Invasion: Facing the Plague of New Pests

November 7, 2023

Victoria Park East Golf Course
1096 Victoria Road South

Website: www.ontariopmc.ca

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CropLife/OPMC Student Competition and Judging Panel

The 2023 Graduate Oral and Poster Competitions, sponsored by CropLife, Ontario Council, award $500 and a plaque to the winning entry in each category. The 2023 Undergraduate Poster Competition is sponsored by OPMC in honour of Dr. Ron Harris, awards $250 and a plaque to the winning entry. The OPMC wishes to thank the members of the judging panel for generously volunteering their time to help make this competition happen.

Graduate Oral
Jason Deveau, OMAFRA
Hannah Fraser, OMAFRA
John Purdy, Abacus Consulting Services
Marty Vermey, Grain Farmers of Ontario

Graduate Poster
Tyler Blauel, U of G
Travis Cranmer, OMAFRA
Katie Goldenhar, OMAFRA
Amanda Tracey, OMAFRA

Undergraduate Poster
Meghann Garlough, Bayer CropScience
Erica Pate, OMAFRA

AGENDA

8:30 a.m **Registration and Coffee, Poster Set Up**

MORNING SESSION

Chair: Rachel Riddle, University of Guelph

9:00 am **Welcome and Opening Remarks: Kristen Obeid**, Chair, OPMC

9:05 am Adaptation of AgRobotics for root and bulb vegetable production in high organic matter soils. **Geoff Farintosh,** University of Guelph. (Invited Speaker)

9:25 am Soil microbiome and calcium content in relation to the risk of cavity spot on carrots. **Umbrin Ilyas,** University of Guelph. (Student Competition)

9:40 am Emerging threat of ring nematode in Ontario's fruit crop production: What we know so far. **Jerry Akanwari,** Brock University. (Student Competition)

9:55 am Resistance to two SDHI fungicides in *Stemphylium vesicarium*, 2023. **Emily McFaul,** University of Guelph. (Student Competition)

10:10 am Optimization and scalability of regenerative in situ electrochemical hypochlorination for closed-loop hydroponics. **Serge Lévesque,** University of Guelph. (Student Competition)

10:25 am **Coffee Break and Poster Viewing**

10:55 am **PLENARY PRESENTATION - Spotted lanternfly past, present and future: Impacts and management of this invasive pest. Dr. Julie Urban,** Pennsylvania State University

11:40 am OMAFRA CropIPM demonstration. **Susan Murray**, OMAFRA. (Invited Speaker)

12:00 pm - 1:00 pm **Lunch and Poster Viewing**

AFTERNOON SESSION

Chair: Cassie Russell, OMAFRA

1:00 pm Examining two *Dicyphus* species (Hemiptera: Miridae) for their potential use as biological control agents on greenhouse crops. **Carly Demers,** University of Windsor. (Student Competition)

1:15 pm Mitigating apple replant disease with biocontrol soil treatments. **Meaghan Mechler**, University of Guelph. (Student Competition)

1:30 pm **PLENARY PRESENTATION - Palmer amaranth: Biology, ecology, management and lessons learned from Georgia, California and New York. Dr. Lynn Sosnoskie,** Cornell AgriTech

2:15 pm **Coffee Break and Poster Viewing**

2:45 pm **PLENARY PRESENTATION - A plague on all our houses: Plant viruses**
Dr. Jonathan Griffiths, Agriculture and Agri-Food Canada

3:30 pm Viatude, a new fungicide for management of white mould in soybean in Eastern Canada. **Jamshid Ashigh,** Corteva Agriscience. (Industry Speaker)

3:50 pm Presentation of Student Competition Award Winners **–** **Kristen Obeid**, OMAFRA
Closing Remarks and Adjourn

POSTER PRESENTATIONS

-Graduate Student Poster Presentations-

GP1 Disease forecasting models for management of Stemphylium leaf blight of onion. **Julia Scicluna**, University of Guelph. **(Time of judging 9:00-9:10 am**)

GP2 Characterizing beta-tubulin dsRNA for RNAi control of an aggressive *Neopestalotiopsis* species. **Sarah Koeppe**, University of Guelph **(Time of judging 9:12-9:22 am**)

GP3 Effect of soil pH and calcium base saturation on severity of clubroot on canola, 2023. **Kirsten Holy,** University of Guelph. **(Time of judging 9:24-9:34 am**)

GP4 Estimating Fusarium head blight severity in winter wheat using deep learning and a spectral index. **Riley McConachie,** University of Guelph. **(Time of judging 9:36-9:46 am**)

GP5 American ginseng: multi-pathogen interactions in ginseng replant disease. **Andrew Rabas,** Western University. **(Time of judging 9:48-9:58 am**)

GP6 *Tetranychus urticae* adaptation to phenylpropanoid defensive compounds in *Arabidopsis thaliana*. **Alexander Harrison**, Western University. **(Time of judging 10:00-10:10 am**)

GP7 Engineering RNA interference precursors to induce silencing of hop latent viroid in hop (*Humulus lupulus* L). **Taylor Atsaidis Royal,** University of Guelph. **(Time of judging 10:12-10:22 am**)

GP8 Managing Verticillium stripe in canola through genetics, omics, and understanding the *Brassica napus - Verticillium longisporum* interaction. **Ayomi Thilakarathne,** Wilfred Laurier University. **(Time of judging 11:40-11:50 am**)

GP9 Pathogenicity of *Ilyonectria mors-panacis* on American ginseng using chlorophyll fluorescence measurements. **Anka Colo**, Western University. **(Time of judging 11:52-12:02 pm**)

GP10 Screening for *Neopestalotiopsis* spp. in Ontario strawberry varieties and F1 hybrids. **Justin McNally,** University of Guelph. **(Time of judging 1:00-1:10 pm**)

GP11 A CRISPR platform for controlling Fusarium dry rot in potato. **Narges Atabaki,** University of Guelph. **(Time of judging 1:12-1:22 pm**)

**** Judging time - Students must be present at their poster at the time indicated and during the morning and afternoon breaks.***

-Undergraduate Student Poster Presentations-

UP1 The influence of cannabis plant tissue type, trichome density and cultivar on cannabis aphid (*Phorodon cannabis*) behaviour. **Carter Mikkelsen**, University of Guelph. **(Time of judging 9:00-9:10 am**)

UP2 Phosphate solubilizing microbes *Pseudomonas poae* (I186) and *Pantoea eucalypti* (I77) demonstrating dual potential as bio-fertilizer and bio-fungicide. **Ryan Joyce,** Western University. **(Time of judging 9:12-9:22 am**)

UP3 Potential companion plants to protect against *Thrips parvispinus* in greenhouse ornamental crops. **Avery Johnson**, Vineland Research and Innovation Centre. **(Time of judging 9:24-9:34 am**)

UP4 The potential of *Pseudomonas flourescens*, I336 and *Bacillus velezensis*, I113 to restore garlic seed stocks with latent fusarium infections. **Anna Hawkins,** Western University. **(Time of judging 9:36-9:46 am**)

UP5 Biocontrol of fungal plant pathogens in cannabis using *Bacillus amyloliquefaciens* I113. **Hayden Hornick-Martyk**, Western University. **(Time of judging 9:48-9:58 am**)

UP6 Fungal endophyte *Beauveria bassiana* suppresses clubroot (*Plasmodiophora brassicae*) on cabbage under controlled environment conditions. **Kelly Ruigrok,** University of Guelph. **(Time of judging 10:00-10:10 am**)

**** Judging time - Students must be present at their poster at the time indicated and during the morning and afternoon breaks.***

-Regular Poster Presentations-

RP1 Assessment of pesticide resistance of *Tetranychus urticae* populations from southwestern Ontario. **Joseane Moreira do Nascimento,** Western University.

RP2 Switchgrass gall midge, an emerging Ontario pest. **Rebecca Hallett,** University of Guelph.

RP3 Assessing the ecological interactions between invasive and endemic species of gall midge pests of canola. **Rebecca Hallett,** University of Guelph.

RP4 Initial testing of weeding robots in vegetable production systems in Ontario Canada. **Kristen Obeid,** OMAFRA.

RP5 Available genetic testing enables early detection and mitigation of herbicide resistant weeds. **Kristen Obeid,** OMAFRA.

RP6 Harmonized surveillance of common waterhemp (*Amaranthus tuberculatus*): A model of national collaboration. **Kristen Obeid,** OMAFRA.

RP7 Invasive insects to watch out for: A Canadian Plant Heath Council initiative. **Tracey Baute,** OMAFRA.

Plenary Speaker Biographies

Dr. Julie Urban – Research Associate Professor, Department of Entomology, Pennsylvania State University

Dr. Julie Urban earned her Ph.D. in Evolutionary Biology from the University at Albany. She studies planthopper evolution and their co-evolution with multiple bacterial and fungal symbionts. Her recent work involves aspects of basic and applied research on the invasive planthopper, the Spotted Lanternfly (*Lycorma delicatula*). She has been a member of the United States Department of Agriculture's Technical Working Group of scientists, advising management and research on the Spotted Lanternfly, since it was first detected in the US in September, 2014. Dr. Urban is the lead PI on a $7.3M regional USDA NIFA Specialty Crops Research Initiative grant studying the biology, management, and reducing the impact of Spotted Lanternfly in specialty crops in the eastern USA.

Dr. Lynn Sosnoskie, Assistant Professor, Cornell AgriTech

Lynn Sosnoskie joined Cornell AgriTech in September 2019 as an Assistant Professor of Weed Ecology and Management in Specialty Crops, which includes tree and vine crops in addition to fresh and processing vegetables. A native of Shamokin, Pennsylvania, she earned a B.Sc. in Biology from L ebanon Valley College, a M.Sc. in Plant Pathology at the University of Delaware, and a Ph.D. in Weed Science at Ohio State. Prior to coming to Cornell, Lynn worked as a research scientist at the University of Georgia, the University of California, and Washington State University. In New York, Lynn's research is multifaceted. One area of focus includes documenting resistance to glyphosate and the ALS-inhibiting chemistries in Palmer amaranth (*Amaranthus palmeri*) and waterhemp (*A. tuberculatus*).

Dr. Jonathan Griffiths, Research Scientist, Agriculture and Agri-Food Canada

Prior to joining Agriculture and Agri-Food Canada, Jonathan obtained his B.Sc.H. from Carleton University, a M.Sc. in Plant Biology from Western University, and a Ph.D. from the Botany Department at the University of British Columbia. Research in the Griffiths lab focuses on the genomics and molecular biology of plant viruses. Major research projects include plant virus diversity and monitoring using bees, and genetic resistance to tomato brown rugose fruit virus. Located near Niagara in Vineland, ON, the Griffiths lab studies many of the major fruit crops in the region including stone fruits (*Prunus spp.*), grape, berries, and greenhouse tomatoes.

Oral Presentation Abstracts

Morning Session

INVITED 1: Adaptation of AgRobotics for root and bulb vegetable production in high organic matter soils

Geoff Farintosh[1], K. Vander Kooi[1], C. Baresich[2], K. Obeid[3] and M.R. McDonald[1]
[1]University of Guelph, Guelph, ON
[2]Haggerty Creek, Bothwell, ON
[3]Ontario Ministry of Agriculture, Food and Rural Affairs, Harrow, ON

The Holland Marsh is home to some of the most intensive agriculture in Canada. While the high organic matter soil is ideal for growing root and bulb vegetables, weeds also thrive. The lack of registered herbicides and increasing herbicide resistance necessitates hand-weeding, but with labour shortages and increased costs, growers are looking to alternative methods. Robots such as the FarmDroid FD20 and Naïo Orio could provide the solution if they can be adapted to work in vegetable production. Trials conducted at the Ontario Crops Research Centre – Bradford and in surrounding grower fields evaluated these two robots for growing onions, carrots and beets on a commercial scale. In the first year of the project, the FarmDroid FD20 was used to seed and weed onions on a commercial farm with weed control issues. The Naïo Orio was supplemented with a camera-guided hitch attached to a cultivator and a custom twin-boom band sprayer. Data on speed, costs, resources, uptime, crop emergence, weeding efficiency and yield were collected and compared to controls grown using conventional techniques and equipment. Early results show potential for robots to cut down labour costs and increase weeding efficacy without reducing yield, but more data is needed to validate the long-term benefits and true costs.

GO1: Soil microbiome and calcium content in relation to the risk of cavity spot on carrots

Umbrin Ilyas[1], M. Raizada[1], M. Kalischuk[1], L. du Toit[2] and M. R. McDonald[1]
[1] Department of Plant Agriculture, University of Guelph, Guelph, ON
[2] Department of Plant Pathology, Washington State University, Mount Vernon, WA, U.S.A.

Cavity spot is an economically important disease of carrots caused by several soilborne species of *Pythium*. The disease appears as superficial lesions on carrot roots, and symptomatic carrots are unmarketable. Currently, disease management is limited to fungicide application at seeding and avoiding fields with a history of cavity spot. There are no diagnostic tools to identify fields with high-risk for cavity spot. It is hypothesized that the soil microbiome and soil properties, in addition to the inoculum, influence disease development. Bulk muck soil (organic matter 40–80%) was collected from six fields in 2021 and 12 fields in 2022 at the Holland Marsh, soon after seeding, for microbiome and soil nutrient analysis. The fields were grouped as low or high-risk, based on cavity spot severity rated by the local integrated pest management program. Metagenomic analysis of both years showed distinct microbial communities in low and high-risk soils. The relative abundance of the following taxa was greater in low-risk soils compared to high-risk soils: fungi - *Fusarium, Mortierella*, *Penicillium*; bacteria - actinobacteria and protobacteria, and oomycetes - *Phytophthora*; the abundance of *Trichoderma* and *Pythium* was greater in high-risk soils. Soil nutrient analysis of both years showed low-risk soils had lower organic matter ~63 %, but higher pH ~7, and calcium content ~83 %, compared to high-risk soils with organic matter ~72 %, pH ~6, and calcium content ~66 %. This information will help to identify fields with greater risk of cavity spots, enabling growers to avoid high-risk fields.

GO2: Emerging threat of ring nematode in Ontario's fruit crop production: What we know so far

Jerry Akanwari[1,2] and T. Sultana[2]
[1]Department of Biological Sciences, Brock University, St. Catharines, ON
[2]Agriculture and Agri-Food Canada, Vineland, ON

Plant-parasitic nematodes (PPNs) pose a significant threat to global food security and plant health. The ring nematode *Mesocriconema xenoplax*, a highly destructive PPN, has become a great concern in fruit crops worldwide. Although Ontario hosts the production of high-value fruit crops, the lack of comprehensive data on PPNs, particularly *M. xenoplax*, necessitates urgent attention. To address this gap, we conducted a systematic study in various fruit orchards in Ontario to assess the prevalence of *M. xenoplax*, aiming to inform critical management decisions. Soil samples were collected from apple, apricot, plum, peach, and sweet cherry orchards in locations including Blenheim, Simcoe, Springwater, Niagara-on-the-Lake (NOTL), Jordan Station, and Beamsville. The results reveal a concerning scenario, with 83% of orchard soil samples testing positive for *M. xenoplax*. Notably, all the orchards (100%) in NOTL are infested with this nematode, while Springwater exhibited the lowest incidence at 31%. High population densities were observed in Jordan Station and NOTL, reaching 824 and 666 ring nematodes per kilogram of soil, respectively. All soil samples collected from plum had *M. xenoplax*, with significantly higher population densities when compared to other fruit orchards. Importantly, our study identified an increasing presence of *M. xenoplax* in Ontario and, for the first time, documented its presence on apricots in the province. In conclusion, these findings underscore the urgent necessity for strategic management measures to mitigate the emerging threat of *M. xenoplax* in Ontario fruit orchards.

GO3: Resistance to two SDHI fungicides in *Stemphylium vesicarium*, 2023

Emily McFaul[1], B.D. Gossen[2] and M.R. McDonald[1]
[1]Plant Agriculture, University of Guelph, ON
[2]Agriculture and Agri-Food Canada, SK

Stemphylium leaf blight (SLB), caused by *Stemphylium vesicarium*, is an important fungal disease of onion (*Allium cepa L.*) in North America. SLB causes premature defoliation of onion and reduced sprout inhibitor absorption, bulb quality and yield. All onion cultivars are susceptible to *S. vesicarium,* and fungicide applications do not provide effective reduction in severity. Previous studies reported fungicide resistance in *S. vesicarium* to FRAC groups 2, 3, 7, 9 and 11 in Ontario and New York. Most fungicides used in Ontario contain FRAC 7 active ingredients. In the current study, isolates of *S. vesicarium* collected from Ontario in 2021–2023 were assessed for sensitivity to two relatively new FRAC 7 active ingredients, fluxapyroxad and penflufen. Penflufen seed treatment may provide early season protection against *S. vesicarium*. Fluxapyroxad is a component of several registered foliar fungicides. A baseline isolate from 1995 was sensitive to both active ingredients based on mycelial growth but was resistant to both based on conidial germination. In a conidial germination assay, 81% (n = 80) of isolates were resistant to 100 µg/mL fluxapyroxad and 82% (n = 71) were resistant to 50 µg/mL penflufen. In contrast, 43% (n = 75) of isolates were resistant to 50 µg/mL fluxapyroxad in mycelial growth assays and 75% (n = 8) were resistant to 50 µg/mL penflufen. Results indicate that resistance to fluxapyroxad and penflufen has increased over time in the *S. vesicarium* population compared to the baseline, possibly because of cross-resistance with other FRAC 7 active ingredients.

GO4: Optimization and scalability of regenerative in situ electrochemical hypochlorination for closed-loop hydroponics

Serge Lévesque[1], T. Graham[1], J. Phillips[2], D. Bejan[3], J. Lawson[1] and M. Dixon[1]
[1]School of Environmental Sciences, University of Guelph, Guelph, ON
[2]School of Fine Art and Music, University of Guelph, Guelph, ON
[3]Consultant-CESRF, Oakville, ON

Closed-loop hydroponics, where the nutrient solution runoff is collected and reapplied to the crop, is an efficient method for producing crops in controlled environment agriculture (CEA) systems. Although an efficient use of water and fertilizer resources, recirculating the nutrient solution does increase the risk of pathogen proliferation in the overall system. Effective water treatment is a key element in any CEA recirculating hydroponic system. Previous research has demonstrated the use of regenerative *in situ* electrochemical hypochlorination (RisE^{HC}) can inactivate common pathogens such as *Fusarium oxysporum spp.*, without causing phytotoxicity. The next challenge is to scale up the technology and validate efficacy. The presented studies explore the scalability of the RisE^{HC} system and its eventual utility in commercial CEA systems. Computational fluid dynamics (CFD) and response surface analysis were used to determine the optimal design for the electrochemical flow cell presented. A prototype was developed and compared to the previous design for free chlorine evolution, power consumption, and microbial inactivation. The CFD informed design increased microbial inactivation on average by 21.4% in comparison to the previous cell. Furthermore, the prototype design achieved these inactivation rates while the volume of treated solution was increased by 23.2%, and the total area of anodes was reduced by 42.4%. This research demonstrated the scalability of the RisE^{HC} process, through a modular approach, for large-scale CEA.

PLENARY PRESENTATION 1:

Spotted lanternfly past, present and future: Impacts and management of this invasive pest

Dr. Julie Urban
Research Associate Professor, Department of Entomology, Pennsylvania State University, Lewistown, PA, USA

Lycorma delicatula (Hemiptera: Fulgoridae), commonly known as the Spotted Lanternfly (SLF), is an invasive and economically damaging phloem-feeding planthopper that was first detected in the US in September 2014 in eastern PA. SLF feeds on over 100 species of plants and trees in North America, exerting economic impact in ornamental nurseries and other agricultural industries, as well as on businesses such as hotels and resorts. However, the greatest impacts from SLF are to vineyards who report that heavy infestations result in vine mortality and yield reduction. During this presentation, Dr. Urban will provide an overview of the invasion history of the Spotted Lanternfly in the US and discuss the known and anticipated impacts on agriculture, and its potential impacts on other sectors. She will also provide an overview of ongoing research to improve this pest's management.

INVITED 2: OMAFRA CropIPM demonstration

Susan Murray and N. Berardi
Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON

The Ontario Ministry of Agriculture, Food and Rural Affairs soft-launched a new CropIPM website on October 31st, 2023. The new website gives access to key integrated pest management information for Ontario including an identification tool, detailed information on pests, scouting methods and management options. During this talk, we will walk through a demonstration of the new tool, highlighting the key features. This is the first version of the new CropIPM tool and future versions will include additional crop and pest content. During the soft launch phase, we are looking to engage users and collect feedback to guide future iterations of the tool.

Afternoon Session

GO5: Examining two Dicyphus species (Hemiptera: Miridae) for their potential use as biological control agents on greenhouse crops.

Carly Demers[1,2], S. VanLaerhoven[1] and R. Labbé[2]
[1]Department of Integrative Biology, University of Windsor, Windsor, ON
[2]Agriculture and Agri-Food Canada, Harrow, ON

The production of tomato crops in greenhouses represents a large component of Canada's agricultural output, valued at $666M in 2020. In these environments, pests represent a threat to crop production. However chemical control agents are not always viable options for mitigating pest pressure due to either insecticide resistance or the frequent application of beneficial arthropods – such as bumblebees for pollination. Therefore, expanding the diversity of alternative pest control tools is essential. *Dicyphus hesperus* (Hemiptera: Miridae) is an effective native biological control agent (BCA) commercially applied in Canadian greenhouses. Recently, two previously unassessed species – *Dicyphus discrepans* and *Dicyphus famelicus* – were locally collected and colonies established at Agriculture and Agri-Food Canada's Harrow Research and Development Centre. Here, I present the results of a laboratory study intended to describe the potential of these two predator species to consume and control pests of greenhouse tomato including greenhouse whitefly, green peach aphids and two-spotted spider mites. The effect of supplemental plant and insect prey on predator longevity and fecundity was also examined. Together, this research, along with ongoing, large scale greenhouse trials, will serve to determine how well these predators establish, persist and control pests on tomato and strawberry crops. In addition, this study will begin to clarify the degree of zoophytophagy and plant damage potential exhibited by these BCAs in a greenhouse system. Determining how to utilize these Dicyphus species as new BCAs will increase the number of available natural enemies for controlling current and future pests of economic significance.

GO6: Mitigating apple replant disease with biocontrol soil treatments

Meaghan Mechler and J. Cline
Department of Plant Agriculture, University of Guelph, Guelph, ON

Apple replant disease (ARD) can increase apple tree (*Malus domestica* Borkh) mortality, delay production, and impair yield, causing losses of up to $60 K/ha over an orchard's lifespan. Common fumigation treatments harm human and environmental health, have variable effectiveness, and disrupt beneficial soil microbial activity and processes. This project aims to reduce long-term ARD in Ontario orchards with commercially available plant growth-promoting (PGP) microbial biocontrols. Experiments were carried out at three commercially managed apple orchards in Norfolk County, Ontario using a randomized block design with five treatments: untreated control, fumigation control (chloropicrin 164 L ha^{-1}), PGP fungi (PGP-F), PGP rhizobacteria (PGP-R), and a mix of PGP-F and PGP-R. Tree growth and soil health was monitored seasonally with several plant, chemical and ecological soil assessments. Differences in soil bacterial and fungal communities were observed among treatments. PGP treatments impacted plant growth at two of the orchards. At the Simcoe Research Station, PGP-R produced the greatest mean root mass (181 g), followed by the chemical fumigation (150 g). PGP-F treatments accumulated less root biomass (130 g) than the untreated control (137 g). Chemical fumigation resulted in the greatest above-ground biomass tree growth (307

g) followed by the PGP-R (252 g), whereas PGP-F (218 g) accumulated less biomass than the untreated control (237 g). At one commercial orchard, the chemical fumigation resulted in the largest annual trunk diameter growth between 2020-2021 with 2.27 cm, followed by the combination PGP-F & R treatment (1.91 cm). The untreated control had the least growth (0.91 cm).

PLENARY PRESENTATION 2:

Palmer amaranth: Biology, ecology, management and lessons learned from Georgia, California and New York

Dr. Lynn Sosnoskie

Assistant Professor, Cornell AgriTech, Geneva NY

Palmer amaranth (*Amaranthus palmeri*), a dioecious pigweed species native to the Southwestern US, is frequently listed as one of North America's worst weeds because of 1) its growth rate and competitiveness relative to other weeds and crops, 2) prodigious seed production, which can range from hundreds of thousands to a million seeds per female plant under optimum conditions (https://wssa.net/wssa/weed/surveys/), and 3) widespread resistance to multiple herbicides/herbicide modes of action. Infestations can reduce yields through direct competition, by interfering with the deposition of crop protection chemicals, and by physically impeding the movement of men/machinery at harvest. Dense populations can also significantly increase the use (and associated costs) of herbicides, soil disturbance and hand-weeding by growers. Palmer amaranth's high degree of plasticity is predicted to support its expansion into northern cropping systems, especially under current climate change models. Consequently, preventing Palmer amaranth spread into new environments is critical for sustainably managing the species.

PLENARY PRESENTATION 3:

A plague on all our houses: Plant viruses

Dr. Jonathan Griffiths

Research Scientist, Agriculture and Agri-Food Canada, Vineland Station, ON

Plant viruses are serious ongoing threats to agricultural food production worldwide. Research has indicated that viral diseases are causing nearly half (47%) of all plant disease epidemics, and can result in over 30$ billion annual losses worldwide. In Canada, multiple different viral disease epidemics are causing severe losses to growers in many different types of production systems. High bush blueberries in British Columbia are severely affected by blueberry shock virus (genus *Ilarvirus*) and blueberry scorch virus (genus *Carlavirus*), grape production in Ontario and BC are battling infections by grapevine leaf roll virus 3 (genus *Ampelovirus*) and grapevine red blotch virus (genus *Grablovirus*), along with the emerging grapevine pinot gris virus (genus *Trichovirus*), tree fruits including apples, peaches, and cherries have been struck with serious decline issues that could be linked to viral infection, and greenhouse tomatoes production has been affected by ongoing issues with pepino mosaic virus (genus *Potexvirus*) and decimated by the recent emergence of tomato brown rugose fruit virus (genus *Tobamovirus*). Each virus-host system is unique, requiring different approaches for controlling and managing these pathogens. Similarities and differences between some of the plagues will be discussed, along with plant-virus interactions and resistance mechanisms.

INDUSTRY 1: Viatude, a new fungicide for management of white mould in soybean in Eastern Canada

Jamshid Ashigh[1], S. Kher[2], K. Falk[3], C. Chytyk[4], K. Guenette[5], L. Smith[6], and T. Goron[3]
[1]Corteva Agriscience, London, ON
[2]University of Alberta, Edmonton, AB
[3]Corteva Agriscience, Carman, MB
[4]Corteva Agriscience, Saskatoon, SK
[5]Corteva Agriscience, Sherwood Park, AB
[6]Corteva Agriscience, West Lorne, ON

Viatude fungicide is a new dual mode of action product for effective management of sclerotinia stem rot, caused by *Sclerotinia sclerotiorum*, in soybean and canola. It contains both a strobilurin and a triazole and works by disrupting mitochondrial respiration and sterol biosynthesis in fungal mycelia. Multi-year research trials conducted in Eastern Canada indicated consistent performance of Viatude fungicide against sclerotinia stem rot in soybean, leading to improved yield relative to non-treated plots.

Poster Presentation Abstracts

Graduate Student Poster Competition

GP1: Disease forecasting models for management of Stemphylium leaf blight of onion

Julia Scicluna[1], B. Gossen[2] and M.R. McDonald[1]
[1]Department of Plant Agriculture, University of Guelph, Guelph, ON
[2]Agriculture and Agri-Food Canada, Saskatoon, SK

Stemphylium leaf blight (SLB) caused by *Stemphylium vesicarium* is an important foliar disease of onion in Ontario. Fungicides are often applied every 7-14 days, starting at the 3-4 leaf stage, resulting in too many applications when disease pressure is low. Disease forecasting can potentially be used to reduce fungicide applications. SLB forecasting models were evaluated in a field trial at the Ontario Crops Research Centre- Bradford in 2023. Several new or modified forecasting models (Conidia 20, Conidia IT, STEMcast 2.0-15, STEMcast 2.0-20 and STEMcast 2.0-15/40) were compared to a 7-14 day calendar spray program, TOMcast 15 (existing model) and an unsprayed control. The Conidia 20 model was sprayed at a threshold of 20 conidia captured per day in a spore trap and the Conidia IT model at thresholds of 10, 25 and 200 conidia. STEMcast 2.0 is a modified version of the TOMcast model in which values only accumulate between 18-25°C and leaf wetness durations over 12 hours. The three variations of the model have different spray thresholds: accumulated values of 15, 20 or 15 (early season) and 40 (late season). None of the treatments provided effective suppression of SLB, likely because of poor fungicide efficacy. The calendar spray, Conidia 20 and STEMcast 2.0-15 reduced the area under the disease progress curve (AUDPC) slightly compared to the control. STEMcast 2.0-15 triggered four fewer sprays than the calendar spray program without an increase in severity. Research is continuing to test forecasting models with different fungicide combinations.

GP2: Characterizing beta-tubulin dsRNA for RNAi control of an aggressive *Neopestalotiopsis* species

Sarah Koeppe and M. Kalischuk
Department of Plant Agriculture, University of Guelph, Guelph, ON

Neopestalotiopsis sp. is an aggressive novel fungal pathogen of strawberry that has been detected in Ontario since 2020 and currently lacks an effective control method. RNA interference (RNAi) is a mechanism that has the potential to be a highly sensitive and specific crop protection strategy, however, its potential has yet to be explored for this pathogen. RNAi is a cross-kingdom mechanism that is triggered by double-stranded RNA (dsRNA) to elicit post-transcriptional gene silencing (PTGS). As a crop protection strategy, dsRNA of an integral gene in the pathogen should be used, as the application of this dsRNA will silence a critical function. The full length of the target gene is not typically used as larger molecules are obstructed from entering the pathogens cells. Thus, dsRNA constructs must be carefully designed to cover optimal regions of the target gene, avoid regions that may obstruct RNAi machinery, and avoid regions that may produce non-specific binding. For control of *Neopestalotiopsis* sp., the β-tubulin gene is being assessed as a candidate as it plays an integral role in the formation of tubulin fibres during chromosome separation in cell division. The gene has been isolated and sequenced using specially designed primers, and locations of splicing sites, introns, exons, and signalling motifs have been predicted to ensure proper development of dsRNA duplexes for testing. This study provides industry with information on dsRNA construct design, RNAi efficacy, and proposes an effective, alternative control method to conventional pesticides.

GP3: Effect of soil pH and calcium base saturation on severity of clubroot on canola, 2023.

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Clubroot, caused by *Plasmodiophora brassicae* (Woronin), causes root deformities and up to 100% yield loss of several important Brassicaceae crops. Calcium soil amendments that increase soil pH can reduce symptom severity. A field trial at the Ontario Crops Research Station – Bradford examined the effect of pH and calcium base saturation on clubroot severity on canola cultivar InVigor L233P. Initial soil tests showed an average soil pH of ~6.5 and calcium base saturation of 85%. The treatments were application and incorporation of two rates of each of the following: 1) gypsum ($CaSO_4$) to increase calcium base saturation (0.86 & 1.7 t/ha), 2) potassium bicarbonate ($KHCO_3$) to increase pH (3.8 & 5.38 t/ha), 3) gypsum (0.86 & 1.7 t/ha) + potassium bicarbonate (3.8 & 5.38 t/ha), one rate of 4) hydrated lime ($Ca(OH)_2$), which raises both pH and Ca levels (4.3 t/ha) and 5) an untreated control. Hydrated lime, potassium (low rate), and gypsum + potassium (high rate) increased biomass relative to the control. Hydrated lime, potassium (both rates) and gypsum + potassium (both rates) reduced plant wilting. Hydrated lime, potassium (high rate), and gypsum + potassium (high rate) reduced clubroot severity by ~40% compared to the control. There was a correlation (-0.62) between clubroot severity and soil pH, and a weak correlation (0.31) between calcium base saturation and severity. The most effective treatments were hydrated lime and potassium bicarbonate, while gypsum alone had little effect. This indicated that pH had a much larger impact on clubroot severity than calcium base saturation.

GP4: Estimating Fusarium head blight severity in winter wheat using deep learning and a spectral index

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Fusarium head blight (FHB) of wheat, caused by the fungal pathogen *Fusarium graminearum* (Fg), reduces yield and grain quality due to the production of the mycotoxin deoxynivalenol. Manual phenotyping methods for FHB resistance are time-consuming and subject to human error. This study uses a deep learning model, combined with a spectral index, to provide rapid and accurate phenotyping of FHB severity. An object detection model was used to localize wheat heads and corresponding boxes were used to prompt Meta's Segment Anything Model to segment wheat heads in an image. Using 2743 images of wheat heads point inoculated with Fg in a controlled environment, a spectral index was developed using the red and green bands to differentiate healthy from infected tissue and estimate disease severity. The model was able to accurately detect the heads (0.995 mAP@0.5) and segment them (IoU = 0.704). An instance segmentation model was also trained to differentiate between healthy and infected tissue, to determine the accuracy of the index. This model was able to accurately differentiate between tissue (0.914 mAP@0.5). A linear regression was then used to determine the relationship between the severity estimates produced by the two models and the visual estimates. The severity estimated by the index was able to predict visual estimates ($r=0.68$, $p=<2e-16$). It was also able to predict instance segmentation estimates ($r=0.87$, $p=<0.0001$). This workflow can be applied to plot size images of wheat heads to develop a rapid and precise estimation of FHB severity to improve selection efficiency for resistance.

GP5: American ginseng: Multi-pathogen interactions in ginseng replant disease

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American ginseng (*Panax quinquefolius*) is a high-value perennial herbaceous crop used in traditional Chinese medicine. The biggest issue facing ginseng growers is a soil condition known as ginseng replant disease (GRD), resulting in reduced growth and severe root rot in ginseng planted in soil previously used for ginseng cultivation. While GRD-associated root rot is caused by the fungus *Ilyonectria mors-panacis* (*Imp*), other root rot pathogens are present in GRD soil. I hypothesize that, combined with other fungal root pathogens, *Imp*-associated root rot will be more severe than with *Imp* alone. To test this hypothesis, one-year old American ginseng seedlings were co-inoculated with combinations of *Imp* with *Ilyonectria radicicola, Fusarium oxysporum,* and *F. solani* in equal proportions. Pathogenicity was monitored using non-invasive chlorophyll fluorescence over 18 days followed by destructive sampling and root assessment. Compared to uninoculated seedlings, *Imp*, *F. solani*, and *I. radicicola*-infected seedlings displayed significant signs of infection. In contrast, *F. oxysporum*-infected seedlings did not exhibit signs of infection. Seedlings infected with fungal combinations (*Imp-F.solani*, *Imp-I.radicicola, Imp-F.oxysporum*, and *F. oxysporum-F. solani*) displayed enhanced infection, with the *Imp-F.solani* combination showing a synergistic interaction. To further characterize the interaction between *Imp* and *F.solani*, varying proportions of each fungi will be combined to determine which organism determines the extent of root rot. Ultimately, these experiments will further our understanding of the underlying complexity of GRD and inform the development of better mitigation practices to control it.

GP6: *Tetranychus urticae* adaptation to phenylpropanoid defensive compounds in *Arabidopsis thaliana*

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The two-spotted spider mite (TSSM), *Tetranychus urticae* (Koch), is a global agricultural pest known for its polyphagous diet that extends over 1100 plant species, many of agricultural importance. This composite generalist can rapidly adapt to novel pesticides and plant defenses leading to a global effort to both identify new methods of pest control, and an expansion in research aiming to understand the biochemistry underlying mite-plant interactions. The goal of my project is to elucidate the role phenylpropanoids play in *Arabidopsis thaliana* defense against mite herbivory. My objectives are to 1) identify Arabidopsis phenylpropanoid compounds involved in defense against mite herbivory, and 2) characterize mite metabolic responses to phenylpropanoid exposure. To identify candidate Arabidopsis phenylpropanoids potentially involved in defense against mite herbivory, I combined in-silico work and chemical screening of Arabidopsis phenylpropanoids using different locally adapted populations of TSSM. The latter included an ancestral population of TSSM adapted to bean, and an Arabidopsis-adapted population derived from the ancestral population. I used high-performance liquid chromatographic (HPLC) coupled with tandem mass spectrometry (MS/MS) to analyse the metabolic profiles of different locally adapted populations of TSSM exposed to candidate Arabidopsis phenylpropanoids. This approach will allow me to characterize and compare the reciprocal responses of different locally adapted populations of TSSM to phenylpropanoid exposure. My project will help uncover strategies mites develop to counteract direct Arabidopsis defences and adapt to initially unfavourable hosts. My project forms the basis of a full characterization of detoxification pathways employed by the TSSM to rapidly adapt to phenylpropanoid secondary metabolites.

GP7: Engineering RNA interference precursors to induce silencing of hop latent viroid in hop *(Humulus Lupulus. L)*

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Hop Latent Viroid (HLVd) is an economically impactful, infectious pathogen of hops and cannabis which reduces yield and may alter the sensitive secondary metabolome of hop (*Humulus Lupulus. L*). RNA interference (RNAi), a form of regulatory post-transcriptional gene silencing (PTGS), is a means of host defence against pathogens, showing effectiveness against fungi and viruses. Research into its success against viroids is captivating as there are no current methods of viroid management. Samples of hops affiliated with the Ontario Crop Research Center in Simcoe confirmed that HLVd was present in 90% of randomly selected 'Chinook' and 'Centennial' cultivars sampled with an average RT-qPCR Ct of 20.9 (SD 4.9). Presence of the viroid has been confirmed in leaf and petiole tissue and is expected to be present in cone and root tissue as well, with possible differences in viroid titer. Greenhouse experiments are underway to determine if RNAi provides control of the viroid. Double-stranded RNA duplexes will be designed following structural characterization of the HLVd's 256-nucleotide genome. Identification of structural motifs including the central conserved region (CCR), pathogenicity region (PR), and functional hairpins will aid in RNAi target selection. Development of RNAi-based defense against HLVd is a promising option for economically favourable viroid management in hops and cannabis.

GP8: Managing Verticillium stripe in canola through genetics, omics, and understanding the *Brassica napus – Verticillium longisporum* interaction

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Canola (*Brassica napus*) is a highly demanded, economically valuable crop in different regions around the world, including temperate and subtropical areas of Europe, Canada, South Asia, China, and Australia. With the consistent utilization of canola for human consumption and livestock production, canola has become Canada's most dominant commercial crop. As a result, canola cultivation and production have increased to face the global demand. Consequently, the rate and the incidence of pathogen invasion were also elevated. Of the most common diseases, Verticillium stripe disease as a new emerged disease, caused by the soilborne fungal pathogen called *Verticillium longisporum*, caused drastic damage to canola yield. Nevertheless, fungicide application, crop rotation, or cultural control measures offer inconsistent and expensive disease management options that do not help ease control. Effective host resistance seems the most affordable and effective means to control the pathogen. Therefore, this study will focus on the impact of *V. longisporum* on the changes in the expression of genes involved in plant growth hormones biosynthesis and antioxidant enzyme activity, as it is poorly studied and understood in this crop. Resistance evaluation of the canola plants against the disease after the inoculation will be assessed in parallel, identifying the most resistant variety. RNA-Seq data will reveal the behaviour of the genes responsible for the antioxidant enzymes and pant growth hormones during the disease progression. Spectrometric outputs will outline the behavior of significant antioxidant enzymes such as Peroxidase, Catalase, and Superoxide dismutase. Furthermore, the outcomes of this study will provide a better understanding of disease progression and aid in effective disease management strategies in the field.

GP9: Pathogenicity of *Ilyonectria mors-panacis* on American ginseng using chlorophyll fluorescence measurements

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American ginseng, *Panax quinquefolius* L., is an economically valuable crop used in Traditional Chinese Medicine; however, yield of ginseng is negatively impacted by ginseng replant disease (GRD). GRD is characterized by a severe root rot, primarily caused by the fungus *Ilyonectria mors-panacis (Imp)* (formerly *Cylindrocarpon destructans*), in ginseng planted in a former-ginseng garden. While *Imp* is typically present in ginseng garden soils during the first cultivation of ginseng, *Imp*-associated root rot is more extensive during subsequent cultivation. Furthermore, the bioactive ginsenoside compounds produced by ginseng accumulate in ginseng garden soils during cultivation and are known to be fungitoxic toward some soil-borne fungi, while growth stimulants of others, including *Imp*. Presently, it is not clear if (1) prior exposure to ginsenosides enhances *Imp* virulence, (2) different *Imp* isolates can metabolize ginsenosides equally effectively, and (3) there is a relationship between *Imp* virulence and the metabolism of ginsenosides. To address these issues, we obtained twelve independent *Imp* isolates that differ in their environmental origin and reported pathogenicity toward ginseng. To confirm the pathogenicity of each isolate, one-year old American ginseng seedlings were inoculated with twelve *Imp* isolates and monitored for disease onset using non-invasive chlorophyll fluorescence detection across 28-days. Disease load was scored using a disease severity index at 28-days. Five *Imp* isolates were avirulent while seven *Imp* isolates were virulent. Future experiments will determine if *Imp* isolates can metabolize ginsenosides equally effectively and whether exposure to ginsenosides enhances virulence, and ultimately further our understanding of *Imp* and its implications in GRD.

GP10: Screening for *Neopestalotiopsis* spp. In Ontario strawberry varieties and F1 hybrids

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Strawberries are a key fruit crop in North America, and Canada plays a significant role in the nursery production of strawberry breeding materials. Like most crops, strawberries face challenges during production due to various pathogens. Some of these pathogens include *Colletotrichum* spp., *Sphaerotheca macularis*, and *Botrytis cinerea*. Recently, multiple strains of *Neopestalotiopsis* spp. have emerged in Canada, particularly in Ontario. Currently, there are no established protection methods for these strains. Over the past three years, the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and our laboratory have conducted surveys of plants across the province. Alarmingly, almost fifty percent of the surveyed plants tested positive for *N.* spp. In response to this issue, our laboratory has developed a detached leaf assay. The primary goal of this assay is to assess the pathogenicity of *N.* spp. And to identify any potential resistance among the strawberry F1 hybrids being bred in Simcoe and compare it to Ontario standards of Albion and Jewel. This information may help provide future strategies for breeders and growers when it comes to dealing with *N.* spp. In Ontario.

GP11: A CRISPR platform for controlling Fusarium dry rot in potato

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Potato (*Solanum tuberosum* L.) is an annual tetraploid plant that belongs to the family Solanaceae. As a vegetatively propagated crop, potato is threatened by various biotic stresses throughout the production season from preharvest to the postharvest production. The CRISPR/Cas system is a versatile genome editing tool that can be used to introduce desirable traits into germplasm. Plant protoplasts are an ideal platform for DNA-free gene editing. The current study established a systematic platform for producing potato cultivars resistant to Fusarium species. A tissue culture technique with MS medium and 16.65 µmol/L of 2,4-D was effective for callus induction. Shoot regeneration was achieved on MS medium with 11.10 µmol/L of 2,4-D, 11.10 µmol/L BAP, 0.55 µmol/L NAA. A combination of 2.77 µmol/L GA3, 16.65 µmol/L BAP, 0.55 µmol/L NAA, and 1.39 µmol/L KIN in MS medium gave the most effective rooting of in vitro shoots. Leaf strips were incubated in a cell wall digestion solution for different durations and protoplasts were purified using a 20% sucrose solution. Protoplasts were cultured in Richard medium until they developed into microcalli. A polyethylene glycol (PEG) mediated transfection method will introduce CRISPR constructs into protoplasts of potato. The results of current investigation provide a reliable protocol for producing potato plants that overcome pressures from Fusarium species.

Undergraduate Student Poster Competition

UP1: The influence of cannabis plant tissue type, trichome density and cultivar on cannabis aphid (*Phorodon cannabis)* behaviour

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Indoor production of drug-type cannabis (*Cannabis sativa*) has increased substantially since legalization of cannabis in Canada in 2018. As a result of increased production, concerns about pest management associated with this valuable crop has captured the attention of growers and researchers alike. Prior research is minimal and largely based on subjective, and unconfirmed observations from the legacy market. The cannabis aphid (*Phorodon cannabis*) is a cannabis specialist, as such its biology is relatively unknown or generalized from what is known about other aphid species. The purpose of this study was to identify the location preferences of cannabis aphid and investigate the impact of plant tissue traits on these preferences. For each trial one adult aphid was introduced to the base of a rooted cutting and left to establish itself and reproduce for one week. The number of aphids found at each of four plant tissue types (i.e., leaf, petiole, stem, and new foliage) was then recorded. Four cultivars were used: Unicorn Poop, French Mac, Cherry Bomb, and Crown Royal. Trichome density was assessed for each tissue type and cultivar using microscopy with subsequent analysis in ImageJ. Trichome density varied between tissue types and cultivars. A strong preference for leaf tissue was observed for all aphid life stages followed by stem tissue for adult aphids. Locations with lower trichome density may be attractive to aphid nymphs. This research will help to improve crop scouting and advances our understanding of plant morphological traits that may decrease susceptibility to cannabis aphid outbreaks.

UP2: Phosphate solubilizing microbes *Pseudomonas poae* (I186) and *Pantoea eucalypti* (I77) demonstrating dual potential as bio-fertilizer and bio-fungicide

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Phosphorus is an indispensable nutrient for plant growth, and its availability in soil plays a pivotal role in agricultural productivity. However, phosphorus often remains insoluble in soil, and to be effectively absorbed, it must generally be transformed to its soluble form. Phosphate solubilizers are microorganisms that provide crucial mechanisms to accelerate this process, such as acidification, chelation, and enzymatic interactions. Additionally, these soil microbes can occasionally demonstrate strong inhibitive effects on plant pathogens. In the study conducted, we sought to investigate the effects of isolated phosphate solubilizing bacterial strains, *Pseudomonas poae* (I186) and *Pantoea eucalypti* (I77), on plant growth promotion and disease management. To determine the effect, multiple plant growth trials were performed in which seeds of a variety of plants (corn, soybean, wheat, cranberry beans, black beans, kidney beans) were drenched and sown into soil with I186 and I77. Analysis of resulting plant biomasses and vigour were used as indications of increased growth. Furthermore, I186 and I77 were subject to inhibition assays against common fungal pathogens. The results indicated that, when treated with I186 and I77, yield increased 11-42% compared to controls. Also, inhibition assays demonstrated that I186 and I77 possess strong inhibitive potential to *Fusarium*,

Pythium, Sclerotinia, Colletotrichum and *Microcodium*. These findings demonstrate that these phosphate solubilizers have considerable potential as biofertilizers to promote healthy soil microbial communities, stimulate plant growth, and limit soil pollution by reducing the demand of synthetic phosphorus fertilizers and fungicide applications on agricultural land.

UP3: Potential companion plants to protect against *Thrips parvispinus* in greenhouse ornamental crops

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Thrips parvispinus (Thysanoptera: Thripidae) was discovered in North America in 2020 and since has become a serious pest of tropical foliage plants in the $900 million Canadian greenhouse ornamental industry. This industry relies on biological control as opposed to pesticides, which are often infeasible due to pest resistance, but biocontrol programs take years to develop. Therefore, *T. parvispinus* is being managed with pesticides. The goal of this trial was to develop strategies to compliment chemical control (and reduce pesticide applications) until a biocontrol program is found. Our work investigated two plants, Alyssum (*Lobularia maritima*) and Garvinea or Gerbera (*Gerbera jamesonii* Garvinea hybrid), as companion plants – plants that offer protection to the crop – for tropical Mandevilla infested with *T. parvispinus*. Benefits could include either trap plants for *T. parvispinus* and/or banker plants to rear natural enemies of thrips, such as *Orius insidious* (Hemiptera: Anthocoridae). The results show the potential of Alyssum as a trap plant for *T. parvispinus.* Garvinea was found to be less attractive to the pests than the crop. It was observed that the Alyssum and Garvinea plants did not encourage enough establishment of *O. insidious* to offset the influx of pests to the plants; therefore, neither were suitable as banker plants. To reduce *T. parvispinus*, and the number of pesticide applications, growers should grow a supply of Alyssum to be placed in the Mandevilla crop. After 2 weeks, trap plants should be bagged and removed before *T. parvispinus* can complete a generation and become a source plant.

UP4: The potential of *Pseudomonas flourescens*, I336 and *Bacillus velezensis*, I113 to restore garlic seed stocks with latent fusarium infections

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Garlic is susceptible to various fungal pathogens, many of which can remain latent until exposed to favourable conditions. Pathogens harboured in seed cloves can, if planted, persist in the soil, resulting in long term crop damage. Seed borne pathogens are often controlled by systemic fungicides, but the large size of garlic seed cloves presents challenge to their effectiveness, resulting in little eradication of deep-seated infections. Microbial agents can promote plant growth and protection against pathogens, particularly pseudomonads and bacillus. The present work aims to test the role of I336 and I113 on mitigating the effects of garlic seed stocks with latent *Fusarium* infections. In addition to broad-spectrum biocontrol characteristics, both isolates are capable of nitrogen fixation and solubilization of other nutrients. The presence of Fusarium in diseased cloves was confirmed through terminal restriction fragment length polymerase (TRFLP) and next generation sequencing (NGS) at multiple time points over a three-month storage of cloves. Initially, inhibition assays were performed,

testing both isolates against *Fusarium*. Then, growth-room trials with various application rates of both isolates showed significant differences in the plant health of garlic when compared to untreated controls. This was demonstrated by an increase in germination of 38-55%, and overall visual health and size when compared to control. The use of these bacterial products represents a promising avenue for managing latent fungal infections in garlic seed stocks, potentially enhancing crop yield. This research highlights the importance of microbial agents in promoting plant health and protection against pathogens, offering sustainable solutions within agriculture.

UP5: Biocontrol of fungal plant pathogens in cannabis using *Bacillus amyloliquefaciens* I113

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Use of bacterial species as biocontrol agents in agriculture has increased prominently due to the global push for more sustainable, environmentally conscious practices. A notable bacterial species *Bacillus amyloliquefaciens,* is used as widespread biocontrol in many crops. In the current study, *B. amyloliquefaciens,* I113 reduced the effect of fungal pathogens in cannabis and other crops significantly due to its ability to produce a variety of antifungal metabolites, such as fengycin, surfactin, and iturin. I113 is also a promising growth promoting agent mainly due to its ability to fix nitrogen. Inhibition assays have shown that I113 strongly inhibits a variety of cannabis fungal pathogens such as *Fusarium*, *Alternaria*, *Colletotrichum*, *Septoria* and *Botrytis* species. I113 was tested on cannabis through a field trial to determine its effectiveness in supressing fungal pathogens throughout the growing season. Liquid formulation of I113 was foliar sprayed on 50 cannabis plants at a 3% rate weekly. Each week plants were scored on the scale of 1-4 depending on the percentage of the plant that was infected. It was concluded that I113 inhibits all fungal disease infection and reduced the disease severity by 28.5% before budding and 20% overall for the duration of the growing season. In past trails I113 provided protection against various fungal pathogens in wheat, tomatoes, cucumbers, squash, and pumpkins. I113 offers a promising alternative to address fungal diseases in cannabis and other crops while limiting the application of synthetic fungicides. This will lead to increased soil and environmental health while protecting yield.

UP6: Fungal endophyte *Beauveria bassiana* suppresses clubroot (*Plasmodiophora brassicae*) on cabbage under controlled environment conditions

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Clubroot, caused by soil-borne chromist *Plasmodiophora brassicae* (Woronin), is a virulent disease of the Family Brassicaceae that threatens cabbage production worldwide. Characteristic distorted roots or “clubs” risk total yield loss as producers have limited control options. The fungus *Beauveria bassiana* (Balsamo) Vuillemin is an entomopathogen for which several commercial formulations are registered for the management of various insect pests. The endophyte forms symbiotic relationships with host plants and beneficial effects, including disease resistance, have been reported. A growth room trial was conducted to assess disease suppression of clubroot. Clubroot susceptible cabbage cv. Bronco was seeded in plug trays and at the cotyledon stage, and a foliar drench of *Beauveria* products BioCeres (10mL/L) and Botanigard (8mL/L) were applied at a rate of 500mL per tray. Early application maximizes root colonization before exposure to *P. brassicae*. Plants were transplanted

into pots 6 weeks after seeding and inoculated with 5 mL of resting spore suspension at 1 x10^5, 10^6 or 10^7 spores per mL. There were controls with no *B. bassiana* and others with no *P. brassicae*. Clubroot severity was assessed 6 weeks after inoculation with *P. brassicae*. With no *B. bassiana*, the disease severity index (DSI) for clubroot was 23, 58 and 87 for plants inoculated with 10^5, 10^6 and 10^7 spores of *P. brassicae*. Application of Botanigard reduced DSI to 7, 14 and 48 on plants with the same concentrations of *P. brassicae*. *B. bassiana* for management of clubroot is valuable research to growers and has potential for future research on canola.

Regular Posters

RP1: Assessment of pesticide resistance of *Tetranychus urticae* populations from southwestern Ontario

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The province of Ontario is the country's largest soybean producer, and the greenhouse sector is also an essential part of Canadian agriculture. *Tetranychus urticae* (Koch), the two-spotted spider mite (TSSM), is an herbivore with an extensive host range and an ability to rapidly develop resistance to different pesticides. The application of pesticides is still the dominant method of controlling TSSM and is frequently implemented on persistent populations. Here we present an assessment of pesticide resistance of 46 populations from Southwestern Ontario collected in 2021 and 2022. Our study covered a variety of crops (cucumber, pepper, strawberry, tomato, and soybean) and production systems (greenhouse and field). The assessed active compounds were abamectin, bifenazate, cyflumetofen, dimethoate, etoxazole, pyridaben, and spiromesifen. We used two types of bioassays using LC90 concentrations, determined for the susceptible reference population (LND). We have considered the mortality rate at or below 40% as a resistance threshold. Our results indicate that only 14/46 populations were fully susceptible to all tested compounds. Resistance to multiple pesticides was present in 45% of the sampled populations, with the greenhouse samples being the most resistant. Soybean-collected mites demonstrated frequent resistance to dimethoate (56%), Ontario's only registered pesticide for TSSM control on soybeans. All tested greenhouse populations showed high resistance to most assessed pesticides, except pyridaben, that was the best-performing compound tested. These results may be used to prioritize and plan pesticide usage on crops where multiple products are registered.

RP2: Switchgrass gall midge, an emerging Ontario pest

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Switchgrass production is increasing in Ontario, however this important biomass crop is under threat from a new pest, the switchgrass gall midge (SGM), *Chilophaga virgati* Gagné (Diptera: Cecidomyiidae), which was first detected in Ontario in 2020. The scientific literature is scant for this pest, which was first discovered in 2008 in South Dakota. Our research aims to generate knowledge about the distribution and biology of SGM in Ontario, including its life cycle, phenology and seasonal abundance. Since 2021, plant samples have been collected from switchgrass fields spanning the geographic limits of the switchgrass-growing region in Ontario to determine the distribution of SGM. SGM larvae have been found at all sites sampled, indicating that SGM is distributed across the entire region. US research has shown that SGM can cause 100% seed loss and 35% biomass yield reduction in infested tillers. Thus, SGM is a potential concern to Ontario's switchgrass growers. In South Dakota, there are likely two generations of SGM per year, but life cycle and phenological information is sparse. Ontario-specific phenological information is needed to develop appropriate and effective IPM strategies. Weekly switchgrass tiller samples were taken from 2-3 fields per year in southern Ontario and all tillers dissected to identify and quantify SGM life stages present. Phenological information for SGM in Ontario will be presented based on 2021 to 2023 data. Phenological and overwintering information for SGM will help inform mowing and harvesting regimes, as well as future research and the development of pest management recommendations.

RP3: Assessing the ecological interactions between invasive and endemic species of gall midge pests of canola

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The swede midge (*Contarinia nasturtii*), an invasive pest of brassicaceous crops, was first discovered in Ontario, Canada in 2001 and until recently was thought to be the only gall midge pest of canola (*Brassica napus* L. and *B. rapa* L.) in Canada. However, the canola flower midge (*Contarinia brassicola* Sinclair)[2], an apparently endemic, newly described species, has since been found to be established throughout the canola-growing regions of the Prairies. Following its discovery in western Canada, monitoring for *C. brassicola* presence and injury symptoms was initiated in Ontario. Although the canola flower galls characteristic of *C. brassicola* infestation have not been observed in Ontario, *C. brassicola* males were captured in relatively high numbers on pheromone-baited sticky traps at canola fields throughout the province. Additionally, *C. brassicola* adults were observed emerging from *C. nasturtii*-infested canola plants. *C. nasturtii* is a devastating pest and has resulted in a 53% decline in canola acreage in Ontario since 2011. Because *C. brassicola* is also present in Ontario, some of the damage attributed to *C. nasturtii* could in fact be the result of its congener. However, management recommendations for *C. nasturtii* may not be effective for *C. brassicola* if there are physiological or behavioural differences between the two species. Studies are underway to determine the host-plant interactions and population dynamics of both species, and the resulting implications for their management in canola.

RP4: Initial testing of weeding robots in vegetable production systems in Ontario, Canada

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Three autonomous weeding robots were trialed and compared to conventional vegetable growing practices in Ontario, Canada. The Naïo Dino, Nexus "La Chèvre," and FarmDroid FD20 were operated with side-by-side control comparison trials to collect and analyze metrics important for practical farming considerations.

RP5: IPM: Available genetic testing enables early detection and mitigation of herbicide resistant weeds

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Since 2015, several multi-partner projects supported by various funding agencies, and a vast collaborative network of federal, provincial and private researchers and laboratory technicians are continuously contributing to a growing list of genetic tests to detect herbicide resistance in weed species.

RP6: Harmonized surveillance of common waterhemp (*Amaranthus tuberculatus*): A model of national collaboration

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The Canadian Plant Health Council was launched in 2018 with the goal to implement the Plant Health Strategy for Canada through improving coordination of plant health surveillance and enhancing the response to pest threats across Canada. Different working groups were formed under the Council focusing on three key pillars: biosecurity, emergency response and surveillance. The Weeds Surveillance Community of Practice (WSCP) focused on *Amaranthus* species, primarily common waterhemp (*A. tuberculatus*) and Palmer's amaranth (*A. palmeri*), as they pose a significant threat to Canadian agricultural production.

RP7: Invasive insects to watch out for: A Canadian Plant Health Council initiative

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Invasive insects pose a serious threat to Canada's important agriculture and forestry landscapes. To aid in the early detection and eradication, community science tools can be used to report insect sightings, but other information resources are needed to inform the public about which insects to look out for. The Insect Surveillance Community of Practice, within the Canadian Plant Health Council has recently developed regional lists of invasive insects of concern and posters to help advertise and inform those interacting with, observing, or photographing insects of what to look for.