridge, AB, Canada, T1J 5N9; [3] Brandon Research Station, Agriculture and Agri-Food Canada, 2701 Grand Valley Rd, Brandon, MB, Canada, R7C; [4] Morden Research and Development Centre, Agriculture Agri-Food Canada, 101 Rte 100 #100, Morden, MB, Canada, R6M 1Y5.*

Fusarium head blight mitigation requires an integrated disease management approach that includes a diverse crop rotation, FHB resistant varieties and depending on risk, a fungicide application. In Canada, intensive cereal rotations make managing the disease difficult. It is imperative to follow a diverse crop rotation that includes non-host crops to reduce the proliferation of FHB pathogens. The aim of this study was to determine the effect of multiple host and non-host crops in a planned sequence on FHB incidence and severity of bread or durum wheat. Crop yield and quality [thousand kernel weight (TKW), test weight (TW), protein content, and deoxynivalenol (DON) content] was assessed with each year. The crop sequences included wheat, canola, barley, and pea, as well as maize, in a split-block design with three replicates. The experiment was conducted over three growing seasons (2018-2020) at three sites; durum wheat sites were Lethbridge, AB and Saskatoon, SK, while the bread wheat site was at Brandon, MB. The incidence and severity of FHB were low in 2018 and 2020; the 2019 stubbles had the greatest impact on the cereals grown in 2020. High FHB severity, leaf spots, F. graminearum, and *F. poae* increased in durum and bread wheat when grown after host crops compared to non-host crops. *Fusarium poae* proliferated in cereal kernels after warm, dry years. When oilseeds and pulses were included in the crop sequences, increased yield (11%), TW, TKW, and protein content were observed indicating the benefit of diverse crop sequences on FHB mitigation.

P8 – Aggressiveness of *Fusarium avenaceum* isolated from different hosts on pea and lentil

A. ERANTHODI, D. OVERY, L. HARRIS, M. HUBBARD, T. SCHWINGHAMER, N.A. FOROUD & S. CHATTERTON *(A.E., T.S., N.A.F., S.C.) Lethbridge Research and Development Centre,*

Agriculture and Agri-Food Canada, 5403-1st Avenue South, Lethbridge, AB T1J 4B1; (D.O., L.H.) Ottawa Research and Development Centre, Agriculture and Agri-Food Canada, 960 Carling Avenue, Ottawa, ON K1A 0C6; (M.H.) Swift Current Research and Development Centre, Agriculture and Agri-Food Canada, 1 Airport Road, Swift Current, SK S9H 3X2.
Fusarium avenaceum Fr. (Sacc). is a causal agent of root rot complex in pulses and is also found associated with head blight of cereals. As a first step to determine the effect of wheat-pulse rotations on *F. avenaceum* pathogenicity, 19 *F. avenaceum* isolates collected from pulses and 16 from wheat were tested for aggressiveness in pea cultivar CDC Meadow, and red lentil cultivar CDC Proclaim, using seed or soil inoculation methods. Seed inoculation of CDC Meadow resulted in very high disease levels such that most plants did not emerge out of soil and therefore the trial was not repeated. In two soil inoculation trials for CDC Meadow, there was variation in aggressiveness among the isolates. Overall, isolates from pulses caused statistically significantly greater disease severity and lower fresh biomass compared to isolates from wheat. There was no significant difference between means of emergence in trial 1. In trial 2, the means of emergence was significantly less for plants inoculated with isolates from pulses. In contrast to seed inoculation in CDC Proclaim, where the mean of disease severity was greater for isolates from pulses, the first trial of soil inoculation resulted in more disease for isolates from wheat. For CDC Proclaim, soil inoculation resulted in relatively low disease levels compared to seed inoculation. A second soil inoculation trial in CDC Proclaim is underway. In addition to the disease assays in pulses, the 35 isolates will be screened for their ability to cause Fusarium head blight in the durum wheat cultivar, Langdon.

Student Abstracts

S1 – Characterization of atypical isolates of *Pyrenophora tritici-repentis* (tan spot) from durum wheat. Z. AUBREY-HÉBERT, I.S. STRELKOV, M. LARIBI, & STRELKOV, S.E. *Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5, Canada*
Pyrenophora tritici-repentis (tan spot) is a complex foliar pathogen that primarily infects hexaploid (bread) and tetraploid (durum) wheat, as well as a variety of wild grass species. Eight races of *P. tritici-repentis* have been described worldwide, based on their virulence patterns on a host differential set. The virulence of these races reflects their capacity to produce three known necrotrophic effectors (NE), either alone or in various combinations. Recently, 'atypical' isolates of *P. tritici-repentis*, which induce the necrosis typical of some of these races but lack the corresponding NE, were identified from durum wheat in North Africa (Tunisia), a secondary centre of diversity of this crop. The aim of this study was to characterize additional collections of *P. tritici-repentis* from Tunisia, in order to determine their virulence profiles and assist in the identification of novel races and NEs. Preliminary characterization of 53 isolates on the standard differential set indicated that 16.6% were classified as races 3 and 8, while 50% were race 5. In addition, 16.6% of the isolates appeared to induce atypical responses, meaning that the host response to inoculation did not seem to fit the standard reactions to the eight known races. Additional testing is underway to confirm these reactions, and all isolates will be assessed for the presence or absence of the known NE-encoding genes. An improved knowledge of the virulence of *P. tritici-repentis*, including the occurrence of novel races and NEs, will be important for the sustainable management of tan spot of wheat.

S2 – Potato early dying disease complex: identification of pathogen(s) and assessing disease severity in Alberta's commercial potato fields. A.U. RAHMAN, M. MUNAWAR, M. KONSCHUH, M. TENUTA, M.W. HARDING & D. P. YEVTUSHENKO. *Department of Biological Sciences, University of Lethbridge, Lethbridge, AB T1K 3M4, Canada; (M. T) Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2, Canada; (M.W.H) Alberta Agriculture,*

Forestry and Rural Economic Development, Crop Diversification Centre South, Brooks, AB T1R 1E6, Canada.
Potato early dying (PED) disease, caused by a complex of soil-borne fungi and nematodes, is a serious threat to potato production. Successful management requires knowledge of which pathogen(s) are present. Resident fungal species associated with PED were characterized in 60 fields in southern Alberta in 2020 and 2021. Risk of PED was estimated based on the *Verticillium dahliae* inoculum densities. Selected fields with either high or low risk of PED were further studied during 2021 and 2022 growing seasons. Potato plants were assessed for PED severity and sampled every 15-16 days. Colonizing pathogens were isolated and detected using PCR. About 120 fungal isolates were obtained from potato stems, with *Verticillium* and *Colletotrichum* species predominating. PCR analyses indicated the presence of *C. coccodes* within potato plants at earlier sampling points than *V. dahliae*. About 59% and 41% of plant samples collected in 2021 and 2022, respectively, showed the co-occurrence of *V. dahliae* and *C. coccodes*. The inoculum level of *V. dahliae* in the soil before potato cropping was positively correlated with PED severity in both years. One field in 2021 and two in 2022, all designated as high-risk PED fields, showed significantly lower tuber yields than low-risk fields. Based on these results, *V. dahliae* is a primary contributing factor to PED symptoms and yield loss. The co-detection of *C. coccodes* with *V. dahliae* raises the question of whether the former is involved in PED symptoms and associated yield loss. Further research is needed to explore the role of *C. coccodes* in the PED complex in southern Alberta.

S3 – Assessing the variability and fungicide resistance of *Sclerotinia sclerotiorum* isolates collected from different host crops across Canada. B. CALDER, M. W. HARDING, A. DICKSON, S. CHATTERTON & D. YEVTUSHENKO. *Lethbridge Research and Development Centre, Agriculture and Agri-Food Canada, 5403 1st Ave S., Lethbridge, AB T1J 4B1; (M.W.H.) Alberta Ministry of Agriculture and Forestry, 301 Horticultural Station Rd., Brooks, AB T1R 1E6; (A.D.) Syngenta Canada Inc., 946863 Twp Rd 14, Plattsville, ON N0J 1S0; (D.Y.) University of Lethbridge, 4401 University Dr W, Lethbridge, AB T1K 3M4.*
Sclerotinia sclerotiorum (Lib.) de Bary causes white mould in dry bean and sclerotinia stem rot in canola, both economically damaging diseases. Fungicides are routinely applied to manage the diseases, but the sensitivity of *S. sclerotiorum* isolates to these fungicides has not been evaluated in Canada. Although *S. sclerotiorum* has been extensively studied for many years, recent studies suggested that there is greater genetic variability in pathogen populations than previously thought. Therefore, the objectives of this study were to determine the variability of aggressiveness and virulence of S. *sclerotiorum* isolates on dry bean and canola, and characterize their sensitivities to fungicides, using a pan-Canadian population. Four-hundred and fifty isolates were collected from field crops in Alberta, British Columbia, Saskatchewan, Manitoba, and Ontario. Mycelium compatibility grouping (MCG) was conducted to identify basic diversity among the isolates, and 18 MCGs have been identified to date, although testing is ongoing. The isolates were assessed for virulence and aggressiveness on two dry bean and two canola lines using a greenhouse pipette inoculation and detached leaf assay. There were clear differences among isolates, and statistical analyses are underway. Following DNA extraction, SSR marker sequencing will be conducted on representative isolates of the MCGs. Fungicide resistance testing against the most commonly used fungicide active ingredients is being conducted as part of a joint initiative with Syngenta Canada Inc. The knowledge generated from these studies will provide new insights into the diversity and fungicide resistance in *S. sclerotiorum* populations and is the first step in developing a genomics-enhanced biovigilance approach to disease management.

S4 – Evaluating the effect of foliar application of salicylic acid on clubroot development in *Brassica napus.* E. STORFIE, S.F. HWANG, & S.E. STRELKOV. *Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5, Canada*

Clubroot disease, caused by *Plasmodiophora brassicae,* poses a significant threat to Canadian canola (*Brassica napus*) production. The deployment of clubroot-resistant (CR) canola cultivars, carrying major gene resistance, has imposed significant selection pressure on *P. brassicae* populations. As a result, novel 'resistance-breaking' pathotypes have emerged, which render the CR cultivars less effective. Previous transcriptomic analyses indicated that rutabaga (*B. napus* subsp. *rapifera*) cultivars rely on the salicylic acid (SA)-mediated defence response during infection by the resistance-breaking pathotype 3A. To assess the effect of SA application on clubroot development, seven-day-old seedlings of the rutabagas 'Laurentian' (compatible) and 'Wilhelmsburger' (incompatible) were inoculated with pathotype 3A or water as a control. Exogenous SA was applied weekly as a foliar spray at 0-, 1-, 5-, and 10-mM SA, and the disease severity index (DSI) was evaluated at six weeks. Roots were harvested for genomic DNA and RNA isolation to quantify *P. brassicae* and transcript levels, respectively. In the compatible interaction, the DSI remained unchanged across all SA treatments, but a reduction in *P. brassicae* quantity was detected with 5-mM SA compared with 0-mM SA. In the incompatible interaction, 5- and 10-mM SA reduced the DSI and there was a reduction in *P. brassicae* across all treatments relative to 0-mM SA. Transcript analysis of SA-related genes is currently underway. This study seeks to confirm the reliance of *B. napus* on SA-mediated defence against the resistance-breaking pathotype 3A while exploring the potential for exogenous hormone application as another approach to improving host resistance to this important pathogen.

S5 – Propiconazole, pyraclostrobin and fluxapyraxad sensitivity of western Canadian *Cochliobolus sativus* populations. D.D. ADIHETTY, K. XI, H. KLEIN-GEBBINCK, R. ABOUKHADDOUR, H.R. KUTCHER, J. TUCKER, X. WANG, S. STRELKOV & T.K. TURKINGTON. *Department of Agricultural, Food and Nutritional Science, 410 Agriculture/Forestry Centre, University of Alberta, Edmonton, AB T6G 2P5, Canada; (K.X.) Alberta Agriculture and Forestry, Field Crop Development Centre, Lacombe, AB, T4L 1W1, Canada; (H.K.-G.) Beaverlodge Research Farm, Agriculture and Agri-Food Canada, Beaverlodge, AB T0H 0C0, Canada; (R.A.) Lethbridge Research and Development Centre, Agriculture and Agri-Food Canada, Lethbridge, AB T1J 4B1, Canada; (H.R.K.) College of Agriculture and Bioresources, Department of Plant Sciences, University of Saskatchewan, Saskatoon, SK S7N 5A8, Canada; (J.T.) Brandon Research and Development Centre, Agriculture and Agri-FoodCanada, Brandon, MB R7A 5Y3, Canada; (X.W.) Morden Research and Development Centre, Agriculture and Agri-Food Canada, Morden, MB R6M 1Y5, Canada; (S.S) Department of Agricultural, Food and Nutritional Science, 410 Agriculture/Forestry Centre, University of Alberta, Edmonton, AB T6G 2P5, Canada; (T.K.T) Lacombe Research and Development Centre, Agriculture and Agri-Food Canada, Lacombe, AB T4L 1W1*

Spot blotch, caused by *Cochliobolus sativus* (anamorph: *Bipolaris sorokiniana*), has emerged as a major concern for western Canadian barley producers. The pathogen can destroy healthy leaf tissue, limiting the plant's ability to set seed and fill grain, ultimately resulting in yield and quality losses. Under conditions favourable for disease, yield losses due to spot blotch have been estimated at 16-33%. Spot blotch management in western Canada is increasingly reliant on the use of fungicides. However, the extensive and repeated application of fungicides can result in the development of insensitivity in fungal populations. It is important, therefore, to monitor pathogen populations regularly for changes in fungicide sensitivity. In this study, a microtiter plate assay was conducted to evaluate the propiconazole, fluxapyroxad, and pyraclostrobin sensitivity of 20 representative *C. sativus* isolates from infected leaf tissue collected across western Canada. One isolate from Manitoba was found to be insensitive to propiconazole, highlighting the importance of judicious use of propiconazole to maintain

its efficacy. Future studies will include the evaluation of up to 100 *C. sativus* isolates against all three fungicides and the use of a molecular approach to study the mechanisms underlying fungicide insensitive isolates. While still in its early stages, knowledge gained from this study will help with the early detection of fungicide insensitivity in the spot blotch pathogen. This will enable improved fungicide stewardship, while emphasizing the importance of using an integrated approach for spot blotch management.

S6 – Race characterization of *Puccinia striiformis* f. sp. *tritici* population in western Canada from 2017 to 2022. K. LOU, R. BAMRAH, M. ABBASI, G.S. BRAR & H.R. KUTCHER

(K.L, H.R.K.) Department of Plant Science/Crop Development Centre, University of Saskatchewan, Saskatoon, SK S7N 5A8 Canada; (R.B., M.A., G.S.B.) Faculty of Land and Food Systems, The University of British Columbia, Vancouver, BC V6T 1Z4 Canada

Stripe rust of wheat is one of the most important diseases worldwide, especially in wheat-growing regions like Canada. *Puccinia striiformis* f.sp. *tritici* (*Pst*), the causal organism of the stripe rust, is often variable in virulence on wheat cultivars with race-specific resistance. Thus, characterization of the *Pst* population based on the virulence spectra is critical for breeding varieties with effective resistance. In the present study, a collection of western Canadian *Pst* isolates (n=30) collected from 2017 to 2022 were characterized on a set of 18 yellow rust (*Yr*) single-gene differential lines into races. Of the 30 isolates characterized, nine races were identified and matched based on both the nomenclature systems described for Canadian (C-), American and Mexican (PSTv-) *Pst* races. Race C-30 (33.3%) was the most prevalent race followed by races C-39/ PSTv-296 (16.7%), C-43/ PSTv-037 (16.7%) and C-49/ PSTv-031 (10%). Races C-17/ PSTv-041 and PSTv-14 were the fourth most prevalent races accounting for 6.7% of the isolates screened. Races C-37, C-46, and the unnamed race (C-) were the least frequently detected, with one isolate (3.3%) of each race. The results suggest that most of the current races of *Pst* in western Canada are like to have migrated from the USA, and some races (C-30, C-37, C-46, and C-) maybe of local origin; race C-30 has become more frequent since last reported in 2015. No virulence was found on *Yr5*, *Yr15*, and *YrSP* suggesting they are effective against the *Pst* population in western Canada.

SP1 – Exploring resistance to *Verticillium longisporum* in *Brassica* genotypes. Y. WANG, S.E. SRELKOV, R. FREDUA-AGYEMAN, & S.F. HWANG. *Department of Agricultural, Food and Nutritional Sciences, University of Alberta, Edmonton, AB T6G2P5, Canada*

Verticillium stripe, caused by *Verticillium longisporum*, is an emerging disease of canola (oilseed rape; *Brassica napus*) in Canada. Since its presence was first confirmed in Manitoba in 2014, *V. longisporum* has been detected in most Canadian provinces. Symptoms of Verticillium stripe include half stem senescence, stem shredding, and the development of black microsclerotia on infected tissues. Western Canadian canola growers reported yield losses due to Verticillium stripe in 2021, and in Europe *V. longisporum* infection reduces yields by up to 50%. Currently, no fungicide or soil amendments are available for Verticillium stripe management, and commercial canola and oilseed rape varieties are susceptible to the disease. The objective of this study was to identify *Brassica* genotypes with resistance to *V. longisporum*. A collection of 110 rutabaga (*B. napus* ssp. *rapifera*) and 57 other *Brassica* genotypes was screened for resistance to the pathogen under greenhouse conditions in replicated experiments. Test seedlings were inoculated using a root-dip method, with susceptible and moderately resistant checks included as controls. Disease severity was assessed at four different time-points on a 1-9 scale, and the area under the disease progress curve (AUDPC) was calculated. Several *B. rapa* and *B. oleracea* genotypes had low AUDPC values, indicating that these could serve as important sources of resistance. The identification of resistance to *V. longisporum* will be important for the effective management of this pathogen in canola.

SP2 – Exploring resistance to Fusarium wilt in Brassica genotypes under hydroponic conditions. C.X. YANG, R. FREDUA-AGYEMAN, S.F. HWANG & S.E. STRELKOV. *Department of Agricultural, Food and Nutritional Sciences, University of Alberta, Edmonton, AB T6G 2P5, Canada*

Fusarium oxysporum is a soil-borne fungal pathogen that causes wilt in a wide range of hosts, including canola (*Brassica napus*) and other Brassicas. At present, Fusarium wilt of canola is managed with resistant cultivars, but the disease has potential to re-emerge as a major concern due to climate change and other factors. Thirty-nine commercial genotypes of *B. napus*, *B. rapa*, and *B. oleracea* were evaluated for resistance to Fusarium wilt under hydroponic conditions. One-week old seedlings were inoculated by incubating the roots in a conidial suspension (10^7 spores mL^{-1}) overnight at room temperature. The seedlings were then transferred to sterilized germination paper soaked in Hoagland's solution and maintained in a growth chamber. Fusarium wilt severity was evaluated 21 days after inoculation on a 0-4 scale, where: 0 = no symptoms, 1 = slight chlorosis and stunting; 2 = moderate chlorosis and stunting; 3 = severe chlorosis (> 50% of the plant), some necrosis, moderate stunting, and wilting; and 4 = severe necrosis, wilting and stunting or even death of the whole plant. Disease severity data were analyzed using a mixed-effect model with estimated marginal means, which indicated that 18 of 39 host genotypes were susceptible (Fusarium wilt severities > 1). Based on the data of disease severity and plant height (cm), cluster analysis was also conducted to find the subgroups of observations among all cultivars. These resistance tests not only provided information on potential sources of Fusarium wilt resistance, but also illustrated the utility of hydroponics as a reliable and simple approach for resistance screening under controlled conditions.

SP3 – Effect of phytohormones on disease progression of *A. euteiches* and *F. avenaceum* infection in field pea. S. PANDIT, R. GOYAL & S. CHATTERTON. (S.P).*University of Lethbridge, 4401 University Drive, Lethbridge, AB, T1K 3M4, Canada; (S.P., S.C.) Lethbridge Research and Development Centre, Agriculture and Agri-Food Canada, 5403–1 Avenue South Lethbridge, AB, T1J 4B1, Canada; (R.G.) Lacombe Research and development center, Agriculture and Agri-Food Canada, 6000 C and E trail, Lacombe, AB, T4L 1W1*

The oomycete *Aphanomyces euteiches* and the fungus *Fusarium avenaceum* are the major contributors to the pea root rot complex (PRRC), the most devastating disease of the field pea (*Pisum sativum*). The PRRC complex can cause complete yield loss, and in the absence of resistant cultivars, the disease management options are limited. Currently, the role of phytohormones in host defense mechanisms is poorly understood. This study aims to further our knowledge of phytohormone participation in plant defense and disease progression. The 14 days old seedlings of susceptible cultivar 'CDC Meadow' were treated with 10, 50, and 100 µM concentrations of salicylic acid (SA), ethephon (ET), methyl jasmonate (MeJA), and ethylene inhibitor, 1-methyl cyclopropene (1-MCP). The hormone treatment was followed by inoculation of *A. euteiches* zoospores and *F. avenaceum* conidia in separate experiments. There was reduced root discoloration due to Aphanomyces in 100 µM SA treated seedlings compared to the controls after 7 and 14 days post inoculation (dpi). This was reflected in a lower disease severity rating (DSR) at 7 dpi. However, the pathogen biomass as quantified through qPCR did not differ significantly from the control. The SA treatment seems to have protected against Fusarium root rot as well. On the other hand, the treatment with 100 µM ET increased Fusarium root rot DSR when observed at 7 dpi. The study suggests a different role for SA and ET in PRRC disease progression, which requires further investigation.

SP4 – Effects of *Fusarium avenaceum, F. oxysporum* and *F. proliferatum* on seedling survival, growth, and root rot severity and yield of canola. H.T. YU, S.F. HWANG, R. FREDUA-AGYEMAN, K.F. CHANG, & S.E. STRELKOV. *Department of Agricultural, Food and Nutritional Sciences, University of Alberta, Edmonton, AB T6G2P5, Canada*

Seedling blight and root rot can have a substantial negative impact on canola (*Brassica napus* L.) stand uniformity and yield in western Canada. Species of *Fusarium* are among the most common causal agents of these diseases, with *Fusarium avenaceum* and *F. oxysporum* reported to be predominant. In contrast, while *F. proliferatum* can infect numerous other crops and cause rots, blights, wilts and diebacks, this fungus has not been evaluated extensively on canola. In this study, we conducted field and greenhouse experiments to determine the effects of *F. avenaceum, F. oxysporum* and *F. proliferatum* on the growth of two canola cultivars. Under field conditions, seedling emergence decreased and root rot severity increased as the inoculum concentration of all three *Fusarium* spp. increased. Yields were significantly lower than in the control at the high inoculum concentration. Interestingly, *F. proliferatum* showed a more marked effect under the dry conditions prevalent in 2021, while *F. avenaceum* was more virulent under higher moisture in 2022. Under greenhouse conditions, plant counts, plant height and shoot weight declined, and root rot became more severe, with increasing inoculum concentration. Plant height responded strongly to infection at the seedling stage. The results suggest that while all three *Fusarium* spp. contribute to the development of canola seedling blight and root rot, their relative contributions may change based on weather conditions.

SP5 – Evaluation of fall and spring lime applications for the management of clubroot of canola

ZHIYU YU, SHEAU-FANG HWANG & STEPHEN E. STRELKOV. *Department of Agricultural, Food and Nutritional Sciences, University of Alberta, Edmonton, AB, T6 G2P5.*

Clubroot, caused by *Plasmodiophora brassicae*, is a serious disease of canola (*Brassica napus*). Since acidic soils favor disease development, the application of lime to increase soil pH holds potential as a clubroot management strategy. Two lime products, Zero Grind limestone (ZG) and hydrated lime (HL) were applied at four field sites to evaluate their efficacy in reducing clubroot on a susceptible canola hybrid in 2020 and 2022. The treatments included an untreated control (UTC), ZG at rates of 5 and 10 t/ha in fall or spring, spring application of HL at 5 and 10 t/ha, and fall ZG application combined with spring application of HL at 2.5 or 5 t/ha each. Significant reductions ($p < 0.05$) in clubroot severity were observed in all of the lime-treated plots relative to the UTC, except for the 5 t/ha spring ZG application at one site in 2022. All lime treatments were more effective in 2020 than in 2022, probably due to higher precipitation in 2022 that favoured clubroot development. The spring HL treatment at 10 t/ha also lowered disease severity in all sites relative to the UTC, but was less effective in 2022. The most consistent reductions in clubroot severity across sites and years were obtained with fall ZG application at 10 t/ha, and a combination of fall ZG and spring HL at 5 t/ha; these treatments also produced the highest yields. The application of lime in the fall may represent an effective component of an integrated clubroot management strategy in canola.

SP6 – Genome wide association study reveals possible SNPs associated with the ToxC phenotype in *Pyrenophora tritici-repentis* (tan spot of wheat).

R. GOURLIE[1], M. MCDONALD[2], & R. ABOUKHADDOUR[1]. *[1]Agriculture and Agri-food Canada, LRDC, Cereal Pathology, 5403 1st Ave South, Lethbridge, AB, Canada, T1J 4B1; [2]School of Biosciences, University of Birmingham, Institute of Microbiology and Infection, Edgbaston, Birmingham, UK, B15 2TT*

Pyrenophora tritici-repentis (Died.) Drechs. (Ptr) is the causal agent of tan spot, one of the most destructive foliar pathogens of wheat worldwide. Ptr secretes three necrotrophic effectors: ToxA, ToxB, and ToxC. The exact nature of ToxC remains unknown, although recently the *ToxC1* gene was shown to be required but insufficient to produce ToxC. We have utilized 37 sequenced genomes of Ptr, 22 of which are ToxC-producing to correlate SNP data with the ToxC phenotype via a genome wide association study (GWAS). SNP variant calls were generated with Genome Analysis Toolkit using isolate M4 (v2.2) as a reference genome. Variants were filtered based on quality scores, minor allele frequency, and percentage of genomes with missed calls. Tassel (v5.2.58) was used to create distance and kinship matrices (centered identity by state) and perform principle component analysis to account

for population structure. GWAS was performed with Tassel using a Mixed-Linear-Model algorithm. A peak *-log$_{10}$(p-value)* of 3.4 was observed near the 5' end of chromosome 6 in M4. The SNP associated with the peak is located within the coding sequence of a gene with no known function (DUF1479), based on the Pfam database. Further work with GAPIT (Genome Association Prediction Integrated Tool), another GWAS program, is currently being conducted to test the robustness of the SNP peak by utilizing different methods for population structure correction (e.g., VanRaden, EMMA) and alternative GWAS modelling (e.g., BLINK, MLMM). Comparative analysis of the region surrounding the peak has not yet provided concrete differences between ToxC-producing and ToxC-non-producing isolates.

SP7 – Stripe rust in Alberta threatens the Canadian wheat. B. WEI, R. GOURLIE & R. ABOUKHADDOUR. *Agriculture and Agri-Food Canada, Lethbridge Research and Development Center, Lethbridge, T1J 4B1, AB, Canada*

Stripe rust is a major wheat disease caused by the biotrophic fungus *Puccinia striiformis* f. sp. *tritici* (*Pst*). In Canada, stripe rust was initially identified in the early 1900s and became an economic threat to wheat since 2000. Commercial cereal fields in southern Alberta were surveyed from 2016 to 2022. Stripe rust was observed in over 25% of surveyed fields in 2016, 2017, 2019, and 2020. However, stripe rust was rare (< 10%) in 2018, 2021, and 2022, which attributed to the high temperatures and prevailing dry conditions. To understand virulence shift in *Pst* in Alberta, 38 single-stripe isolates were recovered from diseased samples between 2020 to 2022 and spores were increased on susceptible host to perform race characterization. Yr-16-5 is a previously identified virulent race from Alberta, and it can defeat 14 known *Yr* genes. Yr-16-5 was used to evaluate the reaction of 100 wheat cultivars representing wheat development in Canada over the past 100 years at the seedling stage. Only 11 (11%) cultivars were resistant, while 60 (60%) and 29 (29%) cultivars were rated as susceptible and intermediate susceptible, respectively on a scale 0 to 9. The high proportion of the susceptible cultivars suggests that stripe rust remains a high threat in Canada. Future work will be concentrated on the race characterization of the additional collected and purified isolates and the genetic analysis of the virulent isolates.

SP8 – Effects of root architecture and nitrogen level on clubroot of canola. D. ROTARIU, R. FREDUA-AGYEMAN, S.F. HWANG, & S.E. STRELKOV. *Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5, Canada*

Clubroot, caused by the obligate, soil-borne parasite *Plasmodiophora brassicae*, is a serious threat to the Canadian canola industry. Additionally, canola crops require a high nitrogen input, leading to the over-application of chemical fertilizers, which can result in harmful effects on the environment and decreased oil concentration in canola seed. Studies have shown that high nitrogen availability can increase the severity of infections from obligate parasites, suggesting a need to develop canola with lower nitrogen requirements. A possible approach to mitigating the clubroot threat and high nitrogen requirements comes from breeding for improved root architecture traits. Root systems play an important role in plant-environment interactions, specifically plant adaptation to stress, because they allow plants to respond to the soil microenvironment. In growth chamber trials, 10 different fertilizer (Hoagland's No. 2 Basal Salt Mixture) concentrations (relative to the recommended full-strength dose of 1.6 g/L) were evaluated for their effects on the roots of four Brassica cultivars. Roots were scanned and root architectural traits were measured including primary root length, primary and lateral branching, density, diameter, angle, and total root surface. Statistical analysis of the results is currently underway. Based on these results, one low and one high rate of fertilizer will be chosen and their effects on the resistance response of ~45 Brassica genotypes to two important pathotypes (3A and 3H) of *P. brassicae* will be measured. This study may help in the identification of clubroot-resistant

germplasm adapted to low-nitrogen conditions, contributing to more sustainable management of this disease.

Technician Abstracts

TP1 – Evaluation of antimicrobial peptides for their inhibitory activities against root rot pathogens of field pea (*Pisum sativum L.*) under *in vitro* and *in planta*. A. J. HANNIG, D. SHAH AND R. K. GOYAL. *Lacombe Research and Development Centre, Agriculture and Agri-Food Canada (AAFC), 6000 C & E Trail, Lacombe, AB T4L 1W1, Canada; and (D.S.) Donald Danforth Plant Science Center, St, Louis, MO, 63132, USA.*

Root rot in field pea (*Pisum sativum L.*), caused by *Aphanomyces euteiches, Fusarium avenaceum,* and other *Fusarium spp*. significantly reduces crop yields. At present, the disease management options through resistant cultivars and chemical treatments are limited. We explored another defense mechanism, innate immunity, which protects plants using small peptides that possess antimicrobial activities against a diverse range of pathogens. Antimicrobial peptides (AMPs) are short-chained (>100 amino acid) with broad antimicrobial activity against bacterial and fungal pathogens. In this study, four AMPs sourced from other plant proteomic data were evaluated for their *in vitro* activity. It showed a potent toxic effect against root rot pathogens. For *in planta* activity, the peptide genes were cloned in *Agrobacterium rhizogenes* (strain R1000), which was used to transform the roots of a susceptible cultivar, 'ACC Chrome'. The transformed hairy roots were characterized for the presence of transgenes. The ability of the expressing peptides to confer tolerance against root rot is being evaluated through inoculation of the transformed roots with pathogens in a controlled environment.

TP2 – The effects of varying freeze/thaw cycles on *Plasmodiophora brassicae* spore mortality. T.B. HILL, G.C. DANIELS, & M.W. HARDING. *Alberta Agriculture and Irrigation, Crop Diversification Centre South, 301 Horticultural Station Road East, Brooks, AB T1R 1E6, Canada*

Clubroot, caused by the protist *Plasmodiophora brassicae* Woronin, is a significant disease of canola in Alberta. Since resting spore quantity in soil is an important risk factor for clubroot disease, biological and environmental factors in soils that affect resting spore mortality can inform clubroot risk predictions. We hypothesized that freeze/thaw cycles within Canadian prairie soils may be one of these factors. For this study, hydrated resting spores were exposed to three patterns of freeze (-15°C)/thaw (+5°C) cycles and two cycle duration periods (14 and 28 days). Additionally, the effects of a long freezing period (10 days) followed by a short thaw period (4 days), equal freezing and thawing periods (7 days of each), and a short freeze (4 day) followed by a long thaw period (10 days) were evaluated. As controls, both hydrated and dry spores were held at freezing or thawing temperatures for the duration of the experiment. Spore mortality was evaluated after each freeze/thaw event using Evans blue vital staining. Spore mortality levels in the non-hydrated controls and frozen, hydrated control remained below 12% and 15%, respectively. Hydrated controls held at 5°C rose significantly to 57.4% after 112 days. Furthermore, mortality was highest in treatments with intermitent freezing and thawing. The shorter freezing period combined with a longer thaw demonstrated the highest mortality, regardless of overall cycle duration (85.4% after 8 cycles of 14 days and 68.7% after 4 cycles of 28 days).

TP3 – Identification of common bunt races from contaminated seed sources. M. ZID, T. DESPINS & R. ABOUKHADDOUR. *Agriculture and Agri-Food Canada, Lethbridge Research and Development Center, Lethbridge, T1J 4B1, AB, Canada*

Common bunt of wheat has been considered one of the most important post-harvest diseases of wheat in the world since the 18th century. The disease is caused by two closely related fungal species *Tilletia caries* and *Tilletia laevis*. Common bunt is endemic in North America. In 2017, wheat seeds from the

USA were planted in the winter wheat breeding plots in Lethbridge and were identified as contaminated with common bunt upon heading. In this study, infected heads from each contaminated line were collected and the infecting isolates were purified on susceptible line inside the greenhouse and were analysed for race identity using a set of sixteen differential wheat lines that contain the bunt resistance genes *Bt1* to *Bt15* and *Btp*. The differentials with genes *Bt1* through *Bt13* and *Btp* are winter hexaploid lines, and the differentials with *Bt14* and *Bt15* are spring tetraploid lines. The virulence/avirulence formula for each of the seven tested bunt isolates was compared with the reaction of already known bunt races in Western Canada and USA. The results showed that these seven isolates were represented three previously unidentified races, and were all virulent on *Bt1, 2, 3, 4* and *5*. All except one were virulent on *Bt7*, four were virulent on *Bt6* and one was virulent on *Bt9*. The *Bt8* and *Bt10* genes which are the most commonly used *Bt* genes in Canadian wheat remain undefeated by these races. Nonetheless, this work indicates the risk of new virulence incursions via seed exchange activities between countries, and the need to keep common bunt resistance breeding as a priority.

Symposium Abstracts

Y1 – Development of a loop-mediated isothermal amplification (LAMP) method to detect the potato zebra chip pathogen '*Candidatus* Liberibacter solanacearum' (Lso) and differentiate haplotypes A and B. JUNYE JIANG, WILL FEINDEL, KYLIE SWISHER GRIMM, MICHAEL HARDING, DAVID FEINDEL, STACEY BAJEMA & JIE FENG. *(J.J., W.F., S.B.) Potato Growers of Alberta, Edmonton, AB, T5Y 6H3, Canada; (J.J., W.F., D.F., J.F.) Alberta Plant Health Lab, Alberta Agriculture, Forestry and Rural Economic Development (AAFRED), Edmonton, AB, T5Y 6H3, Canada; (K.S.G.) USDA-ARS Temperate Tree Fruit and Vegetable Research Unit, Prosser, WA, 99350; (M.H.) Crop Diversification Centre South, AAFRED, Brooks, AB, T1R 1E6, Canada.* *Candidatus* Liberibacter solanacearum (Lso) is the causal agent of zebra chip of potato (*Solanum tuberosum*), which can significantly reduce potato yield. In this study, a loop-mediated isothermal amplification (LAMP) method for the detection of Lso haplotypes A and B was developed and evaluated. Two sets of LAMP primers named LAMP-A and LAMP-B were designed and tested for specificity and sensitivity. Both LAMP-A and LAMP-B were specific to Lso in *in silico* analysis using the Primer-Blast tool. The LAMP-A and LAMP-B could only produce positive signal from DNA mixtures of Lso-infected tomato but not from the genomic DNA of 37 non-target plant pathogens. The sensitivity of LAMP-A and LAMP-B on Lso haplotypes A and B were tested on gBlocks and genomic DNA from Lso-infected tomato. On the genomic DNA, for LAMP-A, the lowest amount of template DNA for a positive LAMP reaction was 2 to 20 ng on four haplotype A strains and 20 to 80 ng on four haplotype B strains; for LAMP-B, the lowest amount of template DNA for a positive LAMP reaction was 0.02 to 2 ng on four haplotype B strains and 20 ng to no amplification on four haplotype A strains. On gBlocks, for LAMP-A, the lowest number of copies for a positive LAMP reaction was 60 on haplotype A and 600 on haplotype B; for LAMP-B, the lowest number of copies for a positive LAMP reaction was 60 on haplotype B and 600 on haplotype A. Therefore, considering the convenience of the LAMP technique, as well as the high specificity and sensitivity, the LAMP-A and LAMP-B primers can be used together to test the probable Lso-infected plant or psyllid samples to rapidly, accurately and directly differentiate haplotypes A and B. We highly recommend this LAMP system to plant pathology practitioners and diagnostic labs for routine detection of Lso and confirmation of zebra chip disease on potato or tomato.

Y2 – Using droplet digital PCR to assess root disease risk for pea and lentil
S. CHATTERTON, A. ERICKSON, & S. ALI. *Lethbridge Research and Development Centre, Agriculture and Agri-food Canada, 5403 1st Ave S., Lethbridge AB, T1J 4B1*

Root rot of field pea and lentil is be caused by a complex of soilborne pathogens. *Aphanomyces euteiches, Fusarium avenaceum, F. solani* and *F. redolens* were the most frequent pathogens detected during surveys of pea and lentil fields in Alberta, Saskatchewan and Manitoba. An accurate and consistent DNA quantification method to simultaneously assess multiple pathogen levels in soil that can be related to disease severity would be ideal for risk prediction of the root rot complex prior to planting pea or lentil. To improve accuracy and sensitivity of a quantitative DNA test, a probe-based assay was designed for simultaneous quantification of *A. euteiches,* using the internal transcribed spacer region, and *F. avenaceum, F. solani* and *F. redolens,* using species-specific elongation factor sequences, on a droplet digital PCR (ddPCR) platform. The four targets could be separated on the ddPCR platform based on the variation of each targets primer and probe concentrations which changed their respective amplitude wavelength. The assay was then applied to root and soil samples, with accurate quantification achieved for diseased root samples. For soil samples, ddPCR comparisons to qPCR for *A. euteiches* quantification indicated that the technique improved accurate quantification for some, but not all soil types. However, sensitivity below 100 oospores/g soil for both methods remains elusive. The next step is to apply this method to a large set of infested soils across the Prairies to determine what soil factors are influencing sensitivity and accurate quantification, and to build a risk model based on DNA quantification and soil bioassays for all four pathogens.

Y3 – Artificial intelligence: a promising technique in crop disease management. L. ZHAO, M. W. HARDING, G. PENG, R. LANGE, S. WALKOWIAK, & W. G. D. FERNANDO. *Department of Plant Science, University of Manitoba, Winnipeg, MB R3T 2N2, Canada; (M.W.H) Crop Diversification Centre South, Alberta Agriculture Forestry and Rural Economic Development, Brooks, AB T1R 1E6, Canada;(G.P) Saskatoon Research and Development Centre, Agriculture and Agri-Food Canada, Saskatoon, SK, S7N 0X2, Canada; (R.L) InnoTech Alberta Inc, Vegreville, AB, T9C 1T4, Canada; (S.W) Canadian Grain Commission, Winnipeg, MB, R3T 6C5, Canada*
Canola (*Brassica napus*) is the number one cash crop but its production is severely threatened by many diseases such as blackleg, clubroot, Sclerotinia stem rot, Verticillium stripe. These diseases damage canola plants substantially, resulting in reduced canola yield and quality. Real-time monitoring of disease signals at key stages and forecasting disease outbreaks based on the sensed data has been desirable but challenging. Artificial intelligence (AI) has been applied in many agriculture areas to forecast yield, count flowers, and identify diseases. In this report, several successful AI (the Mask-RCNN model) applications in monitoring disease have been exemplified. The applications include blackleg disease phenotyping at the greenhouse, flea beetle damage evaluation in the field, and blackleg (canola stubble) incidence and severity evaluation. These applications can provide valuable information for researchers or growers to evaluate and disease. At the same time, we also applied AI models (support vector machine or SVM, and convolutional neural network or CNN) to forecast blackleg disease incidence based on data entries consisting of weather data, pest damage data, and crop rotation history data for 5 years. The AI models can reach as high as 85% accuracy, although this result cannot be applied directly to guide growers because of the relatively small volume of data (only 61 data entries were included). Further, with the dataset, we found crop rotation contributed substantially to these models in disease forecasting, while flea beetle feeding and maggot data did not affect the result apparently when omitting them. The relative contributions of crop rotation and pest damages were also observed in the principal component analysis. The successful AI application in phenotyping and disease forecasting indicated AI's potential in collecting field information, disease forecasting, and understanding blackleg disease contributive factors. These findings strongly support continued data collection from commercial fields for further AI analyses to better understand and validate key factors related to blackleg risks.

Y4 – High throughput phenotyping tools to determine Fusarium damage kernel (FDK) and mycotoxin (DON) in wheat grain. L. WANG, D. MICHEL, K. NAJAFIAN, M. A. OVIEDO-LUDENA, Y. RUAN, A. EL-ANEED, L. JIN, I. STAVNESS & H.R. KUTCHER. *Department of Plant Sciences/Crop Development Centre, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK, S7N 5A8, Canada; (D.M., A.E-A.) College of Pharmacy and Nutrition, University of Saskatchewan, 2D10 HSB, 107 Wiggins Rd., Saskatoon, SK, S7N 5E5, Canada; (K.N., L.J., I.S.) Department of Computer Science, Thorvaldson Building, 110 Science Place Saskatoon, SK, S7N 5C9, Canada; (Y.R.) Swift Current Research and Development Centre, Agriculture and Agri-Food Canada, P.O. Box 1030, Swift Current, SK, S9H 3X2, Canada*

Fusarium head blight (FHB), caused by *Fusarium* spp., is a destructive disease of wheat. FHB affects kernel development, resulting in lightweight, chalky white, shrunken kernels covered with white or pink mycelia; these are known as Fusarium damaged kernels (FDKs). Infected kernels are always contaminated with Fusarium produced mycotoxins, especially deoxynivalenol (DON). FHB significantly reduces grain yield and quality, resulting in hundreds of millions of dollars in losses annually in Canada. Breeding cultivars with high disease resistance and low mycotoxin contamination is a priority for wheat breeders. However, traditional FDK and DON measurement methods are time-consuming, labor-intensive, and of variable accuracy; improvements are needed for large-scale screening in breeding programs. In this study, two high throughput phenotyping tools were developed for FDK and DON measurement. A fast chromatography (FC) - tandem mass spectrometry (MS/MS) method was developed for DON quantification. It employs a one-step acetonitrile extraction protocol with a short guard column to reduce complexity, cost and analysis time. In addition, a high-throughput single-kernel screening tool was developed to assess FDK through automated image acquisition and analysis. It non-destructively images and analyzes samples composed of several hundred seeds, taking close-up top and side images of individual kernels. Meanwhile a customized convolutional neural network (CNN) model was developed and trained to process, count, and analyze vast amounts of scanned sample images. Preliminary results with the CNN model are promising for its ability to automatically determine the percentage of FDK in much less time than visual assessment.

Albert Hannig receives award for “Outstanding presentation by a technician” (upper left), Zhiu Yu (upper middle) and Emillee Storfie (upper right) receive awards for “Outstanding presentation by a student”, for poster and oral presentations, respectively. Delegates enjoy oral and poster presentations (lower left, lower right).

Agenda: Plant Pathology Society of Alberta Business Meeting
Brooks, AB – November 4, 2022

Introductions and Attendance:

1. **Call to order**
2. **Adoption of the Agenda**
3. **Adoption of the 2021 business meeting minutes**
4. **In Memorium**
5. **Treasurer's Report: Noryne Rauhala**
6. **CPS Updates for 2022**
   - CPS Meeting
   - CPS Publications
7. **Reports on Standing Committees**
   - ~~Disease Survey Committee (disbanded)~~
   - Historical Committee:
   - Awards Committee:
8. **Conference Reports**
9. **Unusual/Exceptional Disease Reports**
10. **Nomination of Honorary Life Members**
11. **Resolutions**
12. **Locations/dates for future meetings** (Should we schedule a meeting in Lloydminster to meet jointly with CPS-Sask?)
13. **Election of Officers for 2022-23**
14. **Other Business**
15. **Adjournment**

List of Honorary Life Members:

Table 1. HONORARY LIFE MEMBERS PPSA			
2022	none	2002	?
2021	Kequan Xi, James Calpas	2001	?
2020	None	1999-00	none
2019	None	1998	Jim Letal
2018	Sheau-Fang Hwang, Kan-Fa Chang	1997	Dave Ormrod
2016-17	none	1996	Chuji Hiruki (deceased)
2015	Denis Gaudet	1995	Yasu Hiratsuka (deceased)
2014	none	1994	John Davidson
2013	Byron Puchalski, Ron Howard	1993	none
2009-12	none	1992	Bart Bolwyn (1929-2019), Lu Piening (deceased)
2008	Prem Kharbanda, Ieuan Evans	1990-91	none
2007	none	1989	Gordon Nelson (deceased)
2006	Denise Orr	1988	none
2005	Henry Huang	1987	Frank Harper (deceased), Frank Kozar (deceased)
2004	None	1984-86	none
2003	J.P. Tewari	1983	J. Gurba (deceased), T. Atkinson (1929-2012)
		1982	Bill Broadfoot (deceased), Nicholas Colotelo (??) Bill Cormack (deceased), Bob Hawn (deceased) A.W. Henry (1906-1989), Jack Horricks (1923-2005) J. Lebeau (deceased), W.P. Skoropad (1918-1993) David Stelfox (deceased)

Minutes of the 43rd Annual Plant Pathology Society of Alberta Business Meeting
Brooks, AB - November 4, 2022

Introductions and Attendance
Number of registered attendees for the 43rd annual meeting: 57
Number of attendees: 51
Membership : 60

1. **Call to Order –** Issued by PPSA President Michael Harding at 8:15a.m.

2. Discussion item: Prior to finalizing the meeting agenda, Michael Harding reported that due to the weather, and poor road conditions, two student oral presentations had been missed. It was suggested that these two presentations could be submitted as video recordings and be considered in the Student Presentation Competition. The video recordings were submitted within 12 hours and the membership was asked if they would like to view them during the business meeting, or have them e-mailed to view on demand. A vote was called and due to a significant number of the membership being opposed (more than a third), it was decided to email out both presentations to the membership for viewing and judging.

3. **Adoption of the agenda**
   Reem Aboukhaddour moved to accept the meeting agenda and Jackie Bussan seconded, however, Kelly Turkington suggested adding Lou Piening to the **In memorium** section of the agenda due to his recent passing. The agenda was revised to add his Lou's name.

   Reem Aboukhaddour moved to accept the revised agenda, Robyn Davidson seconded, unanimously voted as approved and the item was carried

4. **Adoption of the 2021 minutes**
   Michael Harding reported some corrections to the minutes, namely that some sections had been voted on, but voting results were not recorded. It was confirmed by the membership that these motions were indeed carried and the minutes were revised to indicate as such. One spelling mistake was corrected.
   The PPSA Directors were added to the **Election of Officers** section in the minutes. Discussion was initiated whether to remove Krista Zuzak as a director, due to her absence at PPSA events since her recent change in employment and responsibilities. It was decided that Michael Harding would contact Krista to determine her willingness to continue as a director.

   Bruce Gossen moved to accept the minutes as revised, Noryne Rauhala seconded, and the motion was carried by a unanimous vote.

5. **In memoriam**
   A moment of silence was observed for two deceased members of the PPSA and one CPS member who passed in the last year: Hafiz Ahmed, W.Lloyd Seaman and Lou Piening

6. **Treasurer's report: Noryne Rauhala**
   Noryne presented the statement of the society's financial situation (detailed report attached)
   a. The society has healthy reserves, including two GICs. The GICs are maturing soon and should receive a higher interest rate than what they have presently. The smaller GIC of around $5000 is required to secure the PPSA credit card.

b. Although the 2022 meeting had higher expenses than previous meetings, sponsorship revenue and registration fees should put the 2022 meeting at a break even point or come close to it. Michael Harding added that the cost of food and facility rental was double that of previous meetings that he had organized.

Noryne Rauhala moved to accept the financial report, Rudolf Fredua-Agyeman seconded. Motion was carried.

7. CPS Updates for 2022

- CPS Meetings: The 2022 CPS meeting will be held in Ottawa in June (17-23)
- CPS Publications:
    - Canadian Journal of Plant Pathology – Linda Jewel became editor in chief on July 1, 2022
    - Michael Harding read a portion of a report on Canadian Plant Disease Survey prepared by the National Editor, Dr. Janice Elmhirst (see attached report)
    - Diseases of Field Crops in Canada – Michael Harding, Syama Chatterton and Bruce Gossen began work on the update of this book in 2019, but the process was delayed due to the Covid-19 pandemic. Text revisions are now complete and the group is beginning the work of updating photos. It is expected that the revisions will be completed late this year or early in 2023, with the book to be available in late 2023 or early 2024 (see attached report).

8. Reports from standing committees

- Disease Survey Committee – Michael Harding commented that he recalled conversation in the past to disband this committee as it has been inactive and its role has been carried out at other forums such as Western Committee on Plant Disease. Dr. Reem Aboukhaddour concurred. Kelly Turkington moved to disband the committee, Ron Howard seconded and the motion carried.
- Historical Committee – Michael Harding read the report of the Historical Committee (see attached report). Denis Gaudet is moving to BC and has stepped down as chair of the committee. Michael Holtz has volunteered to let his name stand to chair the committee. Michael Harding and Michael Holtz have been collecting and archiving business meeting minutes and proceedings for past meetings but have been unable to locate some (see attached report). Michael Holtz has begun digitizing the PPSA documents held in the archives at the University of Alberta, but it has been a long process due to the University's policy of disallowing document scanners in their libraries. Michael Harding issued a call to the membership for documents and photos to add to the archives. Kelly Turkington mentioned that there are documents in Lacombe, formerly held by Lou Piening and Ieuan Evans that he will go through and provide. Greg Daniels moved to accept the Historical Committee report, Ryan Gourlie seconded and the motion carried.
- Awards Committee: Michael Harding presented the report of the awards committee (see attached report). Kelly Turkington moved acceptance of the report, Robyne Davidson seconded, vote carried the motion. Michael Harding also presented a summary on the Swanson Award account (see attached report). Jim Calpas motioned to accept the Swanson Award Report, Noryne Rauhala seconded, voted as approved.
    - Michael Harding then commented that he believed it was time to increase the amounts of the scholarships, as the cost of living and the cost of education continue to rise and the PPSA has the available resources to cover an increase of $250 to $500 to each. He asked the treasurer to comment. Noryne Rauhala responded that the society could increase the awards by $500 without putting the society at risk due to its current financial position. Bruce Gossen also commented that the society could also increase the value of presentation awards. Michael Harding suggested that the PPSA and Terry Swanson scholarships be increased to $1500 and the presentation awards be increased to $250. Ron Howard made a motion to accept these values, Bruce Gossen seconded the motion and it unanimously approved by the membership vote.

9. Conference Reports

Dr. Reem Aboukhadour reported on her attendance at a cereal rust meeting in Cambridge, UK and her subsequent attendance at the British Society for Plant Pathology annual meeting.

10. Unusual/Exceptional Disease Reports

Michael Harding made a call for unusual reports to the membership. No reports were presented

11. Nominations of Honorary Life members

No Honorary Life Members nominated

12. Resolutions

"Without the contribution of speakers, collaborators, sponsors, organizers and service staff, the PPSA meeting would not be a success. Therefore, be it resolved that the meeting participants and PPSA members thank the sponsors, organizers and hotel staff for planning, organizing and executing a great PPSA meeting.

Resolution moved by T.K. Turkington and seconded by R.J. Howard, voted as approved by the membership

13. Locations/Dates of future meetings

Bruce commented that CPS-Saskatchewan would like to hold a joint meeting with the PPSA in 2023, despite Lacombe being next in the rotation for 2023. CPS-Saskatchewan would organize the meeting and that the PPSA handle the funding of the meeting. Bruce Gossen moved that a joint meeting be held in 2023 in Lloydminster and the 2024 meeting would move to Lacombe, AB. Noryne seconded, voted as approved by the membership.

Bruce Gossen then commented that as weather has affected both the 2022 meeting, as well as past joint meetings, it may be worth considering moving up the date of the 2023 meeting by a week. Kelly Turkington commented that this would be dependent on the dates of the Western Committee on Plant Disease meeting in Kelowna, BC in the fall of 2023. The decision was made to table the discussion and allow the local arrangements committee to determine the timing of the meeting at a later date.

2023 – Lloydminster
2024 – Lacombe
2025 – Lethbridge
2026 – Edmonton
2027 - Brooks

14. Election of Officers

Bruce Gossen was nominated as President, Kelly Turkington as Vice President, Michelle Hubbard as Secretary and Sasha Waterman as Treasurer. Trina Dubitz nominated Sasha Waterman for the Treasurer position, Reem Aboukhadour seconded the nomination. Michael Harding called for other nominations, but there were none. The membership unanimously voted to approve the nomination.

President: Bruce Gossen
Vice President: Kelly Turkington
Secretary: Michelle Hubbard
Treasurer: Sasha Waterman

Directors were not changed (Robyne Davidson, Jackie Busaan, Krista Zuzak, Ryan Gourlie).
However, Krista Zuzak will need to be replaced in 2023.

Noryne Rauhala moved to accept the revised list of officers, Rudolf Fredua-Agyeman seconded and voted as accepted, unanimously.

15. Other Business

Item 1: Kelly Turkington suggested adding a field day or summer meeting to replace the Federal/Provincial field day formerly held at Lacombe, prior to the moving of Provincial staff to Olds College. He believes that it would increase the visibility and relevance of the PPSA. Michael Harding suggested that it could also be a grower meeting, which Kelly Turkington concurred may be a good option. Michael Harding suggested striking an ad-hoc committee to evaluate the idea. Volunteers for the committee were Michael Harding, Kelly Turkington and Sajid Rehman.

Item 2: Michael Harding called to grad students who may be interested in creation of a PPSA podcast or social media feed. Brad Calder volunteered to participate. Kelley Turkington also commented that the Prairie Crop Disease Monitoring network has also been looking to create a podcast. Michael Harding asked Brad Calder to submit a proposal to be discussed at a later date.

16. Adjournment

Kelly Turkington made a motion to adjourn the meeting.

Plant Pathology Society of Alberta

Financial Summary November 2022

Opening Balance:			$	9,155.91
Revenues				
Sponsorship	$	2,750.00		
Membership	$	612.00		
Dr.T Swanson Memorial Fund Donations (2021)	$	39.97		
Abstract Publication	$	630.00		
Late Fees	$	30.00		
Total Revenue	$	4,061.97	$	13,217.88
Expenses				
Student Award 2021 meeting		$ 200.00		
Technician Award 2021meeting		$ 200.00		
PPSA Graduate Student Scholarship 2021		$ 1,000.00		
Abstract Publication Fee		$ 735.00		
Meeting Expenses (Professional Zoom)		$ 21.00		
Dr.T Swanson Memorial Scholarship (2021)		$ 1,000.00		
Eventbrite Fee		$ 136.45		
MasterCard Fee		$ 65.00		
Total Expenses		$ 3,357.45		
Balance			$	9,860.43

PPSA Savings

	Interest Rate		Interest Earned	Original Amount Invested
3 Year Springboard GIC - Maturity Date January 9, 2023	2.02%	$	695.73	$17,110.65
3 Year Springboard GIC - Maturity Date May 10, 2023	2.50%	$	217.59	$5,348.03

2022 CANADIAN PLANT DISEASE SURVEY REPORT Sept. 15, 2022

In 2021-22, 53 papers were submitted for Volume 102 of the CPDS comprising 19 Cereal, 18 Oilseed, nine Diagnostic Lab, three Vegetable, two Fruit and Berry, one Forestry report, and the second survey of crop diseases in Yukon Territory. This issue was published online on **July 15, 2022.** I was happy that the publishers at Taylor and Francis were able to achieve an earlier publication date than October/November and hope this will continue.

Starting with Volume 99 in 2019, the CPS Board of Directors contracted with Taylor & Francis to publish the survey as an annual, online supplement to the Canadian Journal of Plant Pathology (CJPP). This has been successful in raising the profile of the Survey. As of mid-September 2022, the 2019 CPDS has been accessed 5640 times, the 2020 issue almost 5000 times and the 2021 issue almost 3000 times. Already, Volume 102 has been accessed 760 times in the two months since it was published.

For the 2023 edition, Vol. 103, submission deadlines remain the same as in the past: November 30 to Section Editors, so that I can receive the final reports by the end of January. I realize that all the data may not be available for some reports by the end of November. Please contact me, or your Section Editor, if an extension is needed and we will do our best to accommodate specific requests.

For Volume 103, the **Section Editors** remain the same as last year except for one change: **Diagnostic Labs** Vippen Joshi**, Cereals** Reem Aboukhaddour, **Oilseeds and Pulses** Syama Chatterton, **Fruit Berries Nuts & Ornamentals** Siva Sabaratnam, and **Forestry** Jean Bérubé. **Vegetables** (previously Cheryl Trueman) and **General or Other** reports can be sent to me.

To help keep track of the numerous submissions and avoid lost and missing papers, authors are asked **to please c.c. me, the National Editor**, Janice.elmhirst@shaw.ca when they **first submit** their articles to the Section Editors.

Authors are asked to please pay particular attention to the **T & F reference format** and citations at https://www.tandf.co.uk//journals/authors/style/reference/tf_CSE.pdf. All tables and figures must be mentioned in the text. Tables should have simple lines and no hidden formatting. For examples, please check Vol. 102, 2022 on the CPS website https://phytopath.ca/publication/cpds/

After four years, all of us involved in the production of the CPDS are better adapted to the new format. Thank you to our authors, section editors, compiler Deidre Wasilyw and the hard-working technical editors at Taylor and Francis, who help to ensure that the CPDS remains an important and relevant publication for plant disease in Canada.

- Janice Elmhirst, National Editor, Canadian Plant Disease Survey

DISEASES OF FIELD CROPS IN CANADA, REVISION UPDATE 2022 Oct. 25, 2022

The book *Diseases of Field Crops in Canada, 3rd Edition* is "A comprehensive guide to identifying diseases of cereal, oilseed, pulse, forage and specialty crops." (https://phytopath.ca/publications/5479-2/).

The book had not been update since 2003 so members of the Canadian Phytopathological Society's Information Products and Marketing Committee undertook a revision in 2019. Complications due to COVID-19 delayed completion of the revision, however nearly all of the text revisions are now complete and updating or adding photographs is now underway.

The group working on the revision is led by Dr. Bruce Gossen, and includes Dr. Syama Chatterton (AAFC-Lethbridge) and Dr. Michael Harding (Alberta Agriculture). The current plan is to finish revisions this winter, and are hopeful that the new Edition will be printed and available for sale in late 2023 or early 2024.

- Michael Harding, Chair, CPS Information Products and Marketing Committee

PPSA Historical Committee Report – November 4, 2022

Goals:

1. List of Honorary Life Members – completed in 2021 (however no proceedings or business meeting minutes for 1985, 2002 and 2003 means there could be a few missing names)
2. Collect proceedings and business meeting minutes from 1980 to 2021 – still missing the following:
    - 1975-1979 (CPS-Alberta)
    - 1985 (PPSA)
    - 1991
    - 2002
    - 2003
    - 2007
    - 2008
    - 2021
3. Digitize and electronically archive our PPSA documents - Michael Holtz has visited and copied information in the PPSA Archives (University of Alberta) from the mid-1980s, and a bit from the 1940s, so far. Still more scanning to do.

Submission of any PPSA documents or group photos for the years listed above are appreciated

Respectfully submitted by:
Michael Holtz (Chair) and Michael Harding, PPSA Historical Committee

PPSA Awards Committee Report, 2022

In 2022 there were six student talks, eight student posters, and three presentations by technicians.
The judges for student and technician competitions were Nora Foroud, Robyne Davidson, James Calpas, Ron Howard, Reem Aboukhaddour, Jennifer Retzlaff, Jie Feng, Michael Harding. The winners of the presentation awards receive a cheque for $100, a certificate acknowledging the achievement, and copy of the book *Plant Pathology in Canada 1970-2008*.

Outstanding presentation by a technician:

Albert Hannig	Evaluation of synthetic antimicrobial peptide expression and resistance to root rot in *Pisum sativum*.

Outstanding student poster presentation:

Zhiyu Yu	Evaluation of fall and spring lime applications for the management of clubroot of canola

Outstanding student oral presentation:

Emilee Storfie	Evaluating the effect of foliar application of salicylic acid on clubroot development in *Brassica napus*

Two scholarships awarded. Each recipient receives a cheque for $1000, a certificate commemorating the achievement and a CPS book "*History of Plant Pathology in Canada",* or "*Diseases of Field Crops in Canada".*

PPSA Scholarship: Emilee Storfie is the recipient of the 2022 PPSA Graduate Student Scholarship. Emilee is a PhD at the University of Alberta supervised by Dr. Stephen Strelkov, and her thesis is tentatively titled "Understanding the molecular interactions between resistance-breaking pathotypes of *Plasmodiophora brassicae* and *Brassica napus*"

Swanson Award: Beth Peacock is the recipient of the 2022 Swanson Award. Beth is a PhD student at the University of California, Riverside supervised by Dr. James Borneman. Her dissertation title is "Elucidating the host-microbe interactions responsible for the survivor tree phenotype in citrus huanglongbing disease".

On behalf of the PPSA Awards committee, our sincere congratulations to the award winners and scholarship recipients.

Respectfully submitted by the PPSA Awards Commmittee:
Michael Harding and Michael Holtz

Report on the
SWANSON AWARD FOR PLANT PATHOLOGY AND NEMATOLOGY
November 4, 2022

The 2022 Swanson Award for Plant Pathology and Nematology is awarded to Beth Peacock, a PhD student at the University of California Riverside. Ms. Peacock is a PhD student in the Department of Microbiology and Plant Pathology studying the Host-Microbe Interactions Responsible for the Survivor Tree Phenotype in Citrus Huanglongbing Disease under the direction of Dr. James Borneman. However, Beth has also contributed to understanding interactions of fungi and root knot nematode - a topic that Terry Swanson also investigated during his time at UCR.

An updated financial statement for the Scholarship Fund for 2021-22 is given below.

Dr. Terry Swanson Memorial Fund		
3 Year Springboard GIC (matures January 9, 2023)	Opening Balance	$ 13,678.40
Donations from 2021 Meeting (in Chequing)		$ 39.97
Interest 2.04%		$ 556.16
	Balance to date	$ 14,274.53

Respectfully submitted by PPSA Awards Committee Chair
Michael Harding

Registrants	First name	Surname	Affiliation
1	Haider	Abbas	Lakeland College
2	Mohammed	Hafez Abdel-Fattah	AAFC-Lethbridge
3	Reem	Aboukhaddour	AAFC-Lethbridge
4	Dilini	Adihetty	University of Alberta
5	Yoann	Aigu	University of Alberta
6	Shimaila	Ali	AAFC-Lethbridge
7	Zyre	Aubrey-Hebert	University of Alberta
8	Jackie	Busaan	AAFC-Lacombe
9	Brad	Calder	University of Lethbridge
10	James	Calpas	Alberta Agriculture - retired
11	Syama	Chatterton	AAFC-Lethbridge
12	Jorge	Cordero Elvia	University of Alberta
12	Greg	Daniels	Alberta Agriculture
14	Robyne	Davidson	Lakeland College
15	Trina	Dubitz	Lakeland College
16	Anas	Erathodi	AAFC-Lethbridge
17	David	Feindel	Alberta Agriculture
18	Jie	Feng	Alberta Agriculture
19	Maria Costanza	Fleitas	University of Saskatchewan
20	Rudolph	Fredua-Agyeman	University of Alberta
21	Nora	Foroud	AAFC-Lethbridge
22	Dianevys	Gonzalez-Pena-Fundora	AAFC-Lethbridge
23	Bruce	Gossen	AAFC-Saskatoon
24	Ryan	Gourlie	AAFC-Lethbridge
25	Albert	Hannig	AAFC-Lacombe
26	Michael	Harding	Alberta Agriculture
27	Lexie	Herspiegel	Olds College
28	Blake	Hill	Alberta Agriculture
29	Ron	Howard	Alberta Agriculture - retired
30	Junye	Jiang	Potato Growers of Alberta
31	Patrick	Labun	Syngenta
32	Kun	Lou	University of Saskatchewan
33	Victor	Manolii	University of Alberta
34	Maria	Munawar	University of Lethbridge
35	Sangheon	Oh	University of Alberta
36	Alejandra	Oviedo Ludena	University of Saskatchewan
37	Sijan	Pandit	University of Lethbridge
38	Atta Ur	Rahman	University of Lethbridge
39	Noryne	Rauhala	AAFC-Lacombe
40	Sajid	Rehman	Olds College
41	Jennifer	Retzlaff	Alfalfa Seed Commission Alberta
42	Danna	Rotariu	University of Alberta
43	Alian	Sarkes	Alberta Agriculture
44	Khurram	Shahzad	spouse
45	Emilee	Storfie	University of Alberta
46	Kelly	Turkington	AAFC-Lacombe
47	Christine	Vucurevich	AAFC-Lethbridge
48	Lipu	Wang	University of Saskatchewan
49	Yixiao	Wang	University of Alberta
50	Sasha	Waterman	Olds College
51	Bohan	Wei	AAFC-Lethbridge
52	Longfei	Wu	University of Alberta
53	Chunxiao	Yang	University of Alberta
54	Haitian	Yu	University of Alberta
55	Zhiyu	Yu	University of Alberta
56	Liang	Zhao	University of Manitoba
57	Mouldi	Zid	AAFC-Lethbridge


PLANT PATHOLOGY SOCIETY
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