PROCEEDINGS OF THE 35TH ANNUAL MEETING OF THE PLANT PATHOLOGY SOCIETY OF ALBERTA

CANMORE, ALBERTA

OCTOBER 27-29, 2014

35TH ANNUAL MEETING OF THE PLANT PATHOLOGY SOCIETY OF ALBERTA – Canmore, AB
October 27-29, 2014

The Organizers of the 35th Annual Meeting of the Plant Pathology Society of Alberta Wish to Acknowledge the Generous Funding of the Following Sponsors:

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2014 Plant Pathology Society of Alberta Business Meeting Minutes – October 29, 2014

Meeting was called to order at 10:30 am. Kelly Turkington moved that the Agenda be adopted, Bruce Gossen seconded. Carried.

The minutes from the 2013 meeting were read and moved by Andre Laroche to be accepted, Mike Harding seconded. Carried.

Noryne Rauhala, the Treasurer of the PPSA read the Financial report and mentioned that $4500.00 of the balance has been moved into a GIC which is the reason that the balance is lower at $3235.00. Noryne moved that the Financial report be accepted as read, Robyne Bowness seconded. Carried.

CPS Updates for 2014:

1. Bruce Gossen reported that the Canadian Phytopathological Society has gotten 1500 new "Diseases of Field Crops" books reprinted as the stock was in short supply. These books need to be stored somewhere as the Distributor wants them gone. The price may need to be increased and it is recommended not to republish. As a consequence the CPS is looking at new ideas for providing the information in this book i.e.: Reformat, revise, and/or make available as an E-book.
2. Deena Errampalli announced that Plant Canada is giving two $500 graduate student travel scholarships for each of the six societies to award to their respective candidates.
3. Ron Howard announced that "Diseases of Pests of Vegetable Crops in Canada" is now out of print. CPS is looking at what direction to head with in terms of this publication. The solution is to split the book into eight volumes which would make it more affordable and appeal to a broader audience. It would be easier to reprint or revise. In 2015 the first volume "Diseases of Pest of Greenhouse Vegetable Crops" will be published as a hard copy and a CD format. Ron also asked if any CPS or Entomological Society of Canada members would like to be involved in the writing and/or editing, or providing information, pictures or illustrations of the volumes please contact him. Mike Harding moved to accept the CPS updates, Khalid Rashid seconded. Carried.

Disease Survey Committee Report:

Kelly Turkington, the chair of the Disease Survey Committee moved the action item from the 2013 meeting minutes to this year's agenda. He will follow up on the action item. It was mentioned that there was not much oilseed survey information from Alberta, possibly the reason was the focus on Clubroot surveys. Kelly indicated that this issue may be brought up at the Western Committee on Plant Disease and Western Forum on Pest Management for discussion. Noryne moved that this action item be accepted, Ron Howard seconded. Carried.

There was nothing to report from the Historical Committee.

Awards Committee Report:

Ron Howard, chair of the Awards Committee, mentioned that this year is the 30th anniversary of Terry Swanson's death. The Terry Swanson award is rotated between three Universities (University of Edmonton,

University of British Columbia and University of California and Hannes Witte (from California) was the recipient ($1000 US) for 2013-14. Ron has asked for letters of nomination and transcripts from University of Alberta, University of Calgary and University of Lethbridge.

Noryne would like to close the Terry Swanson short term cash anytime account and use the PPSA account instead to take in donations. She would then move the donations to a GIC until the award is given. Noryne made a motion to accept the changes to the accounts, Bruce Gossen seconded. Carried.

Conference Reports:

Deena provided a word document that is attached.

Bruce Gossen announced that the International Rapeseed Conference will be held this year in Saskatoon.

There was discussion regarding the travel restrictions within AAFC for technicians being able to attend various conferences or meetings. The suggestion was made that the PPSA write a letter to the DG to recommend that technicians be allowed to attend this meeting in future. Another letter should also be sent to the Deputy Minister (and Assistant Deputy Minister) stating the importance of the attendance of the technicians to other regional meetings. A letter will be drafted and sent.

Kelly Turkington attended the 1st International Workshop on Barley Leaf Diseases on June 3-6, 2014 in Italy with Alireza Akhavan.

Michelle Frick moved that the Conference Report be adopted, Deena Errampalli seconded. Carried.

Unusual/Exceptional Disease Report:

Syama Chatterton brought up the presence of Aphanomyces root rotin pulse crops in Alberta. She has an abstract to further discuss this issue.

Denis Gaudet moved the adoption of the report, Robyne Bowness seconded. Carried.

Nomination of Honorary Life Members:

None to nominate at present, however a list of existing members will be provided by Ron Howard.

Resolutions:

Andre Laroche congratulated the organizing committee of the PPSA.

Locations and Dates of Future Meetings:

2015 – Lethbridge in first or second week of November. Syama Chatterton to coordinate.

2016 – Edmonton

Election of Officers for 2014-15:

President – Syama Chatterton

Vice President – Steven Strelkov

Secretary – Eric Amundsen

Directors – Keep existing ones

Andre Laroche motioned the election of officers cease and be accepted, Khalid Rashid seconded. Carried.

There was no other business to attend to so the meeting was adjourned at 11:16 am.

Letter from the CPS President

Vineland, ON, October 25, 2014

On behalf of the Canadian Phytopathological Society I offer greetings to Kelly Turkington, Chair and members of the Plant Pathology Society of Alberta and wish all the delegates a productive and wonderful meeting from October 27-29, 2014 in Canmore, AB. I thank you for the invitation to attend the PPSA meeting and I am so glad I did.

Here are a few new goals of the 2014-15 CPS Board and some updates

Transition of the CPS to Canada NPF act: The CPS has successfully transitioned and obtained a certificate of continuance under the new Canada Not for profit corporations act on Sept 18, 2014.

The CPS is in a very good financial shape. In 2014, CPS-International Cooperation Committee has begun a program to awarded 5, one year-year membership in CPS and a subscription to CJPP to plant pathology researchers from developing countries in South America, Africa and Asia.

The CPS website re-design is complete and now we are populating the **website with the information** We expect to have the new site up and running in early 2015.

The **Canadian Journal of Plant Pathology** is doing very well. This September, we have added a new position, Associate Editor-in-Chief, to the Editorial Board, to assist CJPP Chief Editor-in-Chief, Zamir Punja. We welcome Steven Strelkov as the Associate Editor-in-Chief. Congratulations to CJPP Chief Editor, Zamir Punja, and section editors and reviewers – contributors! We continue to have an excellent relationship with our journal publisher, Taylor & Francis.

A Code of Practice. Thanks to Bruce Gossen, Mary Ruth McDonald, Krista Anderson and other members of the sub-committee who worked with CROPLIFE Canada on Environment Canada's requirement that plant pathogens produced for research trial inoculum must be on the Domestic Substances List. Environment Canada has proposed an exemption for common, non-regulated, plant pathogens produced and applied to research trials, under a Code of Practice. A Code of Practice has been submitted to Enviro Canada for their review and we hope to have it approved before the next growing season.

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Reduced meeting registration fees for CPS student members: Student registration will be 50% off of regular registration, starting from 2015.(currently the student members pay 75% of the regular member registration fees).

To encourage **technicians participation in CPS**, the Board had approved to provide embership to technicians at 50% off of regular member rate (starting from 2015).

Fostering collaboration with international plant pathology societies and Plant Protection societies:

As the CPS president, Deena, accepted an invitation as the Guest of Honour of the 11th European Foundation for Plant Pathology conference in September 8-13, 2014, Krakow, Poland and offered greetings to the members of the EFPP. Here are the kind words that were sent by Professor Manka, confer4ence Convener, "Dear Dr. Errampalli, It was a great honour for the Organising Committee of 11 Conference on Plant Pathology to have you as an honourable guest at the Conference. We appreciate very much your involvement in all activities of the conference, chairing the session, summarising it and choosing the best poster. We do hope that the stay in Kraków was not only hard work but also pleasure.

Please find enclosed the Report of the conference which is also available at the conference website, together with a choice of photos sent in by some of the participants.

Kindest regards

Małgorzata Mańka, Conference convenor, October 17, 2014"

Other initiatives include organizing a joint seminar between CPS and APS on a common topic to both countries at the APS meeting in Pasedena , California in 2015.

Botany 2015
Science and Plants for People

I invite you to attend the Botany 2015, a joint meeting of 13 Plant Societies from the US and Canada in Edmonton, Alberta, from 25 to 29 July, 2015. The theme of the conference is "Science and Plants for people. There will be 12 symposia, many workshop, colloquia, and subject matter sessions etc. **We are expecting about 2000 delegates and it will be a great place for networking.** The registration will begin in **FEBRUARY 2015.** I will post a link to the Botany 2015 on CPS website, soon. Be sure to get your travel requests in early. Please note that the **CPS Business Meeting will be on the on Tuesday Jul 28, 2014 from noon to 2:00 pm, and a CPS only banquet and awards reception in the evening.**

In closing, I ask you to renew your membership and I encourage others participants, especially students, to become members and volunteer for CPS committees; it is an excellent way to network and gain valuable experience. Have a wonderful meeting and I hope to see you all in Edmonton in July 2015!

Please send me your suggestions and ideas to improve CPS. Thank you for your interest and support.

with very best wishes

Deena Errampalli, Ph.D.

President, Canadian Phytopathological Society

Deena.errampalli@agr.gc.ca

1-905-562-2024

The CPS was founded in 1929 and is a professional organization dedicated to creating and sharing knowledge of plant pathology in Canada and throughout the world. Our objective is to encourage and support research and education in plant pathology, promote public awareness of the importance of plant diseases and the socio-economic benefits of controlling them, and act as a forum for discussion of policies and strategies affecting all aspects of research and education in plant pathology in Canada. The current membership of the CPS is 300. The Society publishes *The Canadian Journal of Plant Pathology* and the books *Diseases of Field Crops in Canada* and *Diseases and Pests of Vegetable Crops in Canada*. We hold annual national and regional scientific meetings in Canada and meet with the American Phytopathological Society once in every 5 to 8 years and with Plant Canada once in every 4 years. The CPS recognizes the achievements of plant pathologists through awards and provides travel awards and scholarships to students. More information can be found at http://phytopath.ca

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Abstracts for Oral and Poster Presentations

Study of resistance to clubroot (*Plasmodiophora brassicae*) in a canola (*Brassica napus*) doubled haploid population. H. ZHANG, J. FENG, S. F. HWANG, S. E. STRELKOV, I. FALAK, X. Q. HUANG AND R. F. SUN. *Institute of Vegetables and Flowers, Chinese Academy of Agricultural Sciences, Beijing, 100081, China; (H.Z., S.E.S.) Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada; (J.F.,S.F.H.) Crop Diversification Centre North, Alberta Agriculture and Rural Development, Edmonton, AB T5Y 6H3, Canada; and (I.F., X.Q.H.)Pioneer Hi-Bred Production Ltd., 12111 Mississauga Road, Caledon, ON L7C 1X1, Canada*

Currently, most of the identified clubroot (*Plasmodiophora brassicae*) resistance genes are derived from turnip (*Brassica rapa* ssp. *rapifera*). In this study, a population of 134 doubled haploid (DH) lines derived from a cross between a resistant and a susceptible canola (*Brassica napus*) was subjected to phenotypic and genotypic studies to determine the inheritance and location of the resistance gene(s). The resistance was originally derived from *B. rapa* spp. *rapiferea*. After inoculation with pathotype 3 of *P. brassicae*, the lines showed a 1:1 segregation ratio for resistance, indicating that resistance in this population is controlled by a single gene. Twelve markers linked to known resistance genes in the A genome were screened. Marker GC1680 linked to *CRa* was found to be polymorphic between the parents as well as the resistant and susceptible bulks. Several *CRa*-specific primers were screened against the parents and the sequences of the amplified nucleotide binding site domain were compared. A high sequence similarity between the parents was found and no insert fragment could be identified in the susceptible parent. In contrast, polymorphisms were detected between sequenced leucine rich repeat domains from the parents. Based on these results, we conclude that the resistance gene in this population is *CRa* or is tightly linked to *CRa*.

Detection of stripe rust spores through self-assembly antibody conjugations by rt-IPCR. F. WANG, M. FRICK, E. AMUNDSEN, D.A. GAUDET, A. LAROCHE AND C. SHEEDY. *Lethbridge Research Centre, Agricultural and Agri-food Canada, 5403-1 Avenue South, Lethbridge, AB T1J 4B1 Canada*

Stripe rust (caused by *Puccinia striiformis* f. sp. *tritici*) is one of the most important diseases of wheat. In this report, we describe the development of a rapid and sensitive real time immuno-PCR (rt-IPCR) assay for the detection of stripe rust spores. The general scheme of this assay is similar to that of an enzyme-linked immunoassay (ELISA); however, rt-IPCR employs oligomeric reagents for signal amplification by PCR rather than colorimetric reagents. Antibody conjugates are widely used as diagnostics and imaging reagents but many such conjugates suffer losses in sensitivity and specificity due to nonspecific labeling techniques. Here, we used a rabbit polycolonal antibody raised against spores isolated in 2006. A 60-mer oligonucleotide sequence was covalently bound to a secondary antibody with S-4FB and S-HyNic protein cross-linkers. The rt-IPCR assay increases the sensitivity of the analogous ELISA by as much as 25 fold, with a limit of detection of 40 spores so

far. The assay can quantify from 40 to 5000 stripe rust spores per sample. This assay strategy is highly adaptable, and any antigen of interest can be quantified providing a sensitive and specific primary antibody is available.

Sensitivity of *Leptosphaeria maculans* isolates from canola to pyraclostrobin fungicide in Alberta, Canada. M. C. FRASER, S. F. HWANG, H. U. AHMED, W. BARTON AND S. E. STRELKOV. *Department of Agricultural, Food and Nutritional Science, 410 Agriculture/Forestry Centre, University of Alberta, Edmonton, AB T6G 2P5, Canada; (S.-F.H., H.U.A.) Crop Diversification Centre North, Alberta Agriculture and Rural Development, 7000-113 Street, Edmonton, AB T5Y 6H3, Canada; and (W.B.) BASF, Research & Commercial Development, 100 Milverton Drive, Mississauga, ON L5R 4H1, Canada*
Blackleg disease, caused by *Leptosphaeria maculans* (Desmaz.) Ces. & De Not poses a serious risk to canola production in Canada. Pyraclostrobin is commonly used to manage blackleg disease, but as a strobilurin fungicide, it has the potential to select for fungicide intensive isolates within the *L. maculans* population. In 2011, infected canola stubble was collected from Camrose, Ponoka, Lacombe, Lethbridge, Strathcona, and Wetaskiwin, Alberta. From these samples, 117 single-spore isolates of *L. maculans* were prepared and their sensitivity to Headline EC fungicide (pyraclostrobin) was evaluated through a growth plate assay. The mean EC_{50} value of 13 reference isolates was determined to be 0.25 mg L^{-1}. The 117 isolates were then screened with the EC_{50} dose. Two thirds of the isolates were highly sensitive (>50% growth inhibition relative to the non-amended control), while one third was moderately sensitive (<50% inhibition). Lethbridge had a greater proportion of moderately sensitive isolates, while Camrose, Strathcona, and Ponoka had a greater proportion of highly sensitive isolates. Further research will include testing of the isolates with a discriminatory dose to determine if any insensitive isolates are present in the sample population. Preliminary results of this study show that the sensitivity of isolates to pyraclostrobin in Alberta varies.

Genetic diversity of the wheat pathogen *Zymoseptoria tritici* in Alberta, Canada. M.D. HOLTZ, T.K. TURKINGTON AND K. XI. *Field Crop Development Centre, Alberta Agriculture and Rural Development, 6000 C and E Trail, Lacombe, AB T4L 1W1, Canada; and (T.K.T.) Lacombe Research Centre, Agriculture and Agri-Food Canada (AAFC), 6000 C & E Trail, Lacombe, AB T4L 1W1, Canada*
Zymoseptoria tritici (Desm.) Quaedvlieg & Crous, comb. nov. (Synonyms: *Septoria tritici* and *Mycosphaerella graminicola*) is a member of the leaf spot complex of wheat. Eighty-nine isolates were collected from central and southern Alberta. The species population genetic structure was analyzed by examining the mating type and 13 microsatellite loci. Both mating types were detected in approximately equal proportions in both central and southern Alberta. At each microsatellite locus, 2 – 5 alleles were detected, for a total of 35 alleles. A high level of genotypic diversity was found, with a clonal fraction of only 4.5%. There was no evidence of linkage disequilibrium between the loci. Cluster analysis using the shared allele distances between the isolates showed no differentiation between regions and all clusters had low bootstrap support. Based on these results, *Z. tritici* in Alberta appears to be one large panmictic population. The equal mating type ratios, lack of linkage disequilibrium, and high genetic variation suggest that frequent and ongoing sexual recombination occurs.

A QTL for all-stage resistance to stripe rust (*Puccinia striiformis* f. sp. *hordei*) in the barley cultivar 'Seebe'. M.D. HOLTZ, S. XUE, P. JUSKIW, K. XI, K. KUMAR AND J. ZANTINGE. *Field Crop Development Centre, Alberta Agriculture and Rural Development, 6000 C and E Trail, Lacombe, AB T4L 1W1, Canada*

Barley stripe rust caused by *Puccinia striiformis* Westend f. sp. *hordei* is an important disease of barley in Central America and parts of the United States. There is concern the disease may become more severe within Canada. Genetic resistance is the best approach for controlling the disease. The 2-row barley cultivar 'Seebe' possesses all-stage resistance to barley stripe rust. To determine the source of the resistance, Seebe was crossed with the cultivar 'Harrington' and from the resultant F1 seeds a population of recombinant inbreed lines (RILs) was developed by single-seed descent. The parents and RILs were screened for stripe rust resistance at the seedling stage under controlled conditions. Eighty-two lines were analyzed with Diversity array technology (DArT) and simple sequence repeat (SSR) markers. Single marker analysis and confidence interval mapping indicate that this all-stage resistance is controlled by a single QTL located on chromosome 5H. This QTL has the potential to be incorporated into breeding lines by marker assisted breeding at the Field Crop Development Centre.

The role of pollen in the development of blossom blight of seed alfalfa caused by *Botrytis cinerea*. J. REICH, D. JOHNSON AND S. CHATTERTON. *University of Lethbridge, 4401 University Drive, Lethbridge, AB T1K 3M4, Canada; and (S.C.) Lethbridge Research Centre, Agriculture and Agri-Food Canada (AAFC), 5403–1 Avenue South, Lethbridge, AB T1J 4B1, Canada*

Blossom blight of seed alfalfa, caused by fungal pathogens *Botrytis cinerea* Pers.:Fr. and *Sclerotinia sclerotiorum* (Lib.) de Bary, is an economically important disease in the Canadian Prairies. Both *B. cinerea* and *S. sclerotiorum* readily infect alfalfa pollen *in vitro*, though the extent to which infection occurs under field conditions is unknown. Leafcutter bees (*Megachile rotundata*) are intensively managed to pollinate the florets and may transmit the pathogens if pollen infection is common. A greenhouse study was conducted to investigate the role of pollen in the development of blossom blight caused by *B. cinerea*. Racemes of alfalfa plants were tripped or not tripped, inoculated with conidia applied in a suspension (wet) or dry dusted (dry), and placed in a humidity chamber at 100% relative humidity for 24 hours. Florets were harvested at 0, 24, 48, and 96 hours post-inoculation and subsamples were tested for pollen and floret infection, pollen viability, and used for histopathological analysis. No infection of pollen was observed and there were no significant effects of tripping or harvest time on floret infection ($p>0.1$). However, wet-inoculated florets had a higher percentage of blossom blight than dry-inoculated florets ($p\leq0.005$). These results suggest that infected pollen does not play a significant role in pathogen transmission, though trials are ongoing.

Prevalence of avirulence genes in *Leptosphaeria maculans* isolates from Alberta, Canada.

S. B. RONG, J. FENG, W. X. FEI, S. F. HWANG AND S. E. STRELKOV. *Anhui Academy of Agricultural Sciences, Hefei, Anhui, China; (J.F, S.F.H.) Crop Diversification Centre North, Alberta Agriculture and Rural Development, Edmonton, AB T5Y 6H3, Canada; and (S.E.S.) Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada*

Blackleg, caused by the species complex of *Leptosphaeria maculans* and *L. biglobosa*, is a severe disease of canola or oilseed rape (*Brassica napus*) worldwide. In this study, 121 single-spore isolates of *L. maculans*were obtained from infected canola plantscollected from six locations in Alberta. Race structure was investigated byPCR amplification of five avirulence genes. Among these, *AvrLm1*was found to be absent in all isolates while *AvrLm4-7*and *AvrLm6* were present in all isolates. *AvrLmJ1* and *AvrLm11* were present in most isolates but absent in isolates 334, 437 and 491. *AvrLm11* was absent in isolates 235 and 245. This result suggests a low level of race diversity in the *L. maculans* populations from Alberta. The absence of *AvrLm1* suggests that the corresponding resistance gene *Rlm1* maybe well distributed in Alberta's canola cultivars. The prevalence of the other four *Avr* genes in most isolates is consistent with the race structure of *L. maculans*found in Ontario and in other countries, such as Mexico and Chile. The absence of *AvrLmJ1* and *AvrLm11* in a few isolates suggests that the corresponding resistance genes may have limited effectiveness in Alberta.

The impact of barley variety rotation, mixtures, and intercropping on leaf disease and silage production.

T.K. TURKINGTON, K. XI, K.N. HARKER, J.T. O'DONOVAN, R. BLACKSHAW, T. McALLISTER AND N. LUPWAYI. *Lacombe/Beaverlodge Research Centre, Agriculture and Agri-Food Canada, Lacombe, AB T4L 1W1, Canada; (K.X.) Field Crop Development Centre, Alberta Agriculture and Rural Development, Lacombe, AB T4L 1W1, Canada; and (R.B, T.M., N.L.) AAFC, Lethbridge Research Centre, Lethbridge, AB T1J 4B1, Canada*

Three year rotational treatments were established in 2008 at two Alberta locations with comparisons made in 2010 and 2013. Treatments included: continuous barley, same variety; a mixture of the same three barley varieties each year; a mixture of three different barley varieties each year; an intercrop of barley, oat, and spring triticale with the same or different crop varieties each year; and an intercrop of barley, oat, and winter triticale with the same or different crop varieties each year. In 2010 and 2013, all treatments had the six-row barley variety Sundre. For both locations leaf disease, primarily net-form net blotch, was generally highest for continuous Sundre, and lowest for mixtures or intercrops with different varieties. At Lacombe in 2010 and 2013, silage yields were lowest for the continuous Sundre, highest for the intercropping treatments with the same or different varieties, and intermediate for barley mixtures. At Lethbridge in 2010 and 2013, continuous Sundre tended to have the lowest silage yield, although the intercrop treatments with winter triticale also had lower yields. Barley variety mixtures and intercropping with spring triticale tended to have higher, but similar yields. Results suggest that adding diversity in crop types and barley genetics may reduce leaf disease and improve silage productivity.

Immunofluorescent detection of clubroot resting spores. T. VUCUREVICH, C. SHEEDY, G. DUKE AND L. KAWCHUK. *Lethbridge Research Centre, Agricultural and Agri-food Canada, 5403-1Avenue, South, Lethbridge, AB T1J 4B1, Canada*
Clubroot caused by the pathogen *Plasmodiophora brassica* is becoming an important disease in Alberta, affecting plants of the *Brassica* family such as canola. Purified clubroot resting spores and 45µm cross-sections of infected canola root tissue were examined under a confocal microscope following specific labelling with a polyclonal antibody and a fluorochrome for immunofluorescent detection. This method shows that binding is occurring as we see highly fluorescing clubroot spores under confocal imagery when the spores are antibody-labelled, as opposed to the negative controls. The antibodies were highly specific to clubroot resting spores and did not exhibit cross-reactivity to closely related spores of the powdery scab causing agent, *Spongospora subterranea*. These findings support results obtained by other detection methods being developed in our laboratory (rt-iPCR, proximity ligation assay and enzyme-linked immunoassay) and are being used to develop a rapid on-farm detection method of clubroot disease for Alberta's producers.

Effect of inoculum concentration on growth of clubroot-resistant canola and Napa cabbage. J. A. DALTON, B. D. GOSSEN AND M. R. MCDONALD. *Plant Agriculture, University of Guelph, Guelph, ON N1G 2W1, Canada; and (B.D.G.) Agriculture & Agri-Food Canada, Saskatoon, SK S7N 0X2, Canada*
Clubroot, caused by *Plasmodiophora brassicae* (Woronin), reduces yield in canola (*Brassica napus* L.) and Brassica vegetables such as Napa cabbage (*B. rapa* L. ssp. *pekinensis*). Genetic resistance is essential for clubroot management. However, studies indicate that high spore loads may reduce growth and delay development in clubroot-resistant cultivars of canola and Napa cabbage. Area under the growth stairs (AUGS) was calculated using weekly measurements of height for canola and leaf length for Napa cabbage. Inoculation with 1×10^6 spores mL^{-1} of *P. brassicae* reduced plant height by 11% (± 5%) in three resistant canola cultivars, but leaf length of Napa cabbage cultivars was only reduced by 3% (± 1%). A field trial was conducted in 2014 to compare the growth of clubroot-resistant canola cultivars at two adjacent sites at the Muck Crops Research Station, University of Guelph, King, ON, selected based on a field history differing only in spore loads of *P. brassicae* (estimated at 5×10^8 vs.7×10^7 spores g^{-1} dry soil). There were no symptoms of clubroot in the resistant cultivars, but severe clubroot developed in the susceptible control at both sites. At the location with a higher inoculum concentration, plant height of the resistant canola cultivars was reduced by 36% (± 6%) and leaf length of Napa cabbage was reduced by 18% (± 3%) relative to the lower inoculum concentration. These results support previous reports that the growth of resistant cultivars of canola and Napa cabbage is reduced when resting spore populations are high.

Metam-sodium and chloropicrin soil treatments reduce resting spore populations of *Plasmodiophora brassicae,* 2014. J. ROBSON, B. D. GOSSEN AND M. R. MCDONALD. *Department of Plant Agriculture, University of Guelph, Guelph ON N1G 2W1, Canada; and (B.D.G.) Agriculture & Agri-Food Canada, Saskatoon, SK S7N 0X2, Canada*
Clubroot (*Plasmodiophora brassicae* Woronin) is an important disease of canola (*Brassica napus* L.) and other Brassica crops. The efficacy of metam-sodium (trade name Vapam HL or Busan 1236) and chloropicrin (Pic

Plus) fumigants against *P. brassicae* was assessed in growth room and field studies. Efficacy was assessed in a bioassay of severity (disease severity index, DSI) on Shanghai pak choi (*B. rapa* L. subsp. *chinensis* var. *communis*) under controlled conditions. In a growth room study, severity was low (< 2 DSI) on infested muck soil treated by drenching with Vapam (146, 292, 585 L a.i. ha^{-1}) or Busan (145, 290, 581 L a.i. ha^{-1}) in air-tight plastic bags, but high (70 DSI) in the nontreated control. In soil from treatments on a muck soil (~70% organic matter) site, a low rate of chloropicrin (89 L) covered with an impermeable plastic film reduced subsequent clubroot severity compared to the check (45 vs. 89 DSI), but moderate to high rates of Vapam (292, 585 L) that was packed but not tarped were much less effective (78 DSI). In soil from treatments on mineral soil, severity in the control was low (3 DSI) and no symptoms developed from treatment that received metam-sodium (Vapam and Busan) or chloropicrin. There was no difference between Vapam and Busan at any application rate in any study. Chloropicrin was more effective than metam-sodium in the field, but sealing the soil surface (as used with chloropicrin) may improve the efficacy of metam-sodium.

SNP markers for clubroot resistance gene *CR01* based on RNA sequencing. F. YU, X. ZHANG, Z. HUANG, T. SONG, M. CHU, K. C. FALK, B. D. GOSSEN, A. DEORA, M. R. MCDONALD AND G. PENG. *Agriculture and Agri-Food Canada, Saskatoon Research Centre, 107 Science Place, Saskatoon, SK, S7N OX2, Canada; and (A.D., M.R.M.) Department of Plant Agriculture, University of Guelph, Guelph, ON N1G 2W1, Canada*

A clubroot resistance gene *CR01*, effective against pathotype 3 of *Plasmodiophora brassicae* Wor., was previously mapped to chromosome A03 of *Brassica rapa* L. in pak choy cv. 'Flower Nabana' (FN). A number of differentially expressed genes associated with this gene were identified using RNA sequencing. In the current study, genetic mapping demonstrated that resistance to pathotypes 2, 5 and 6 co-segregate with *CR01*, indicating that the *CR01* locus may confer broad resistance against *P. brassicae*. About 350 M short sequences were identified from resistant (FNR) bulks and and 320 M from susceptible (FNS) bulks. The sequences were assembled, and SNP (85% of total) and Indel (15%) variants were identified, about 80% of which were homozygous. Unique FNR, unique FNS and heterozygous variants were below 10%, 9% and 4%, respectively. The frequency of homozygous variants in chromosome A03 was only 66%, but unique FNR, unique FNS and heterozygous variants were identified on A03, at about 14%, 12% and 8%, respectively. Four closely linked genes on A03 that carried the highest numbers of variants, including unique FNR in the *CR01* region, were used to confirm the presence of SNPs. Seven SNP markers identified in these genes co-segregated with 12 recombinants obtained from a segregating population consisting of 1600 plants, indicating these gene-specific SNP markers are completely linked to *CR01*. These markers are polymorphic between the resistant donor and three *B. napus* canola lines, indicating they can be used for marker-assisted selection during the introgression of *CR01* into canola.

Plant Pathogen Interaction Enzyme Expression (PPIEE) assay for linking enzymes to fusarium head blight resistance in barley. K. KUMAR, J. ZANTINGE, K. XI, K. STEENBERGEN, P. JUSKIW, S.

WATERMAN AND M. D. HOLTZ. *Field Crop Development Centre, Alberta Agriculture and Rural Development, 6000 C and E Trail, Lacombe, AB T4L 1W1, Canada*

Fusarium Head Blight (FHB) of barley, primarily caused by the fungus *Fusarium graminearum*, has become a major production problem in the humid and semi-humid areas of the world. This disease has well established in Manitoba and has been moving westward and northward in western Canada. In addition to yield losses, FHB is detrimental to grain quality due to the mycotoxin contamination. This has resulted in grain unsuitable for malting or feed. The objective of the present study is to develop an *in vitro* assay to screen barley germplasm for FHB resistance. In this petri dish assay, the seed of barley cultivars/lines inoculated with *F. graminearum* were incubated on growth medium amended with a specific enzyme substrate to measure 1-3 β-glucanase, an enzyme previously identified to increase plant resistance to pathogens. Enzyme activity was visible in the growth medium and could be measured with a simple optical density (OD) reading. The blue colour and OD readings were significantly higher in resistant cultivars/lines compared to susceptible ones. Some lines showed variation in both lab and field data, this variation emphasized the complex nature of the pathogen-plant relationship. Further research is planned to reduce variability by identifying the optimal test conditions and standardizing the assay measurements.

Expression patterns of selected *Plasmodiophora brassicae* genes in resistant and susceptible canola. W.X. FEI, S. RONG, J. FENG, S. F. HWANG AND S. E. STRELKOV. *Crop research institute, Anhui Academy of Agricultural Sciences, Hefei, Anhui, 230031,China; (J.F., S.F.H) Crop Diversification Centre North, Alberta Agriculture and Rural Development, Edmonton, AB T5Y 6H3, Canada; and (S.E.S.) Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5, Canada*

Plasmodiophora brassicae causes clubroot disease in cruciferous plants, and is an emerging threat to Canadian canola (*Brassica napus*) production. The *in planta* expression patterns of 12 *P. brassicae* genes were analyzed by quantitative PCR over a time-course following inoculation of resistant and susceptible canola genotypes. For all 12 genes, a single expression peak was observed in the resistant genotype at 5 or 7 days after inoculation (dai), indicating the involvement of these genes in the early stages of infection. In the susceptible genotype, the 12 genes were classified into three groups: two genes showed a single expression peak at 14 dai, three showed two expression peaks at 14 and 35 dai, and the remainder showed a single expression peak at 35 dai. The genes specifically up-regulated during the early stages of infection in the resistant genotype are likely responsible for causing a similar amount of primary infectionin the susceptible genotype. Furthermore, if the molecular interaction between canola and *P. brassicae* follows the traditional gene-for-gene model, any effort to search for *Avr* genes should focus on candidates that have an expression pattern with a specific up-regulation in the resistant genotype at the early stages of infection.

Does drought stress affect the resistance reaction of wheat and triticale to different pathogens? A. LAROCHE, M.M. FRICK, S. VERMA, N. GAUDET, G. DHARIWAL, M. SCHUSSLER, M.J. FRICK, S. WOGSBERG, K. KUNDRIK AND D. GAUDET. *Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB T1J 4B1, Canada*

Whether abiotic stress interacts positively or negatively with the plant responses to different pathogens has important implications to cereal production. The induction of the stress signaling pathway mediated by abscisic acid (ABA) following a drought treatment is well documented in the literature. It is less clear how the developmental hormones auxin, cytokinins (CKs) or defence signaling hormones jasmonic acid (JA), salicylic acid (SA), ethylene (ET), and brassinosteroids, interact with drought stress to finally determine the outcome of the plant-pathogen interactions. Additionally, numerous plant resistance genes are known to be effective only at the adult plant stage. Our goal is to understand the interaction between drought stress and resistance expression to stripe rust and powdery mildew in wheat and triticale during several seedling and adult developmental stages. Numerous defence- and stress-related plant transcripts were profiled during infection of drought-stressed wheat and triticale at the Zadoks' Z12, Z21, Z42 and Z59 stages. Results suggest that the regulations of specific key genes regulating stress response are under the control of regulatory processes that control plant developmental stages. Furthermore, the response to pathogen inoculation was different in root and leaf tissues. Up-regulation of different WRKY transcription factors previously associated with the drought stress response were also up-regulated following inoculations with the pathogens.

Molecular characterization of late blight pathogen (*Phytophthora infestans*) using microsatellite and T-RFLP analysis. C.P. WIJEKOON, B.B. PAGENI AND L.M. KAWCHUK. *Agriculture and Agri-Food Canada, Lethbridge, AB, T1J 4B1; (B.B.P) University of Lethbridge, Lethbridge, AB T1K 3M4, Canada*

Phytophthora infestans (Mont.) de Bary has reduced potato and tomato yield and quality during recent late blight epidemics in North America. Genetically diverse and aggressive *P. infestans* genotypes migrated to Canada and USA during the 1990s. Genotype US-8 was found to be more aggressive in potato than previous clonal lineages of *P. infestans*. Recent *P. infestans* genotypes found in the USA and Canada include US-11, US-8, US-22, US-23, and US-24 representing clonal lineages with unique epidemiological characteristics. Phenotypic traits have been described for these *P. infestans* genotypes based on the mating type, mefenoxam sensitivity, pathogenicity and rate of germination. Characterization of genotypic variations are mostly based on allozyme banding patterns at the glucose 6-phosphate isomerase (*Gpi*) locus, mitochondrial DNA haplotype (mtDNA) and the restriction fragment length polymorphism (RFLP) analysis using the multilocus RG57 sequence. Recently, microsatellite analysis using polymorphic markers on these clonal variants was introduced. In this study, we describe microsatellite analysis and a new terminal restriction fragment length polymorphism (T-RFLP) method using RG57 as a marker gene to distinguish the pathogen isolates from various regions of Canada. Five different US genotypes (US-8, US-11, US-22, US-23 and US-24) were characterized at the molecular level by microsatellite and T-RFLP analysis.

Pathogenic fungi from roots, crowns, and stems of field pea on the Canadian prairies. A. ESMAEILI TAHERI, S. CHATTERTON, N. FOROUD, B. D. GOSSEN AND D. L. MCLAREN. *Lethbridge Research Centre, Agriculture and Agri-Food Canada (AAFC), 5403 1st Avenue South, Lethbridge, AB T1J 4B1, Canada; (B.D.G.) Saskatoon Research Centre, AAFC, 107 Science Place, Saskatoon, SK S7N 0X2, Canada; and (D.L.M.) Brandon Research Centre, AAFC, 2701 Grand Valley Road, Brandon, MB R7A 5Y3, Canada*

Root and lower stem diseases are becoming important constraints to field pea (*Pisum sativum* L.) production on the Canadian prairies, but the pathogen communities associated with symptomatic plants have not been systematically assessed. The fungal communities associated with symptomatic roots, crowns and lower stem tissues of pea were characterized using plate culture and PCR-based identification. Symptomatic plants were sampled at the mid-flowering stage from 10 fields; 4 in Alberta, 3 in Saskatchewan, and 3 in Manitoba. Tissue segments were surface sterilized, incubated on potato dextrose agar, and > 500 pure fungal isolates were collected. Seventy-nine Operational Taxonomic Groups (OTU) were constructed based on isolate morphology and colour on Spezieller-Nahrstoffarmer agar. Some 30 fungal taxa were identified according to translation elongation factor-1 alpha or the ITS sequences. *Fusarium* spp. accounted for more than 60% of total isolations. The fungal communities associated with roots and crowns were similar, but differed significantly from communities invading lower stems. The *Mycosphaerella/Ascochyta* complex and *Alternaria* spp. were most abundant in lower stems and *F. avenaceum* (Fr.) Sacc. occurred at the highest incidence of all pathogens in crowns. *Aphanomyces euteiches* Drechs., an important root pathogen of pea in the region, was not detected in this study, suggesting plate culture may be biased against this fungus.

Pea root rot in Alberta: surveys and pathogen identification. S. CHATTERTON, R. BOWNESS AND M.W. HARDING. *Lethbridge Research Centre, Agriculture and Agri-Food Canada (AAFC), 5403–1 Avenue South, Lethbridge, AB T1J 4B1, Canada; (R.B) Lacombe Research Centre, Alberta Agriculture and Rural Development, 6000 C E Trail, Lacombe, AB T4L 1W1, Canada; and (M.W.H.) Crop Diversification Centre South, Alberta Agriculture and Rural Development, 301 Horticultural Station Road East, Brooks, AB T1R 1E6, Canada*

Late season root rot of field pea, causing wilting and death of mature plants, is threatening sustainable pea production in Alberta. To assess the prevalence and severity of root rot in Alberta, approximately 150 pea fields were surveyed each year in July 2013 and 2014. Roots were dug up at each of 10 sampling sites/field, washed and assigned a visual rating for disease severity (1=healthy…7=dead). Root rot was found in almost all fields surveyed with a mean incidence of 86% in both years, and a mean severity of 3.0 and 3.3 in 2013 and 2014, respectively. However, disease severity differed significantly between regions. Pathogens present in root samples were identified using multiplex PCR assays with species-specific primers targeting common root rot pathogens, and by classical culturing techniques. Results indicated that *F. avenaceum, F. solani, F. redolens* and *F. oxysporum* were primarily associated with root rot symptoms. In 2013, seven fields also yielded a positive result for the destructive oomycete, *Aphanomyces euteiches*, whose presence was confirmed with soil baiting assays. This was the first record of *A. euteiches* on field pea in Alberta. Identification of pathogens found in roots collected during the 2014 survey is currently ongoing. The high incidence and severity of root

rots documented in the survey substantiates the concern expressed by Alberta producers in recent years, and indicates that further investigations into control strategies, as well as continued monitoring for spread of *A. euteiches*, is necessary.

Irrigation and cultivar interactions effect development of white mold of dry bean. S. CHATTERTON, P.M. BALASUBRAMANIAN AND R.S. ERICKSON. *Lethbridge Research Centre, Agriculture and Agri-Food Canada, 5403 – 1st Avenue South, Lethbridge, AB T1J 4B1, Canada*

White mold, caused by *Sclerotinia sclerotiorum* (Lib.) de Bary, is the most serious disease of dry bean in Canada. The pathogen is favored by cool, moist conditions such as those provided by frequent irrigation and a thick crop canopy. A field study was conducted in Lethbridge, Alberta in 2014 to determine the influence of dry bean plant architecture and irrigation management on in-crop microclimate and white mold infection. Five cultivars (AAC Burdett, AC Island, Othello, CDC Pintium, and I9365-31) with varying plant architectures and three irrigation levels (high, medium, and low) were arranged in an inoculated field in a split-plot design with irrigation level as the main treatments and cultivar as sub-plot treatments. Leaf wetness and soil moisture were recorded during white mold susceptible period. Results showed significant (P<0.05) effects of irrigation level on soil moisture, flowering date, incidence of flower infection and lodging. Significant effects of bean cultivar were observed on flowering date, first occurrence of white mold, incidence of flower infection and lodging. Significant irrigation x cultivar interactions were detected for the variables of canopy porosity, plant height, and incidence and severity of white mold. White mold incidence and severity were generally the most severe under high irrigation. The late-flowering, partially resistant cultivar, I9365-31, consistently had the lowest incidence and severity of white mold. The study will be repeated for three years until 2017.

Metam sodium soil fumigation as an additional tool for management of clubroot (*Plasmodiophora brassicae*) in canola (*Brassica napus*). K. A. ZUZAK, S. F. HWANG, G. D. TURNBULL, V. P. MANOLII AND S. E. STRELKOV. *Department of Agricultural, Food and Nutritional Science, 410 Agriculture/ Forestry Centre, University of Alberta, Edmonton, AB T6G 2P5, Canada; and (S.F.H., G.D.T.) Crop Diversification Centre North, Alberta Agriculture and Rural Development, 17 507 Fort Road N.W., Edmonton, AB T5Y 6H3, Canada*

Clubroot disease of crucifers, caused by the pathogen *Plasmodiophora brassicae*, is spreading across canola (*Brassica napus* L.) fields in Alberta, with nearly 1500 confirmed clubroot infestations as of 2013. The first cases have recently also been reported from the Prairie Provinces of Saskatchewan and Manitoba. With the appearance of new pathotypes of the pathogen capable of causing disease on our current resistant cultivars, it is important to consider additional clubroot management strategies, including soil fumigation. Fields with new or localized infestations may benefit from soil fumigation with Vapam, a metam sodium solution targeting weeds, nematodes, insects and soilborne pathogens such as *P. brassicae*. In this study, the efficacy of Vapam was assessed over two years at field sites in Edmonton, Alberta. Sequential levels of the treatment were appraised for their ability to reduce clubroot severity and protect crop growth parameters. There was an approximately 50% reduction in clubroot severity at one site, and 30% at the second site in 2012. However, no residual activity

was detected when the same sites were sown to clubroot-susceptible canola in 2013. Treatment with Vapam resulted in an approximately 30% reduction in disease severity, upon repetition of the trials at one of the sites.

Potential for metam sodium to eradicate *Plasmodiophora brassicae* in field soils. B. D. GOSSEN, S. F. HWANG AND M. R. MCDONALD. *Agriculture and Agri-Food Canada, Saskatoon Research Centre, 107 Science Place, Saskatoon, SK S7N 0X2 Canada; (S.F.H.) Crop Diversification Centre North , Alberta Agriculture and Food, Edmonton, AB T5B 4K3, Canada; and (M.R.M.) Department of Plant Agriculture, University of Guelph, Guelph, ON N1G 2W1 Canada*

Canola (*Brassica napus* L.) is a major crop in western Canada, grown on about 8 M ha with a value > $19 B per year. Clubroot (*Plasmodiophora brassicae* Wor.) was first identified on canola in western Canada in 2003 and has already been confirmed in > 1450 fields. Resting spores of the pathogen can survive for many years in soil, and movement of infested soil on farm machinery and other equipment is an important mechanism of clubroot transmission. The disease has spread across large areas of the Canadian province of Alberta, but has been confirmed in only a few sites in the provinces Saskatchewan and Manitoba. Although treatment with a soil fumigant is not economical for commercial crop production, it may have a role in containing or eradicating infestations at sites that have only recently become infested. Fumigation may also have a role in reducing the transmission of the pathogen to new sites associated with industrial activities such as oil and gas exploration / development, construction of roads, and provision of utilities. Under controlled conditions, application of high rates of metam sodium (Busan 1236 at 85 and 170 kg ai ha^{-1}) to naturally–infested soil reduced clubroot severity (DSI) from 38% in the untreated check to 1.8 and 0 in Shanghai pak choy, a highly susceptible indicator crop, in a soil with high organic matter. Application of Vapam, another formulation of metam sodium, at a moderate rate (21 L ai ha^{-1}) reduced, but did not eliminate, clubroot severity in canola in a mineral soil (31 DSI compared to 82 DSI in the untreated check).

A TaqMan multiplexed qPCR assay for quantification of *Plasmodiophora brassicae* in soil. A. DEORA, B. D. GOSSEN, S. AMIRSADEGHI AND M. R. MCDONALD**.** *Department of Plant Agriculture, University of Guelph, Guelph, ON N1G 2W1 Canada; and (B.D.G.) Agriculture and Agri-Food Canada, Saskatoon Research Centre, Saskatoon, SK S7N 0X2 Canada*

Physical and chemical components of soils can inhibit detection and quantification of soil-borne plant pathogens by polymerase chain reaction (PCR) assays. An accurate and sensitive assay was developed for quantification of resting spores of *Plasmodiophora brassicae* Woronin (cause of clubroot on *Brassica* spp.) using multiplexed TaqMan quantitative real-time PCR (qPCR). The standard curve for genomic DNA of *P. brassicae* was linear ($R^2 > 0.99$) from 10^3 to 10^8 resting spores and the assay detected as few as 200 spores/g of soil. The assay included a competitive internal positive control (CIPC) from the *GFPuv1* gene, which was used to quantify inhibition of qPCR. Co-amplification of the *P. brassicae* gDNA and CIPC did not affect the sensitivity, specificity, or reproducibility of the assay. Samples exhibiting high level of inhibition were further diluted 5-or 10-fold and assayed again. In samples with moderate or low level of inhibition, the delay in CIPC amplification was used to correct the concentration of *P. brassicae* resting spores to account for losses from

inhibition. The assay, which was suitable for use on a wide range of soil types, could reduce the frequency of false negatives, which can be a problem with conventional qPCR assays.

Effect of saponins on clubroot (*Plasmodiophora brassicae*) in canola and Shanghai pak choy. A. DEORA, B. D. GOSSEN, J. A. DALTON AND M. R. MCDONALD. *Department of Plant Agriculture, University of Guelph, Guelph, ON N1G 2W1 Canada; and (B.D.G.) Agriculture and Agri-Food Canada, Saskatoon Research Centre, Saskatoon, SK S7N 0X2 Canada*

Plasmodiophora brassicae (Woronin) causes clubroot on many members of the Brassicaceae family. No information is available on the efficacy of saponins against clubroot. The present study assessed application of two saponins of plant origin on susceptible canola (*Brassica napus* L. cv. Westar) and Shanghai pak choy (*B. rapa* subsp. *Chinensis* cv. Mei Qing Choi) under controlled conditions. *Vaccaria hispanica* (cow cockle), a common weed on the Canadian prairies, was the source of saponin applied as a pre-plant drench application at 0, 3, 9, 27 and 81 kg/ha. Seed treatment of saponin from cow cockle and Heads Up (source: *Chenopodium quinoa*) applied at 28 g/100 kg of seed were also examined. There were differences in clubroot incidence and severity among drench treatments for both crops, but seed treatment had no effect. Both incidence and severity decreased with increasing rate. At the highest rate, clubroot incidence and severity in canola were reduced by 43% and 52%, respectively. Incidence and severity in Shanghai pak choy were reduced by 46% and 44% in one repetition of the study, and by 25% and 43% in a second repetition. Although saponins reduced clubroot severity, the rate required to obtain acceptable levels of reduction are not economical for canola production, and likely not economical for Brassica vegetables.

Vertical profile of *Plasmodiophora brassicae* resting spores in mineral and muck soils. T.J. CRANMER, B.D. GOSSEN AND M.R. MCDONALD. *Plant Agriculture, University of Guelph, Guelph ON N1G 2W1, Canada; and (B.D.G.) Agriculture & Agri-Food Canada, Saskatoon, SK S7N 0X2, Canada*

Canola (Brassica napus L.) is a major crop in Canada, with an economic value of over $19 billion per year. Plasmodiophora brassicae Woronin, the causative agent of clubroot, can cause substantial decreases in yield of canola and other susceptible crucifer species. Resting spores of P. brassicae can survive in soil for many years, but information on their vertical distribution in the soil profile is lacking. Vertical soil cores from the soil surface to 53-cm depth were collected by hand from naturally infested mineral soil sites near Bassano Alberta and Milgrove Ontario, and a muck soil (70% organic matter) from the Holland Marsh in Ontario. A multiplex TaqMan qPCR assay, including an internal control based on GFPuv1, was used to quantify resting spore concentration in soils at selected points along the vertical profile. Spore concentrations ranged from 1×10^3 to 6×10^6 g^{-1} of dry soil. Resting spores were present throughout the soil profile, with concentrations of 1.0×10^3 spores g^{-1} or more at 45–53 cm below the surface in each soil type. Resting spores are generally produced near the soil surface, so this observation indicates that spores are likely carried down into the soil profile by movement of water. These results indicate that management techniques are more likely to be effective if they are aimed across the entire rhizosphere.

Molecular characterization of *Pst* races from western Canada. M. FRICK, B. PUCHALSKI, E. AMUNDSEN, B. PUCHALSKI, H. RANDHAWA, R. GRAF, D. GAUDET AND A. LAROCHE. *Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB T1J 4B1, Canada*
The stripe (yellow) rust pathogen *Puccinia striiformis* f. sp. *tritici* (*Pst*) is highly aggressive and new races quickly evolve to overcome existing resistance genes in wheat. The genome size of this pathogen is ≈110 Mb. Races that predominated during 1960-2000 were adapted to the cooler temperatures of the intermountain regions of western North America. Since 2000, races that are adapted to the warmer regions of the western Great Plains have become widespread. The goals of this project are to identify genetic elements in *Pst* that related to race virulence or to temperature adaptation. Genomic DNA from two strains of *Pst* sampled in 1984 and 2012 has been sequenced with deep coverage using the HiSeq instrument (Illumina). Sequence reads were mapped to reference strains *Pst*78 (Dr. Cuomo, Broad Institute, Cambridge, MA, USA) and CY32. Unmapped reads may represent new and interesting genes. The unmapped reads were mapped to the mitochondrial reference, fungal transposable elements (TE), reference assemblies from related rust species and finally, *de novo* assembled to identify previously unidentified genes. Sequences unique to the race sampled in 2012 when compared to the race sampled in 1984, were identified that may be important to the increased virulence of stripe rust and/or adaptation to the Great Plains since year 2000.

Stripe Rust in Southern Alberta in 2014. D. A. GAUDET, E. AMUNDSEN, M. FRICK, K. KUNDRIK AND A. LAROCHE. *Agriculture and Agri-Food Canada, Lethbridge Research Centre, 5403 1st Avenue South, Lethbridge, AB T1J 4B1, Canada*
Severe epidemics of stripe rust (*Puccinia striiformis* Westend.) can cause extensive yield and quality losses and fungicides are recommended to reduce losses. We surveyed wheat fields in Southern Alberta in the autumn of 2013, the early spring and at weekly intervals throughout the 2014 growing season. There was no evidence for overwintering in Southern Alberta although moderate levels of stripe rust were reported in winter wheat plots in Olds, Alberta in early June 2014. This suggested that overwintering had occurred in the region. Stripe rust was first observed in southwestern Alberta at trace levels (<1% severity) on June 13 in a winter wheat field near Cardston and one east of Lethbridge. By June 25, stripe rust was widespread in winter wheat, occurring in 75% of the winter wheat fields in the Lethbridge region with severity levels exceeding 10% in several fields. By mid-July, stripe rust had been recorded in 70% of the winter wheat fields surveyed with 30% of the fields exceeding 10% severity. Stripe rust was first observed in the Lethbridge region on spring wheat at trace levels on July 10. By early August, 64% of the spring wheat fields surveyed were recorded with stripe rust with 18% of the fields exceeding 10% severity. The elevated severity levels were observed in a corridor north and south of Highway 3 that extended from Cardston to Lethbridge to Bow Island with few spring and winter wheat fields outside of the corridor exceeding trace levels. Fungicide application was widespread in both winter and spring wheat.

The impact of seed treatment, foliar fungicide timing, and plant growth regulator on leaf-disease severity and productivity of barley. T.K. TURKINGTON, K. XI, K.N. HARKER, J.T. O'DONOVAN, G. PENG, R.A. MARTIN, B. BERES, W.E. MAY AND R.M. MOHR. *Lacombe/Beaverlodge Research Centre, Agriculture and Agri-Food Canada (AAFC), Lacombe AB T4L 1W1, Canada; (K.X.) Field Crop Development Centre, Alberta Agriculture and Rural Development, Lacombe, AB T4L 1W1, Canada; (G.P.) Saskatoon Research Centre, AAFC, Saskatoon, SK S7N 0X2, Canada; (B.B.) AAFC, Lethbridge Research Centre, Lethbridge, AB T1J 4B1, Canada; (W.E.M.) AAFC, Indian Head Research Farm, Indian Head, SK S0G 2K0, Canada; (R.M.M.) AAFC, Brandon Research Centre, Brandon, MB R7A 5Y3, Canada; (R.A.M.) Crops and Livestock Research Centre, Charlottetown, PEI C1A 4N6, Canada*

At Lacombe and Lethbridge, AB, Melfort and Indian Head, SK, Brandon, MB, and Charlottetown, PEI, the impact of seed treatment, foliar fungicide timing (flag leaf versus head emergence), and plant growth regulator (PGR) on leaf disease severity and crop productivity of barley was assessed in 2013. Insure™ (triticonazole + pyraclostrobin + metalaxyl) seed treatment was used at two times the recommended rate, while Twinline™ (metconazole + pyraclostrobin) and Prosaro (tebuconazole + prothioconazole) fungicides were applied at recommended rates at flag leaf and head emergence, respectively. The PGR Ethrel™ (Ethephon) was applied between flag leaf emergence and just prior to head emergence. Preliminary results suggest a negative effect of seed treatment on emergence at most sites. Reduced emergence due to seed treatment may have also led to slightly later maturity at some locations. The most significant treatments impacting leaf disease severity at the late milk/early dough, were between the two fungicide applications. Yields tended to be highest at most sites when a fungicide was applied, especially at the head emergence stage. Smaller yield increases were observed with seed treatment, but only at Lethbridge, Melfort, and Indian Head. The application of PGR also increased yields, especially at sites where significant lodging occurred.

Program and Agenda

Monday, Oct. 27th

6:30-8:30pm Registration at Sunrise Room, Best Western Plus, Pocaterra Inn, 1725 Mountain Avenue, Canmore, AB

7:00-9:00pm Reception at the Pocaterra Inn, Sunrise Room

Tuesday, Oct. 28th

8:00-8:30am Registration at the Pocaterra Inn, outside of Bryant, Dawson & Wheeler (BDW) rooms
Poster Set-up at the Pocaterra Inn, BDW Rooms

8:30-9:00am Welcome and Opening Remarks (Pocaterra Inn, BDW Rooms)

- T. Kelly Turkington, PPSA President
- Deena Errampalli, CPS-SCP President

9:00-10:00am Paper Session I – Keynote presentations: Plant Pathology in Alberta and Montana (Pocaterra Inn, BDW Rooms)
Moderator - T. Kelly Turkington

9:00 - O1 - Ron Howard - Plant Pathology Then and Now: Reflections on a 40-Year Career in Alberta

9:30 - O2 - Mary Burrows, MSU - Wheat streak mosaic virus: Research, education and outreach efforts in Montana

10:00-10:30am Refreshment Break (Pocaterra Inn, BDW Rooms)

10:30-11:45pm Paper Session II (Pocaterra Inn, BDW Rooms) - Student and Technician Presentations
Moderator - T.K. Turkington

10:30 - T1 - F. Wang - Detection of stripe rust spores through self-assembly antibody conjugations by rt-IPCR

10:45 - T2 - M. Frick - Molecular characterization of Pst races from western Canada

11:00 – S1 - M.C. Fraser - Sensitivity of *Leptosphaeria maculans* isolates from canola to pyraclostrobin fungicide in Alberta, Canada.

11:30 – S2 - J. Reich - The role of pollen in the development of blossom blight of seed alfalfa caused by *Botrytis cinerea*

11:45 – S3 - K. A. Zuzak - Metam sodium soil fumigation as an additional tool for management of clubroot (*Plasmodiophora brassicae*) in canola (*Brassica napus*)

Tuesday, Oct. 28th Continued

12:00-1:00pm Lunch (Pocaterra Inn, Sunrise Room)

1:00-2:00pm Paper Session III (Pocaterra Inn, BDW Rooms)
Moderator - R. Bowness

1:00 - O3 - S. Chatterton - Pea root rot in Alberta: surveys and pathogen identification
1:15 - O4 - A. Esmaeili Taheri - Pathogenic fungi from roots, crowns, and stems of field pea on the Canadian prairies
1:30 - O5 - K. Kumar - Plant Pathogen Interaction Enzyme Expression (PPIEE) assay in linking enzymes to fusarium head blight resistance in barley
1:45 - O6 - T.K. Turkington - The impact of seed treatment, foliar fungicide timing, and plant growth regulator on leaf-disease severity and productivity of barley
2:00 - O7 - C. Wijekoon - Molecular characterization of late blight pathogen (*Phytophthora infestans*) using microsatellite and T-RFLP analysis
2:15 – O8 - D. A. Gaudet - Stripe rust in southern Alberta in 2014

2:30-3:00pm Poster Session I (Pocaterra Inn, BDW Rooms)
Note: presenters must be at posters during this time

3:00-3:30pm Refreshment Break (Pocaterra Inn, BDW Rooms)
3:30-3:45pm Group Photo (BDW Rooms)
3:45-4:30pm Poster Session I continued (Pocaterra Inn, BDW Rooms)
Note: presenters must be at posters during this time

7:00-7:30pm Cocktails **(Gaucho Brazilian Barbecue, 629 Main Street, Canmore, AB)**
7:30-9:30pm Banquet and Awards **(Gaucho Brazilian Barbecue, 629 Main Street, Canmore, AB)**

Wednesday, Oct. 29th

8:45-9:45pm Paper Session III (Pocaterra Inn, BDW Rooms)
Moderator - K. Kumar

8:45 – O9 - Murray Hartman - Pathotype shifts in clubroot populations in response to canola resistance gene deployment
9:15 – O10 - Deena Errampalli - Update from CPS on the Environment Canada NSN regulations

9:45-10:30am Refreshment Break (Pocaterra Inn, BDW Rooms)

10:30-12:00pm PPSA Business Meeting (Pocaterra Inn, BDW Rooms)

12:00pm Adjourn

Poster Presentations

ID#	Presenter	Title
P1	M. Holtz (Technician)	Genetic diversity of wheat pathogen *Zymoseptoria tritici* in Alberta, Canada
P2	M. Holtz (Technician)	A QTL for all-stage resistance to stripe rust (*Puccinia striiformis* f. sp. *hordei*) in the barley cultivar 'Seebe'
P3	T. Vucurevich (Technician)	Immunofluorescent detection of clubroot resting spores
P4	S. Chatterton	Irrigation and cultivar interactions effect development of white mold of dry bean
P5	W. Fei	Study on the expression pattern of twelve genes from *Plasmodiophora brassicae* in resistant and susceptible canola
P6	B. Gossen	Potential for metam sodium to eradicate *Plasmodiophora brassicae* in field soils
P7	M.R. McDonald	Effect of inoculum concentration on growth of clubroot-resistant canola and Napa cabbage
P8	B. Gossen	Metam-sodium and chloropicrin soil treatments reduce resting spore populations of *Plasmodiophora brassicae,* 2014
P9	B. Gossen	A TaqMan multiplexed qPCR assay for quantification of *Plasmodiophora brassicae* in soil
P10	B. Gossen	Effect of saponins on clubroot (*Plasmodiophora brassicae*) in canola and Shanghai pak choy
P11	B. Gossen	Vertical profile of *Plasmodiophora brassicae* resting spores in mineral and muck soils
P12	B. Gossen	SNP markers for clubroot resistance gene *CR01* based on RNA sequencing
P13	S. Rong	Prevalence of avirulence genes in *Leptosphaeria maculans* isolates from Alberta, Canada
P14	T.K. Turkington	The impact of barley variety rotation, mixtures, and intercropping on leaf disease and silage production
P15	H. Zhang	Study of resistance to clubroot (*Plasmodiophora brassicae*) in a canola (*Brassica napus*) doubled haploid population
P16	A. Laroche	Does abiotic stress increase wheat and triticale susceptibility to different pathogens?