



19th Annual

Building Resiliency into Pest Management

November 1, 2022

**Victoria Park East Golf Course
1096 Victoria Road South**

Website: www.ontariopmc.ca

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OPMC Organizing Committee

Kristen Obeid, Chair - OPMC, Ontario Ministry of Agriculture, Food and Rural Affairs
Chris Duyvelshoff, Ontario Fruit and Vegetable Growers' Association
Melanie Filotas, Ontario Ministry of Agriculture, Food and Rural Affairs
Katie Goldenhar, Ontario Ministry of Agriculture, Food and Rural Affairs
Kristy Grigg-McGuffin, Ontario Ministry of Agriculture, Food and Rural Affairs
Julie Schipper, Valent Canada
Cheryl Trueman, University of Guelph-Ridgetown
Sean Westerveld, Ontario Ministry of Agriculture, Food and Rural Affairs

Post Conference Survey

Thank you for attending the 2022 OPMC. Please take a few minutes to complete a post-event survey. Your feedback is important in organizing future events. To complete the survey, visit <https://forms.office.com/r/zad7yuS4K6> or scan the QR code below:



CropLife Student Competition Judging Panel

The OPMC wishes to thank the members of the judging panel for generously volunteering their time to help make this competition happen.

Judging Coordinator: Sean Westerveld, OMAFRA

Graduate Oral

Hannah Fraser, OMAFRA
 Erica Pate, OMAFRA
 John Purdy, Abacus Consulting Services
 Cassie Russel, Cohort Wholesale

Graduate Poster

Travis Cranmer, OMAFRA
 Justin Renkema, AAFC
 Sara Stricker, University of Guelph
 Amanda Tracey, OMAFRA

Undergraduate Poster

Jason Deveau, OMAFRA
 Amy Shi, Ontario Ginseng Growers Association

Conference Sponsors

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AGENDA

8:30 a.m – 9:00 a.m **Registration and Coffee
Poster Set Up**

MORNING SESSION

Morning Session Chair: Katie Goldenhar, Ontario Ministry of Agriculture, Food and Rural Affairs

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

9:05 am Harvesting genomics to develop molecular tools for integrative pest management strategies. **Chris Grainger**, Harvest Genomics, Inc. (Industry Speaker)

9:15 am Suitability of *Euonymus* spp. for box tree moth (*Cydalima perspectalis*) survival and development. **Abigail Wiesner**, H. Fraser, S. Smith and C. Scott-Dupree. (Student Competition)

9:30 am A novel field kit to detect DMI fungicide resistance in *Clarireedia jacksonii*. **Edward McNab** and T. Hsiang. (Student Competition)

9:45 am Synergistic and antagonistic herbicide interactions for control of volunteer corn in glyphosate/glufosinate/2,4-D-resistant soybean. **Emily Duenk**, N. Soltani, R. Miller, D. Hooker, D. Robinson and P. Sikkema. (Student Competition)

10:00 am Inheritance of Cry1F resistance and life history of the first field-evolved Cry1F-resistant population of the European corn borer (*Ostrinia nubilalis*, Hübner). **Emily Glasgow**, Y. Farhan, A. Michel, R. Hallett and J. Smith. (Student Competition)

10:15 am – 10:45 am **Coffee Break and Poster Viewing**

10:45 am **Plenary Presentation 1**

Best practices for implementing biopesticides for fungal and bacterial disease of apples

Dr. Kerik Cox, Associate Professor, School of Integrative Plant Science
Cornell University

11:30 am Control of multiple-herbicide-resistant waterhemp (*Amaranthus tuberculatus*) with acetochlor-based tank mixtures in soybean. **Hannah Symington**, N. Soltani, A. Kaastra, D. Hooker, D. Robinson and P. Sikkema. (Student Competition)

11:45 am An investigation of the insect pest and beneficial insect complex for cannabis grown outdoors in Ontario and the potential of companion plants as an IPM tactic. **Lillian Auty** and C. Scott-Dupree. (Student Competition)

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

AFTERNOON SESSION

Afternoon Session Chair: Chris Duyvelshoff, Ontario Fruit and Vegetable Growers' Association

1:00 pm **Plenary Presentation 2**

Battling the billion dollar bug

Dr. Jocelyn Smith, Research Scientist, University of Guelph Ridgetown

1:45 pm Improving disease forecasts for Stemphylium leaf blight of onion, 2021 and 2022.
Michael Kooy, B.D. Gossen and M.R. McDonald. (Student Competition)

2:00 pm The confirmation and characterization of auxinic herbicide resistance in a population of green pigweed (*Amaranthus powellii*) from Ontario. **Isabelle Aicklen**, P. Smith, B. Metzger, T. Gaines, M. Jugulam, D. Robinson, P. Sikkema and F. Tardiff. (Student Competition)

2:15 pm New modes of action for fruit and vegetable growers. **Cassie Russell**, Cohort Wholesale (Industry Speaker)

2:25 pm Tough Herbicide - Resistance Management Tool for Field and Specialty Crops.
Wesley Cook, Belchim Crop Protection Canada (Industry Speaker)

2:35 pm-3:05 pm **Coffee Break and Poster Viewing**

3:05 pm **Plenary Presentation 3**

Soft chemistries to manage hard problems in Niagara vineyards

Ryan Brewster, Brewster Consulting and **Aaron Oppenleander**, Grape Grower and Custom Applicator

3:50 pm **Presentation of Student Competition Award Winners – Julie Schipper**, CropLife Canada
Closing Remarks and Adjourn

Poster Presentations

-Graduate Student Poster Competition-

- GP1** Biology and management of cannabis aphid: An emerging pest challenging cannabis production in Ontario. **Jason Lemay** and C. Scott-Dupree. **(Time of judging 9:00-9:15 am)**
- GP2** Grapevine viruses, insect vectors and management strategies in Canada and the United States: A scoping review. **Kaitlyn Carr**, J. Baird and M.A. Lemay. **(Time of judging 1:45-2:00 pm)**
- GP3** Examining two *Dicyphus* species (Hemiptera: Miridae) for their potential use as biological control agents on greenhouse tomato. **Carly Demers**, S. VanLaerhoven and R. Labbé. **(Time of judging 9:45-10:00 am)**
- GP4** Risk of cavity spot on carrots can be related to soil microbiome. **Umbrin Ilyas**, J Manish, N. Raizada, M. Kalischuk, L. du Toit and M.R. McDonald. **(Time of judging 11:30-11:45 am)**
- GP5** The interaction of lime and boron to manage clubroot on canola, 2022. **Shauna Chesney**, B.D. Gossen and M.R. McDonald. **(Time of judging 9:30-9:45 am)**
- GP6** Survey of *Neopestalotiopsis* spp. in Ontario strawberries. **Justin McNally**, K. Pragapar, K. Goldenhar, E. Pate and M. Kalishchuk. **(Time of judging 11:45 am-12:00 pm)**
- GP7** The sterile insect technique as a novel tool for the management of pepper weevil (*Anthonomus eugenii* Cano) in greenhouse and field pepper crops. **Jacob Basso**, R. Labbé and C. Scott-Dupree. **(Time of judging 2:00-2:15 pm)**
- GP8** Improving the management of western bean cutworm, *Striacosta albicosta*, in edible dry beans. **Josee Kelly**, C. Gillard, J. Smith and Y. Farhan. **(Time of judging 10:00-10:15 am)**
- GP9** The effect of *Metarhizium brunneum* on wireworm populations. **Ala Abdel Rahman**, I. Scott, T. Kabaluk and H. Henry. **(Time of judging 9:15-9:30 am)**
- GP10** Optimization and Scalability of Regenerative in situ Electrochemical Hypochlorination for Closed-Loop Hydroponics. **Serge Lévesque**, T. Graham, J. Phillips, J. Lawson, D. Bejan and M. Dixon. **(Time of judging 2:15-2:30 pm)**

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

-Undergraduate Student Poster Competition-

- UP1** Comparing the effectiveness of select companion plants for management of insect pests on cannabis grown outdoors in Ontario. **Chloe El Hani**, L. Auty and C. Scott-Dupree. **(Time of judging 9:00-9:15 am)**
- UP2** Does companion plant density impact insect pests and beneficial insects in outdoor cannabis crops? **Margaret Mantel**, L. Auty and C. Scott-Dupree. **(Time of judging 9:40-9:55 am)**
- UP3** Comparison of an amended agar assay vs. a microplate assay for assessing fungicide sensitivity. **Andrea Rether**, E. McNab and T. Hsiang. **(Time of judging 9:20-9:35 am)**
- UP4** Broad spectrum biocontrol of plant pathogens with *Bacillus amyloliquifaciens* strains through selective enhancement of its antibiotic production using carbon sources and culture additives. **Saghar Mazarei**, L. Chien, C.Y. Yuan, K. Dumont, S. Tagliabracci, S. Kandasamy, R. Nicol, S. Saldias and G. Lazarovits. **(Time of judging 10:00-10:15 am)**

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

-Regular Posters-

- RP1** Soil bacteria with biocontrol potential for ginseng replant disease. **Isadora Bischoff Nunes** and P. Goodwin.
- RP-2** Evaluating efficacy of a novel nematicide for management of northern root knot nematode in greenhouse strawberry production. **Jerry Akanwari** and T. Sultana.
- RP-3** Efficacy and market potential of biopesticides developed from saponins and essential oils. **Rob Nicol**, M. Berhow, M. Charbonneau, I. Scott; K. Tamming and S. Lachance.
- RP-4** Integrated pest management of root maggots in Ontario leafy green and root brassica vegetables. **Ian Scott**, J. Stokes-Rees, J. Beardsley and M. Vankosky.
- RP-5** IPM: Photosensitizer... lights... action!. **Zelda Pieterse**, R. Buitenhuis, M. Fefer, J. Liu and I. Teshler.
- RP-6** Fighting blight: Evaluating fungicides for efficacy against *Stemphylium* leaf blight in Ontario. **Emily McFaul**, B.D. Gossen, K. VanderKooi and M.R. McDonald.
- RP-7** Improving semiochemical attraction for management of Colorado potato beetle in solanaceous field crops. **Andrew Colton**, A. Gradish and R. Hallet.
- RP-8** **RP-8** Pesticide resistance levels in field and greenhouse populations of *Tetranychus urticae*. **Joseane Moreira do Nascimento**.

*** Regular poster presenters should be available at their poster to answer questions during the morning and afternoon breaks.**

Plenary Speaker Biographies

Dr. Kerik Cox – Associate Professor of Plant Pathology and Plant-Microbe Biology, School of Integrative Plant Science, Cornell University



Dr. Kerik Cox manages a program of tree fruit and berry research and extension at Cornell University's New York State Agricultural Experiment Station, AgriTech. Principal research efforts include antimicrobial resistance (fungicides and antibiotics), and applied disease management with a focus on apple, stone fruit, strawberries. His extension efforts focus on pesticide education, disease forecasting, and applied disease management with emphasis on covered production in small fruit. Teaching efforts include undergraduate and graduate level Plant Pathology and IPM courses as well as leadership on student learning committees. Since the establishment of his program, Dr. Cox has been conducting antimicrobial resistance and invasive pathogen surveys in New York and the Northeastern United States.

Dr. Jocelyn Smith, Research Scientist – Field Crop Pest Management, University of Guelph - Ridgetown



Dr. Jocelyn Smith is an entomologist at the University of Guelph, Ridgetown Campus specializing in integrated management of insect pests of field crops (corn, soybean, and wheat) and resistance management for insect-protected transgenic corn and insecticides. Dr. Smith also studies the interaction and management of insect injury and mycotoxigenic fungi in corn. Her research activities include collaboration with commodity organizations, seed and pesticide industries, public researchers, and government specialists in Canada and internationally.

Ryan Brewster, Brewster Consulting Services



As an agricultural consultant, Ryan has been working in the Niagara area grape and tender fruit sectors since 2002. He began as a summer student, monitoring and reporting on pest presence in Niagara area vineyards and tender fruit orchards under the tutelage of Kevin Ker (KCMS Inc.). In 2019, Ryan branched out and started his own agricultural consulting company, Brewster Consulting Services Inc. (BCS), focusing primarily on pest monitoring/trapping, development of IPM based spray programs and soil/tissue sampling to optimize nutrient management programs. Ryan is a member of the Ontario Institute of Agrologists (OIA) and the Agricultural Institute of Canada (AIC), and a proud graduate of Brock University.

Aaron Oppenleander – Grape Grower and Custom Applicator



Aaron is the operations manager at Huebel Grapes Estates in Niagara-on-the-Lake. Huebel Grapes Estates manages both their own vineyards and custom manages multiple other vineyards throughout the Niagara Region. They believe in practicing sustainable viticulture and are an authorized dealer for Farm for Profit, a sustainable agriculture program.

Oral Presentation Abstracts

Morning Session

INDUSTRY 1: Harvesting genomics to develop molecular tools for integrative pest management strategies

Chris Grainger

Harvest Genomics, Inc.

Through tremendous advancements in the field of genomics, there has been a "digitization" of biological information for economically important food species and the pathogens that affect them. This enables new and innovative ways to develop and deploy molecular tools to help face the challenges of producing and protecting our food supply. Two areas of focus for integrating these tools are controlled environments and uncontrolled environments. While the majority of routine genetic testing is done using endpoint-based molecular assays (e.g., PCR/qPCR-based) there is a shift towards using DNA sequencing technologies (next generation and long read sequencing) to offer a metagenomics-based approach to biomonitoring in integrative pest management strategies.

GO-1: Suitability of *Euonymus* spp. for box tree moth (*Cydalima perspectalis*) survival and development

Abigail Wiesner¹, H. Fraser², S.M. Smith³ and C. Scott-Dupree¹

¹School of Environmental Sciences, University of Guelph, ON

²Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON

³Institute of Forestry & Conservation - Daniels Faculty, University of Toronto, Toronto, ON

Native to Asia, box tree moth (BTM) (*Cydalima perspectalis*) (Walker, 1859) is an invasive pest first confirmed in Ontario in 2018. Although boxwood (*Buxus* sp.), is acknowledged as the primary host, alternate hosts, including *Euonymus* species have been documented within its native range. In the invaded range of BTM, there is negligible data available on the suitability of *Euonymus* hosts in terms of successful reproduction of the insect pest. Using no-choice feeding experiments, the alternate host suitability of two *Euonymus* species, *E. alatus* and *E. fortunei* were examined. Experiments were conducted with BTM larvae using leaf-discs, and entire plants of each plant species within the laboratory. Although feeding attempts were made on each *Euonymus* spp., boxwood was consumed 15 times more, confirming its superior palatability. Additionally, after 40 days, BTM larvae only survived and progressed to pupation on boxwood. Confirming boxwood as the primary host for BTM survival and development is crucial for the Ontario nursery and landscape industry, influencing phytosanitary protocols as well as trade agreements.

GO-2: A novel field kit to detect DMI fungicide resistance in *Clariireedia jacksonii*

Edward McNab and T. Hsiang

School of Environmental Sciences, University of Guelph, Guelph, ON

Dollar spot, caused by *Clariireedia jacksonii* Salgado, is the most common turfgrass disease in North America. This pathogen is managed with multiple applications per season of fungicides, such as DMIs (demethylation-inhibitors). In Canada, the first DMI fungicide registered for use on turfgrass was propiconazole in 1994. Since then, there has been a detectable decline in the sensitivity of *C. jacksonii* populations to propiconazole. Identification of DMI-resistant populations of *C. jacksonii* has required lab facilities to grow the isolated fungus on different concentrations of the target fungicide. To

develop a field kit, we have determined a fungicide concentration (0.5 µg/ml propiconazole) that is capable of differentiating between DMI-sensitive ($EC_{50} < 0.1$ µg/ml) and DMI-resistant ($EC_{50} > 0.1$ µg/ml) isolates of *C. jacksonii* using pure cultures and inoculated plants in a growth room. The addition of antibiotics and tartaric acid increased the selectivity of the medium, making it suitable for field use. This discriminatory medium was tested using plots of managed turfgrass inoculated with DMI-resistant or sensitive isolates. Over 1400 leaf blades were assessed with the discriminatory medium, and 96% of the samples were correctly identified as sensitive or resistant based on the inoculated isolate, while 10% of the samples showed fungal growth but were not *C. jacksonii* based on morphology. This field kit will allow end users to assess isolates of *C. jacksonii* in the field and will be useful for saving time, money, and resources. This proof of concept can be adapted for other fungal pathogens to detect fungicide resistance.

GO-3: Synergistic and antagonistic herbicide interactions for control of volunteer corn in glyphosate/glufosinate/2,4-D-resistant soybean

Emily Duenk¹, N. Soltani¹, R. Miller², D. Hooker¹, D. Robinson¹ and P. Sikkema¹

¹Plant Agriculture, University of Guelph, Ridgetown, ON

²BASF Canada Inc., Mississauga, ON

Glyphosate/glufosinate-resistant (GGR) volunteer corn interference reduces soybean yield and quality. The release of glyphosate/glufosinate/2,4-D choline-resistant (GG2) soybean allows for expanded POST herbicide tank-mixture options for broad-spectrum weed control. Herbicide antagonism between acetyl-Coenzyme A carboxylase (ACC)ase-inhibiting and synthetic auxin herbicides has been documented for several grass species. Four field trials were conducted over a two-year period (2021, 2022) to assess the interaction between glufosinate, 2,4-D choline, or dicamba with clethodim or quizalofop-p-ethyl applied POST for control of GGR volunteer corn in GG2 soybean. Quizalofop-p-ethyl and quizalofop-p-ethyl + glufosinate controlled GGR volunteer corn 90 and 98%, respectively, 6 weeks after application (WAA); the addition of 2,4-D choline or dicamba reduced control to ≤8%. Clethodim controlled GGR volunteer corn 83%, the addition of glufosinate increased control to 96%. In contrast, the addition of 2,4-D choline or dicamba to clethodim reduced GGR volunteer corn control to 50 and 31%, respectively at 6 WAA. Results indicate a synergistic improvement in GGR volunteer corn control when glufosinate is co-applied with an ACCase-inhibiting herbicide. Interactions between the ACCase-inhibiting herbicides and the synthetic auxin herbicides were antagonistic; greater antagonism occurred when the synthetic auxin herbicides were co-applied with quizalofop-p-ethyl. All tankmixes of quizalofop-p-ethyl or clethodim with synthetic auxin herbicides resulted in unacceptable control of GGR volunteer corn. The results from this study conclude that tank-mixtures of quizalofop-p-ethyl or clethodim with 2,4-D choline or dicamba should be avoided for control of GGR volunteer corn. Enhanced control of GGR volunteer corn occurs with co-applications of quizalofop-p-ethyl or clethodim with glufosinate.

GO-4: Inheritance of Cry1F resistance and life history of the first field-evolved Cry1F-resistant population of the European corn borer (*Ostrinia nubilalis*, Hübner)

Emily Glasgow¹, Y. Farhan², A. Michel³, R. Hallett¹ and J. Smith²

¹School of Environmental Sciences, University of Guelph, Guelph, ON

²Department of Plant Agriculture, University of Guelph Ridgetown Campus, Ridgetown, ON

³Department of Entomology, The Ohio State University, Columbus, OH

The European corn borer, *Ostrinia nubilalis* (Hübner), is a major crop pest in North America. While *O. nubilalis* can infest more than 200 hosts, it primarily affects corn (*Zea mays* L.) and >80% of the corn acres in Canada produce insecticidal proteins from *Bacillus thuringiensis* (Bt proteins) that target *O.*

nubilalis. The first case of field-evolved resistance in *O. nubilalis* to a Bt protein was discovered in Nova Scotia, Canada, in 2018. Due to more than 25 years of successful *O. nubilalis* management using Bt corn hybrids, much of our understanding of the life history characteristics of *O. nubilalis* is outdated and this information is critical to inform resistance mitigation strategies. This project examined the lifespan, fecundity, and developmental time among Cry1F-susceptible and Cry1F-resistant *O. nubilalis* and their reciprocal crosses in laboratory experiments. No reduction in fecundity, fertility, adult lifespan, or larval growth and development was observed. Bioassays were also conducted on the progeny of homozygous susceptible, homozygous resistant, and reciprocal crosses to determine the inheritance pattern of Cry1F resistance. Bioassay results indicate that Cry1F resistance is an autosomal recessive trait. The results of these studies suggest that no fitness costs within the parameters tested are associated with Cry1F resistance. Additionally, the high-dose refuge strategy may be at risk as heterozygotes that survive on refuge plants will still pass on the resistance trait, and most pyramids targeting *O. nubilalis* still contain Cry1F so selection pressure has not been removed.

PLENARY PRESENTATION 1:

Best practices for implementing biopesticides for fungal and bacterial disease of apples

Dr. Kerik Cox

Associate Professor, School of Integrative Plant Science, Plant Pathology and Plant-Microbe Biology Section, Cornell University, Geneva, NY

This presentation will cover research demonstrating the effective use of biopesticides in conjunction with horticultural practices and disease forecasting to manage both apple scab and fire blight of apple. Specific biopesticide products for use in apples and guidelines for best use practices will be presented.

GO-5: Control of multiple-herbicide-resistant waterhemp (*Amaranthus tuberculatus*) with acetochlor-based tank mixtures in soybean

Hannah Symington¹, N. Soltani¹, A. Kaastra², D. Hooker¹, D. Robinson¹ and P. Sikkema¹

¹Department of Plant Agriculture, University of Guelph, Guelph, ON

²Bayer Crop Science Inc., Guelph, ON

The evolution of herbicide resistance in waterhemp has made the control of this genetically diverse, prolific, and competitive weed even more difficult. Waterhemp has evolved resistance to Group 2, 5, 9, 14, and 27 herbicides in Ontario. This is the first 5-way herbicide resistant weed in the province. Acetochlor is a Group 15, chloroacetanilide herbicide that has activity on many small-seeded annual grasses and some small-seeded annual broadleaf weeds including waterhemp. The objective of this study was to determine the efficacy of acetochlor applied alone and co-applied with broadleaf herbicides, applied preemergence (PRE), for the control of multiple-herbicide-resistant (MHR) waterhemp in soybean. Five trials were conducted over two years (2021-2022) on commercial farms in southwestern Ontario. Acetochlor applied PRE controlled MHR waterhemp 77% at 12 weeks after application (WAA). Acetochlor applied in a tank mixture with dicamba, metribuzin, diflufenican, sulfentrazone, or flumioxazin controlled MHR waterhemp 84 to 96%. The addition of acetochlor to dicamba, metribuzin, diflufenican, sulfentrazone, and flumioxazin increased MHR waterhemp control 53, 42, 53, 43, and 24%, respectively. The acetochlor tank mixtures caused $\leq 2\%$ soybean injury except acetochlor plus flumioxazin which caused 11% soybean injury. This research concludes that the addition of dicamba, metribuzin, diflufenican, sulfentrazone, or flumioxazin to acetochlor improves

MHR waterhemp control; the most efficacious tank mixture was acetochlor plus flumioxazin.

GO-6: An investigation of the insect pest and beneficial insect complex for cannabis grown outdoors in Ontario and the potential of companion plants as an IPM tactic

Lillian Auty and C. Scott-Dupree

School of Environmental Sciences, University of Guelph, Guelph, ON

Following the 2018 legalization of recreational drug-type *Cannabis sativa* L. in Canada, the licensed area for outdoor cultivation has rapidly increased to meet growing demands. However, cannabis grown outdoors is threatened by economically damaging arthropod pests and pathogens that we know very little about. Research is required to properly identify and subsequently manage them. This project involves the first Canadian survey of economically relevant insect pests and natural enemies associated with outdoor cannabis production at two licensed operations in Ontario. The most common insect pests observed include: cannabis aphid (*Phorodon cannabis*) and two-spotted spider mite (*Tetranychus urticae*). The most common associated natural enemies include: minute pirate bug (*Orius insidiosus*) and Asian lady beetle (*Harmonia axyridis*). Additionally, the few pesticides registered for outdoor cannabis production do not provide reliable control against pest outbreaks. Conservation biological control, an effective integrated pest management (IPM) method, consists of modifying the landscape to promote beneficial insects while disrupting pest populations. This project also assessed the potential of companion plants such as borage, cosmos, marigold, sunflowers and aromatic herbs as an IPM tactic to manipulate the behavior of insect pests and beneficial insects to the advantage of the grower. Using standard insect collection techniques, insect activity associated with outdoor cannabis and effects of companion plants grown in association with cannabis were evaluated from June through September in 2021 and 2022. The findings of this project will provide cannabis growers with valuable information on the utilization of companion plantings as an effective IPM tactic for outdoor crops.

Afternoon Session

PLENARY PRESENTATION 2:

Battling the billion dollar bug

Dr. Jocelyn Smith

Research Scientist, University of Guelph – Ridgetown Campus, Ridgetown, ON

Corn rootworm *Diabrotica* spp. (Coleoptera: Chrysomelidae) is one of the most notorious corn pests in North America, not only because of their destructive behaviour in corn, but also because they have developed resistance to almost every management strategy deployed against them. In Ontario, crop rotation remains the best management strategy for this pest; however, some growers, especially livestock producers, depend on using their land for continuous corn production. Since the early-2000s, the development of corn hybrids expressing transgenic insecticidal proteins has been one of the most advantageous management strategies against corn rootworm in North America. However, resistance to these proteins has become widespread in the US and is increasing among CRW populations in Ontario, therefore, new, or supplemental strategies for corn rootworm management are needed. A review of corn rootworm biology and management will be presented as well as recent research on the potential of entomopathogenic nematodes for biological control of corn rootworm in Ontario.

GO-7: Improving disease forecasts for *Stemphylium* leaf blight of onion, 2021 and 2022

Michael Kooy¹, B.D. Gossen² and M.R. McDonald¹

¹Department of Plant Agriculture, University of Guelph, Guelph, ON

²Agriculture and Agri-Food Canada, Saskatoon, SK

Stemphylium leaf blight (SLB), caused by the fungus *Stemphylium vesicarium*, is an important foliar disease of onion in Ontario. Small, dark or tan water-soaked lesions on the leaves develop into severe leaf dieback. Improvements in disease forecasting are needed to identify when fungicide applications are not needed. Replicated field trials were established at the Ontario Crops Research Centre – Bradford in 2021 and 2022 to evaluate various spray timing models to manage SLB. Treatments were a calendar spray (7-10 days), and nontreated check, compared to four models: two thresholds of TOMcast, BSPcast and STEMcast. TOMcast was developed for foliar diseases on tomatoes and BSPcast was developed for SLB on pear. STEMcast is a variation of TOMcast that is specific for SLB of onion. Treatments were assessed weekly from the three-leaf stage until the onions lodged by rating the percentage of the leaf dieback on the three most mature leaves of 20 plants per plot. A final assessment was made in mid-August on each leaf of 20 plants per replicate plot. SLB severity was relatively low in 2021 and lower 2022 (43 and 24 DSI in the nontreated check, respectively). In 2021, all forecasting models reduced disease severity compared to the nontreated check, but there were no differences in yield. The most effective treatment reduced DSI to 33, with four fungicide applications. The calendar spray had similar DSI and triggered six sprays. No differences were found in 2022. The results indicated that the models triggered more fungicide sprays than needed.

GO-8: The confirmation and characterization of auxinic herbicide resistance in a population of green pigweed (*Amaranthus powellii*) from Ontario

Isabelle Aicklen¹, P. Smith¹, B. Metzger², T. Gaines³, M. Jugulam⁴, D. Robinson², P. Sikkema² and F. Tardif¹

¹Department of Plant Agriculture, University of Guelph, Guelph, ON

²Department of Plant Agriculture, University of Guelph, Ridgetown, ON

³Department of Agricultural Biology, Colorado State University, Fort Collins, CO, USA

⁴Department of Agronomy, Kansas State University, Manhattan, KS, USA

Auxinic herbicides are used for the selective control of dicot weeds in crop production. These herbicides are becoming less effective due to the development of herbicide resistant weeds, creating management challenges for farmers. A population of *Amaranthus powellii* with suspected resistance (R) to the auxinic herbicide MCPA has been reported in Ontario. The objective of this study is to confirm resistance of this population to MCPA and to determine the pattern of cross resistance to other auxinic herbicides. Dose response experiments were conducted to compare differences in GR₅₀ values (dose causing growth reduction of 50%) between R and a known susceptible population using MCPA, mecoprop, 2,4-D, dichlorprop, halauxifen-methyl, dicamba, and aminocyclopyrachlor. Field trials were conducted using auxinic herbicides applied post emergence in corn to evaluate the control of green pigweed and to confirm herbicide resistance at the field level. Dose response results confirmed that R has 4.4-fold resistance to MCPA with cross resistance to aminocyclopyrachlor (3.0-fold), dichlorprop (2.5-fold), and mecoprop (2.4-fold). Field trials showed that dicamba provided superior control (>80%) at 56 days after application but control was 30% with MCPA alone, 46% with MCPA + fluroxypyr and 36% with MCPA + fluroxypyr/halauxifen-methyl. This confirms that the level of resistance observed in the lab brings the effectiveness of MCPA or MCPA and other auxinic herbicides below commercially acceptable levels. Future studies will focus on determining the mechanism of resistance and further confirming the pattern of cross resistance.

INDUSTRY 2: Tough Herbicide - Resistance Management Tool for Field and Specialty Crops

Wesley Cook

Belchim Crop Protection Canada

We will examine the use of Tough 600EC Herbicide (pyridate – 600g/L), a recently registered herbicide as a resistance management tool for problematic weeds in Ontario such as linuron-resistant redroot pigweed (*Amaranthus retroflexus*) and multiple-resistant common waterhemp (*Amaranthus tuberculatus*). In addition, we will discuss technical information on Tough 600EC Herbicide around optimizing efficacy and managing tolerance in sensitive crops. Finally, an update will be provided on research collaborations, current minor-use projects and potential minor-use opportunities.

INDUSTRY 3: New modes of action for fruit and vegetable growers

Cassie Russell

Cohort Wholesale

Cohort Wholesale is a Canadian distributor of crop protection products servicing the outdoor fruit and vegetable markets. In 2022, Cohort and supplier partner Nichino released Gatten® Fungicide - a new mode of action to control powdery mildew in grapes and cherries. Gatten's unique mode of action provides a new solution for growers to manage powdery mildew and helps mitigate potential of fungicide resistance. For the 2023 season, Cohort and supplier partner Vestaron anticipate PMRA registration of Spear-Lep® insecticide. Spear-Lep® was assigned a new insecticide group - with its new mode of action and using the power of peptides it controls lepidopteran pests. This unique offering allows growers to manage lepidopteran pests in fruits and vegetables while providing a new solution to manage pesticide resistance with minimal impact on beneficials.

PLENARY PRESENTATION 3:

Soft chemistries to manage hard problems in Niagara vineyard

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Grape growers are consistently faced with making a number of critical pest management decisions, and recent pesticide re-evaluations have made these decisions more challenging. More and more, conventional growers are turning to softer/organic chemistries to fill pest management gaps, along with investigating different cultural practices to reduce negative pest impacts. Management of grapevine virus-vectoring insects using horticultural oils, and disease management using new biological-based fungicides are some of the use patterns of softer chemistries being adopted by grape growers in Niagara.

Poster Presentation Abstracts

Graduate Student Poster Competition

GP-1: Biology and management of cannabis aphid: An emerging pest challenging cannabis production in Ontario

Jason Lemay and C. Scott-Dupree

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Cannabis aphid (CA) (*Phorodon cannabis*) is a specialist insect pest with a host range limited to only *Cannabis sativa*. Due to this restricted host range, and the previous legal status of cannabis, very little is known about CA biology or management strategies. Cannabis aphid has rapidly spread throughout the cannabis industry and has been challenging for growers to manage. Few insecticides are registered for use in cannabis, forcing growers to rely on other IPM strategies. Yet, these strategies remain under-developed for cannabis production systems. First, a better understanding of the life-history of the cannabis aphid is needed. Using leaf-disk assays, 24 hour and lifetime fecundity, as well as time to sexual maturity were measured for both apterous and alate CA. This information on population dynamics is crucial for developing effective management strategies for this pest. Additionally, multiple aphid parasitoids can complete their life cycle on CA. We evaluated five parasitoids (*Aphidius matricariae*, *A. ervi*, *A. colemani*, a wild-caught *Aphidius* sp. and *Aphelinus abdominalis*) as potential biological control agents to manage CA. Using a caged arena trial, female parasitoids were allowed 24 hours to forage and parasitize groups of 10 CA. The number of parasitized aphids and the sex of emergent parasitoids were recorded. Identifying the parasitoid most effective at managing CA will provide growers specific recommendations to maximize the effectiveness of their biological control programs. These data establish the starting point for biological control strategies to be developed for the management of CA, providing significant benefit to Ontario's cannabis growers.

GP-2: Grapevine viruses, insect vectors and management strategies in Canada and the United States: A scoping review

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The extent of research regarding grapevine viruses in Canada has expanded remarkably over the last decade as Canadian vineyards battle increased widespread viral outbreaks impacting the health of grapevines and the quality of grapes. However, a comprehensive summary of this research is not yet available. Synthesizing the research on grapevine viruses is critical for developing effective management strategies and setting the direction of future research efforts in Canada. This scoping review synthesizes what is known about grapevine viruses of economic concern, their impacts and symptoms, the insects known or suspected of vectoring viruses, and strategies for managing virus incidence and vector populations in Canada and the United States, providing a comprehensive overview of grapevine virus research. By adhering to the predefined stages of a systematic review, this scoping review follows a rigorous approach that assures an accurate and reproducible synthesis of the literature on grapevine viruses in Canada. Prior to conducting the review, the credibility of this study was enhanced by registering a protocol to Open Science Framework to encourage

methodological transparency. Five bibliographic databases, one web-based search engine, and correspondence with industry organizations and researchers were used to collect all relevant scholarly and grey literature articles published from 2010 to 2022. After duplicates were removed, 2,801 articles remained. Articles were screened against specific eligibility criteria by considering articles' titles and abstracts, followed by full texts. Eligible articles were reviewed and analyzed, and results were collated to develop a detailed summary of the literature.

GP-3: Examining two *Dicyphus* species (Hemiptera: Miridae) for their potential use as biological control agents on greenhouse tomato.

Carly Demers^{1,2}, S. VanLaerhoven¹ and R. Labbé²

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²Agriculture and Agri-Food Canada, Harrow, ON

Greenhouse tomato production represents a large component of Canada's agricultural output, valued at \$666M in 2020. In these environments, pests are a year-round threat to crop production. Chemical control is not always a viable option due to insecticide resistance and detrimental effects on beneficial arthropods – such as pollinators, predators, and parasitoids – that are essential for production. Expanding the diversity of alternative pest management tools is essential. *Dicyphus hesperus* (Hemiptera: Miridae) is a well-established and native biological control agent (BCA) commercially applied in Canada for control of many greenhouse pests, including whiteflies. Recently, colonies were established for two additional and previously unassessed native mirid species - *Dicyphus discrepans* and *Dicyphus famelicus*. Here, I present the results of a laboratory study elucidating the potential of these two predator species to consume and control multiple pests of greenhouse tomato, including greenhouse whitefly, western flower thrips and two-spotted spider mites. The value of alternative host plant feeding on predator longevity and fecundity was also examined. This research, together with ongoing greenhouse trials, measures how well these predators establish, persist, and control pests on tomato crops. In addition, this study will begin to clarify the degree of zoophytophagy and potential for plant damage exhibited by these novel BCAs in a greenhouse system. Determining how to utilize these *Dicyphus* species as BCAs will increase the number of native beneficial predators available for use against currently established and future invasive pests of economic significance.

GP-4: Risk of cavity spot on carrots can be related to the soil microbiome

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Cavity spot is an economically devastating disease caused by several soil-borne *Pythium* species. Lesions develop on carrot roots, making them unmarketable. Cavity spot is widespread in Canada and around the world. Management recommendations are limited to avoid problem fields and applying fungicides at seeding if the field has a history of cavity spot. Currently, diagnostic tools to identify high-risk fields are not available. The hypothesis is that the soil microbiome influences disease development. Six growers' fields with high organic matter soils in the Bradford, Ontario, were identified as low or high risk of cavity spot, based on disease history from crop scouting. Disease assessment of carrots at harvest confirmed the risk assessment. Cavity spot severity in the low-risk fields was 15–21% and 38–55% in the high-risk fields. A comparative metagenomic analysis showed that microbial communities were different in the soils with high and low risk of cavity spot. The relative abundance of the following taxa was greater in low-risk soils compared to high-risk: fungi *Mortierella*, *Tetracladium*, *Penicillium*, and *Fusarium*; bacteria *Bauldia* and *Rhizobium*, and oomycetes *Phytophthora* and *Albugo*. Furthermore, the low-risk soils had a higher soil pH ~7 and soil calcium content ~8400 ppm

compared to high-risk soils with an average pH ~6 and calcium content ~3800 ppm. Soil pH and calcium were correlated with fungal and bacterial communities but not with oomycetes. This information will help with assessing the risk of cavity spot in soils before seeding. Assessment of additional fields is continuing to verify these results.

GP-5: The interaction of lime and boron to manage clubroot on canola, 2022

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Clubroot of canola is caused by the soilborne pathogen *Plasmodiophora brassicae*. Raising the pH of soil with agricultural lime can reduce the severity of clubroot. Application of moderate levels of boron also reduces clubroot severity. Two field trials were conducted on naturally infested muck (high organic matter) soil to assess the interaction of boron and lime on clubroot severity. In one trial lime was applied as calcium carbonate in the fall and supplemented with calcium hydroxide in the spring to reach the target pH of 7.0 and 7.5, from a starting pH of 6.4. In a second trial, lime was applied in the spring as calcium hydroxide. Treatments were incorporated into the soil with a rototiller. Boron was applied as Solubor to the soil surface at a rate of 16 kg B/ ha using a backpack sprayer for both trials, two weeks after calcium hydroxide application. Both trials were then seeded with clubroot susceptible canola. Clubroot severity was assessed 6 weeks after seeding. Application of lime lowered clubroot severity compared to the non-amended check and there was a negative linear correlation between pH and clubroot severity in both trials. In the trial with lime applied in the spring, boron reduced clubroot severity compared to the control, but there was no difference in the fall trial. There was no interaction between lime and boron in either trial. Using lime to raise the soil pH can be an effective tool to manage clubroot but the use of boron requires further study.

GP-6: Survey of *Neopestalotiopsis* spp. in Ontario strawberries

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Strawberries are a key fruit crop in North America and in many regions across the continent. Strawberries like most crops have unique challenges during production when it comes to pathogens. Recently, various strains of *Neopestalotiopsis* spp. have appeared in North America. Two species of *Neopestalotiopsis* have been found in Ontario that cause disease and major economic damage in strawberry. The symptoms of *Neopestalotiopsis* spp. are like other pathogens making observational identification of *Neopestalotiopsis* spp. difficult. Over the past three years, 40 symptomatic plants collected from commercial fields were tested for *Neopestalotiopsis* spp. using PCR and direct sequencing, with 35% (14/40) testing positive for the fungus. To examine the pathogenicity of the two species of *Neopestalotiopsis*, a visual bioassay was developed by inoculating detached leaves with 1.375×10^4 – 1.23×10^5 CFU and observations of the pathogen taken at various intervals post inoculation. Lesion color, size and occurrence were noted and have been further analyzed using Image software. The bioassay reduces the amount of time taken in the lab to identify the pathogen compared to sending samples away for genomic sequencing. Future work will examine *Neopestalotiopsis* spp. resistance in day neutral F1 Hybrid strawberries developed conducive to Ontario climatic conditions.

GP-7: The sterile insect technique as a novel tool for the management of pepper weevil (*Anthonomus eugenii* Cano) in greenhouse and field pepper crops

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The pepper weevil (PW; *Anthonomus eugenii* Cano) is a significant pest of pepper crops in North America, associated with up to 50% crop losses in severe infestations, and together with PW management, result in millions of dollars in economic damage annually. Larvae develop entirely within pepper buds and fruit causing premature fruit drop. This cryptic lifestyle also means that insecticide sprays are generally ineffective for managing PW, which is exacerbated by resistance in this species. Furthermore, no biocontrol agent targeting PW is currently commercialized. The sterile insect technique (SIT) is a novel approach to PW management, though it is an established method used to control a diversity of other pests worldwide. This foundational study focuses on producing high-quality sterile male insects for a PW-SIT system. We showed that 100% of late-instar PW pupae of both sexes irradiated at 110 Gy of gamma radiation failed to produce adult offspring, and egg sterility was >97%. The longevity of irradiated weevils was shorter than non-irradiated weevils, though it may be sufficiently long for a viable PW-SIT system. Of relevance is that irradiated males produced significantly less sperm than non-irradiated controls, and their ability to compete for mates in a field cage test was also impacted. Finally, flight activity was also decreased in irradiated insects, but not completely absent. Taken together, this study suggests a PW-SIT program may be feasible and lays the groundwork for development of a sustainable new tool for PW suppression both in field and greenhouse pepper crops.

GP-8: Improving the management of western bean cutworm, *Striacosta albicosta*, in edible dry beans

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Western bean cutworm (WBC; *Striacosta albicosta* (Smith; Lepidoptera: Noctuidae)) is a pest that has expanded its range in Canada within the past decade resulting in damage in corn (*Zea mays*) and dry beans (*Phaseolus vulgaris*). Much remains inconclusive regarding effective control tactics for WBC in beans. Field studies were conducted in Ridgetown and Exeter, ON concurrently in 2021 and 2022 to assess insecticide efficacy. This study was designed to document the feeding behaviour of WBC and subsequent bean injury when treated with single or multiple insecticide application(s) – early or late – in response to different WBC infestation loads. Plots were infested at 0, 7 and/or 14 days after pin pod stage and treated with chlorantraniliprole (50 g ai ha⁻¹) at 4, 11, 18, 25 and/or 32 days after the initial infestation. Sentinel plants within each plot were monitored weekly and dissected post-harvest to differentiate superficial pod injury observed in the field from feeding that affected seed quantity and quality. No difference in pod or seed injury were observed at harvest or through post-harvest assessments in 2021; this finding was extremely unexpected. The experimental design was adjusted in 2022 to limit larval movement between plots. This field study is supplemented by a laboratory experiment investigating the coverage and residual effectiveness of the insecticide. Pods were collected on 1, 4, 7, 10, 14, 17 and 21 days after insecticide application, and mortality of exposed WBC larvae will be assessed. This research will provide vital information on effective management of WBC for bean growers.

GP-9: The effect of *Metarhizium brunneum* on wireworm population

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Wireworms, the larval stage of click beetles (Coleoptera, Elateridae), have caused severe damage to potato crops across Canada and the globe, making them a major pest. Many of the insecticides used to manage wireworm populations are now banned due to their negative effect on both the environment and human health. The use of cover crops in combination with the entomopathogenic fungus, *Metarhizium brunneum*, is an effective alternative strategy in reducing wireworm populations. Recent reports indicate that certain cover crops can reduce wireworm population through natural compounds released by the growing plant (allelopathy) or after they are mulched into the soil (fumigants). This study will investigate whether brown mustard, buckwheat, sorghum Sudan grass and barley (control) in combination with *Metarhizium brunneum*, will reduce wireworm populations (*Limonius agonus*) in southwestern Ontario.

GP-10: Optimization and scalability of regenerative *in situ* electrochemical hypochlorination for closed-loop hydroponics

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Closed-loop hydroponics is a water-efficient way of producing food, floriculture, and medicinal crops. The efficiencies arise through the capture and reuse of water and fertilizers that support plant growth in controlled environment agriculture (CEA). However, recirculating the nutrient solution, which could become contaminated as it passes through the system, increases the risk of pathogen spread. Water treatment is therefore a necessity in CEA systems. Previous research has demonstrated the efficacy of regenerative *in situ* electrochemical hypochlorination (RisE^{HC}) against common pathogens such as *Fusarium oxysporum* spp., without causing phytotoxicity. The presented research focussed on system optimization, specifically scalability of the technology for CEA commercial applications. Computational fluid dynamics and response surface analysis was used to determine the optimal design for the electrochemical flow cell. A next generation prototype was developed and compared to the previous design for chlorine evolution, power consumption, and microbial inactivation. The next generation design increased microbial inactivation on average by 21.4% while increasing the treatment volume capacity by 23.2%. This was achieved with an overall 42.4% reduction in electrode area. The research demonstrates that the RisE^{HC} process is suitable to scale for large-scale CEA and further research will incorporate a modular system for closed-loop hydroponics.

Undergraduate Student Poster Competition

UP-1: Comparing the effectiveness of select companion plants for management of insect pests on cannabis grown outdoors in Ontario

Chloe El Hani, L. Auty and C. Scott-Dupree

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Outdoor grown *Cannabis sativa* L. is threatened by economically damaging insect pests. Unlike many outdoor crops, cannabis has only a few registered insecticides that can be used to manage arthropod pests to reduce economic damage. Growers are therefore required to rely on other IPM tactics to

mitigate arthropod pests on outdoor grown cannabis. Companion planting, a form of cultural control, focuses on modifying the growing environment of the crop which consequently can promote existing natural enemy populations and potentially disrupt pest populations. This project aimed to compare select companion plants for their effectiveness to manage insect pests and their economic feasibility in outdoor cannabis production in Ontario. To identify the most effective companion plants for outdoor grown cannabis, a plant performance index was used during the 2022 growing season. This was done to observe the effectiveness of select companion plants to attract natural enemies and disrupt insect pest behaviour. Furthermore, we evaluated the vitality and management efforts required to maintain the companion plants. Through the use of this performance index, the most effective companion plants were identified to inform growers about companion plants that can best aid in managing insect pests in outdoor cannabis.

UP-2: Does companion plant density impact insect pests and beneficial insects in outdoor cannabis crops?

Margaret Mantel, L. Auty and C. Scott-Dupree

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Outdoor cannabis production is economically threatened by insect pests, and growers have few registered insecticide options available to properly manage them. Companion planting in outdoor cannabis is a novel cultural control to mitigate insect pest issues within the crop. This tactic involves the planting of flowering or aromatic plants alongside cannabis to attract beneficial insects and repel pests. This strategy has not been widely adopted by the cannabis industry and thus planting strategies need to be determined to make effective recommendations to growers. In this study, we determined whether low-density or high-density companion planting in outdoor cannabis production systems is more effective. Insect recruitment data was collected weekly in the 2021 and 2022 field seasons for high-density plots and in the 2022 field season for low-density plots at a commercial cannabis facility in Ontario. Differences in abundance and diversity of both beneficial and pest insects were statistically analyzed. By identifying effective companion planting densities, IPM strategies can be optimized for outdoor cannabis production. Results of this study will determine whether companion planting at a low density is an economically feasible option for pest management in outdoor grown cannabis.

UP-3: Comparison of an amended agar assay vs. a microplate assay for assessing fungicide sensitivity

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Clariireedia jacksonii Salgado causes dollar spot disease on turfgrass, and frequent fungicide application is used to manage this disease. Reduced sensitivity to the fungicide propiconazole has been detected in populations of this fungus. A microplate absorbance assay was developed and compared to a conventional amended agar assay to assess the sensitivity of *C. jacksonii* to propiconazole. EC₅₀ values (effective concentration required for 50% inhibition of growth) were calculated from both assays using 32 isolates of previously assessed sensitivity. Spores of bacteria and fungi have been used previously in microplate absorbance assays, but this fungus is not known to produce spores. A hyphal microplug inoculum was developed to seed the wells in the microplate, and absorbance was measured at 595 nm after 24 and 48 hr of incubation with eight replicate wells per fungicide concentration (0, 0.01, 0.1, 1.0, and 10 µg/ml). For the amended agar assay, radial growth was measured between 24 and 48 hr with three replications using the same range of concentrations. Data from three repeated experiments of each assay were subjected to Probit analysis to obtain EC₅₀

values. Correlation analysis revealed a statistically significant relationship between results of the two assays ($p \leq 0.0001$); however, this relationship showed a low correlation ($R^2 = 0.06$). This relationship was improved by \log_{10} transformation of EC_{50} values ($R^2 = 0.47$, $p \leq 0.0001$). The microplate absorbance assay cannot directly replace the amended agar assay for calculation of EC_{50} values, but future developments in the methods may allow for such use.

UP-4: Broad spectrum biocontrol of plant pathogens with *Bacillus amyloliquefaciens* strains through selective enhancement of its antibiotic production using carbon sources and culture additives

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Utilization of bacterial species as biocontrol agents continues to receive considerable attention in the agriculture industry. One such species is *Bacillus amyloliquefaciens*, a Gram-positive spore-forming bacterium used to combat pathogens in many crops. Notably, nearly 10% of its genome is involved in antimicrobial metabolite synthesis and immune responses. Initially, the presence of antibiotic ketides of three *B. amyloliquefaciens* isolates (94, 113, 279) were tested in this study through PCR amplification of antibiotic-specific genes such as surfactin and fengycin. Further, to better target specific pathogens, the expression levels of various antibiotics were manipulated in all three isolates through the addition of specific additives in growth media. Overall, 110 culture conditions were tested to determine the effect of signalling agents, growth hormones, and organic acids on antibiotic production. The effects of the various culture conditions were then measured via quantification of 31 different antibiotics through liquid chromatography–mass spectrometry (LC-MS). It was ultimately concluded that the addition of organic acids to culture media significantly increased the amount and numbers of antibiotics produced. Further growth room and field trials targeting economically relevant plant pathogens concluded that application of the amended cultures reduced fusarium head blight by 49% while reducing the grain toxin (DON) levels by 83%. The formulation also increased protection against fusarium root rot in tomato by 60% and delayed symptom expression in cucumbers against *Alternaria* blight, and in pumpkins and squash against powdery mildew.

Regular Posters

RP-1: Soil bacteria with biocontrol potential for ginseng replant disease

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Panax quinquefolius production is limited by its inability to grow in soil previously planted to ginseng, a phenomenon known as ginseng replant disease, which is often related to root rot caused by *Ilyonectria mors-panacis*. To obtain potential biocontrol agents against this disease, bacteria were isolated and identified from soil sampled from a ginseng field between 10 and 231 days post-harvest. The genomes of selected isolates were analyzed. *Paenibacillus urinalis* MWO2.10, MWO2.73 and MWO2.231, and *Bacillus megaterium* MWT2.73 showed similar genes for PGPR (Plant Growth Promotion Rhizobacteria) traits. For secondary metabolites, MWT2.73 had genes for paeninodin, fosfomycin, alkylresorcinol, amylocyclin, micrococcin P1, microcin C7, eremophilene, petrobactin

and bacilysin, while all *P. urinalis* isolates had genes for keywimsyn, fellutamide B, enttheonella and bacillibactin. For lytic CAZymes, the number of genes per genome for PLs (polysaccharide lyases) and GHs (glycoside hydrolases) of MWO2.10 were 101 and 14, MWO2.73 were 130 and 15, MWT2.73 were 74 and 2, and MWO2.231 were 162 and 17, respectively. Bioconfrontation culture assays of *Bacillus subtilis* LWO2.73, *Bacillus megaterium* LWO4.73, *Pseudomonas putida* MWO1.73 and *Pantoea agglomerans* LYT1.73 were done against *I. robusta* (IR), *I. mors-panacis* (IMPT1), and *I. mors-panacis* (IMPT2). IMPT1 was significantly inhibited only by LWO2.73, IR was significantly inhibited only by LWO4.73 and no isolate significantly inhibited IMPT2. Later, the genomes and bioconfrontation assays will be determined for the entire isolate collection, and isolates will be added to replant soil to determine which ones increase ginseng seed germination and seedling survival.

RP-2: Evaluating efficacy of a novel nematicide for management of northern root knot nematode in greenhouse strawberry production

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Northern root knot nematode, *Meloidogyne hapla* is a major pest of horticultural and field crops. In Canada, reduction in total yield and quality of fruits and vegetables due to this nematode is an increasing concern. Therefore, there is a need to develop new nematicides to control *M. hapla* for greenhouse production. In this study we have tested the efficacy of a newly developed non-fumigant nematicide (Y) that is potent against *M. hapla* but has minimal effect on free-living nematodes and the environment. *M. hapla* is an important plant parasitic nematode on greenhouse strawberries and understanding how it responds to different doses of Y is imperative in determining the best recommended use. Towards this goal, we have tested different application rates (560, 1120, 1680, 1120+560, and 2240 g ai/ha) of Y against *M. hapla* on strawberries. Nematode reproduction was determined 8 weeks and 11 weeks after nematicide application. There was no significant difference in nematode reproduction after 8 weeks. However, at the 11 weeks count, all concentrations except one significantly reduced nematode reproduction. Among the concentrations, 2240 g ai/ha had the lowest nematode reproduction at second count. Although there was no significant difference in average weight of marketable fruits, Y at a concentration of 2240 g ai/ha had the lowest average weight of nonmarketable fruits when compared to our reference nematicide, Velum Prime. These results indicate that applying Y at 2240 g ai/ha rate is effective in managing *M. hapla* in strawberry production and can be used as part of integrated pest management programs.

RP-3: Efficacy and market potential of biopesticides developed from saponins and essential oils

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The global market for biopesticides, crop protection products based on living microbes, microbial products or plant natural chemicals, is predicted to represent 20% of total pesticide use in 2025. For those biopesticides that are based on plant chemicals, the chemical active ingredient generally falls within the category of vegetable oils and fatty acids, or small molecules also known as secondary plant metabolites. We are evaluating the use of saponins and essential oils, secondary metabolites found in a variety of plants, as active ingredients in innovative biopesticide formulations. The effect of

essential oils on behaviour and mortality of melon aphid, *Aphis gossypii*, was assessed in a fumigant bioassay. The antifungal activity of saponins and hop essential oils, alone and as mixtures, was assessed using in vitro as well as using whole plant bioassays. Hop essential oil and, to a lesser extent, geranium essential oil, were found to have a profound effect on the behavior of aphids on cucumber plants, in addition to causing aphid mortality at higher doses. Saponins and essential oils were found to have in vitro antifungal activity against a broad range of fungal pathogens and were also found to protect tomato plants from infection by *Fusarium oxysporum*. The extrapolated retail value of new saponin and essential oil biopesticides for use in Canadian strawberry production alone was estimated to be potentially over \$3 million annually. Additional tests of the fumigant effects and antifungal activity should be conducted in a commercial greenhouse setting.

RP-4: Integrated pest management of root maggots in Ontario leafy green and root brassica vegetables

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Brassica leafy green vegetables (cabbage, broccoli) and root vegetables (rutabaga, turnip) are important and economically profitable crops in Ontario. Damage to these crops from insects impacts their marketability and yield, with cabbage root maggot (*Delia radicum*) being the most concerning pest. Chlorpyrifos applied to transplants at time of seeding or as a mid-season soil drench is the most commonly used option for root maggot control. However, all uses of chlorpyrifos in brassica vegetables will be phased out by 2024. In light of the loss of this key control tool, the Pest Management Centre's (PMC) Priority Setting Workshop for IPM selected sustainable management of *Delia* root maggots to meet this need of Brassica vegetable growers. Field trials were initiated in 2022 in Exeter, ON to evaluate various combinations of IPM tactics to manage *Delia* root maggots in cabbage and rutabaga crops. The strategies include physical barriers (netting), biological controls (nematodes) and the combination of both, based on grower experience and feasibility for potential uptake. The strategies will be compared to conventional management practices (seed and transplant treatment with cyantraniliprole). The project is expected to develop and facilitate the adoption of IPM systems for *Delia* root maggots that combine practical and effective alternative tactics that are easy to implement, are cost effective, and provide multiple mechanisms for reducing *Delia* spp. populations, with reduced reliance on insecticides.

RP-5: IPM: Photosensitizer... lights... action!

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Suncor Energy Inc. has developed photosensitizer formulations that cause high mortality rates in common greenhouse pests. These novel, photodynamic insecticides are non-toxic derivatives of natural compounds that fit into an ecosystems-approach of growing food more sustainably. Photosensitizers are inactive when applied to the target insect and only enter an excited state when activated by natural or artificial light, such as LEDs. Activated photosensitizers produce reactive oxygen species that lead to the death of the target pest. Photodynamic insecticides have proven to be as effective as registered synthetic chemical pesticides. In trials conducted at Vineland Research and Innovation Centre, mortality rates above 70% were observed when photosensitizers were sprayed to control western flower thrips. Mortality rates increased to above 80% when the photosensitizer formulations

were combined with Suncor's registered oil product, PureSpray Green. Photosensitizers can be applied with equipment currently used in greenhouses and in the field. Due to their unique mode of action the products degrade after light exposure, thereby minimizing the risk of buildup of toxicity or resistance. These photosensitizer formulations are non-toxic to pollinators and pose much lower risk to human health than any registered synthetic chemicals. Additionally, but critically important, Suncor's photodynamic insecticides can likely be used with bios as part of existing IPM programs.

RP-6: Fighting blight: Evaluating fungicides for efficacy against stemphylium leaf blight in Ontario

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Stemphylium leaf blight (SLB) is a foliar disease caused by the fungal pathogen *Stemphylium vesicarium*. SLB can reduce onion yield and bulb quality through premature defoliation. Current SLB control relies on integrated pest management (IPM) strategies. For IPM to be successful, there must be fungicides that are effective for disease management. A field trial was conducted to evaluate pyraclostrobin + fluxapyroxad (Merivon), pydiflumetofen + difenoconazole (Miravis Duo), mefentrifluconazole (Revysol), fluxapyroxad (Sercadis), *Bacillus amyloliquefaciens* (Serifel), 24-epibrassinolide (Sunergist) and *Trichoderma atroviride* (T-77) fungicides for efficacy against SLB. Onions were rated weekly to assess leaf dieback on the oldest three leaves of 20 plants per replicate plot and a destructive assessment was done in early August to assess all leaves. Disease pressure was low in 2022, with a DSI of 48.5 on the untreated check. Weekly fungicide applications did not reduce SLB incidence, severity, or area under the disease progress curve (AUDPC) compared to the untreated control. In assessing SLB severity across the whole season (AUDPC), all treatments reduced AUDPC compared to the control (148.1), with the greatest decrease (115.2) seen in pyraclostrobin + fluopyram (Merivon) foliar treatment. Destructive sampling evaluations of severity and incidence indicated a trend with the pyraclostrobin + fluopyram (Merivon) fungicide treatment reducing DSI by 44% and SLB incidence by 21% relative to the control. Research will continue to identify fungicides and biologicals that are effective in managing SLB. The lack of efficacy may be because of low disease pressure during the 2022 season.

RP-8: Improving semiochemical attraction for management of Colorado potato beetle in solanaceous field crops

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Historically, Colorado potato beetle (CPB), *Leptinotarsa decemlineata*, (Chrysomelidae: Coleoptera), a serious pest of solanaceous crops, has been managed almost exclusively with insecticides. However, effective insecticides are being lost to resistance and regulatory activities, and therefore, alternative, non-insecticidal tactics are needed for CPB. A CPB aggregation pheromone [(S)-CPB I] has been identified and synthesized, and if an attractive pheromone-based lure could be developed, it could be used in a mass-trapping strategy to reduce CPB population sizes and to prevent adults from entering potato and tomato fields in the spring. The objective of this study was to determine the attractiveness of (S)-CPB I alone and in combination with potato kairomones to CPB adults. In a preliminary 2-choice olfactometry assay, the response of male and female CPB adults to (S)-CPB I, a 2-component kairomone blend (2-phenylethanol and nonanal), and a 3-component kairomone blend [linalool, methyl salicylate and (z)-3-hexenyl acetate] was determined. Only males showed a preference for (S)-CPB I compared to a neutral control, while only females showed a preference for

the 3-component blend compared to a neutral control. Both males and females showed a preference for a combination of pheromone and 3-component blend compared to the blend alone. These results suggest (S)-CPB I is generally attractive to CPB adults, and adding kairomones may increase the attractiveness of the pheromone. However, response to the pheromone by males and females was low overall, and therefore, additional assays with a different isomer of (S)-CPB I will be conducted.

RP-8: Pesticide resistance levels in field and greenhouse populations of *Tetranychus urticae*

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Two-spotted spider mite, *Tetranychus urticae* (Koch), is a chelicerate herbivore with an exceptionally wide host range. It is a frequent pest of a wide variety of economically important crops. While low-level infestations are controlled by biological agents such as beneficial predatory mites, midges, and bugs, chemical controls are frequently implemented for persistent pest populations. However, pesticide resistance is frequently reported in *T. urticae* populations across the globe. Here we present a 2021 assessment of pesticide resistance of *T. urticae* populations coming from Southwestern Ontario. 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, bifentazate, cyflumetofen, dimethoate, etoxazole, pyridaben, and spiromesifen. Our results indicate that resistance to multiple pesticides was present in the majority of the sampled populations with the greenhouse-collected populations being the most resistant. These results may be used to prioritize and plan pesticide usage on crops where multiple products are registered. Our assessment may also inform a choice of additional pesticide registration for spider mite control on soybean, which is currently performed exclusively with dimethoate that was demonstrated to have limited effectiveness.