WESTERN COMMITTEE ON CROP PESTS – 2024
SASKATCHEWAN ENTOMOLOGY RESEARCH SUMMARY
Regina, Saskatchewan, November 5-7

Compiled by Tyler Wist

Of the Agriculture and Agri-Food Canada Saskatoon Research and Development Centre

1. Title: Population dynamics and monitoring programs for midges attacking canola

Author and associates: Meghan Vankosky (PI, AAFC Saskatoon), Boyd Mori (co-PI, University of Alberta)

Funder(s): Canola Agronomic Research Program

Abstract: Two species of midge pose a potential threat to canola production in Canada. First, swede midge, which is not present in western Canada, and is well studied in eastern Canada and known to have devastating impacts on canola yields. Second, canola flower midge, which is present in western Canada and has only been studied since 2016. The project will continue to monitor for both species and will conduct research to determine if canola flower midge poses a threat to canola yields.

Problem: In western Canada, two species of midge could potentially affect canola yields: swede midge and canola flower midge. Swede midge is invasive to Canada and is established in eastern Canada but remains absent in western Canada. In the United States, swede midge distribution is expanding westward. Annual monitoring is needed to ensure early detection of swede midge in western Canada. Canola flower midge was discovered and described in 2016 in western Canada. After an initial prairie-wide survey, no formal monitoring has taken place for canola flower midge. There are also still questions about the potential for this insect to affect canola yield.

Objectives: The project objectives include: 1) continued annual monitoring for swede midge, a potentially invasive pest of canola and other brassica species, 2) to initiate a pheromone-based monitoring program for canola flower midge, using species specific lures and following the same general protocol as the swede midge monitoring program, and 3) to conduct field cage studies to determine if there is a relationship between canola flower midge density and canola yield losses.

Summary of results and continuing research: The first year of monitoring for both midge species in this project was supported by volunteers across Alberta, Saskatchewan, and Manitoba. Traps have been returned to Dr. Vankosky's lab at AAFC in Saskatoon to be processed and results will be available soon. The cage study to investigate the relationship between canola flower midge density and canola yield loss will start in spring 2025.

Contact: Meghan Vankosky (meghan.vankosky@agr.gc.ca)

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2. Title: Coordinated monitoring of field crop pests in the Prairie Ecosystem

Authors and associates: Meghan Vankosky and Jennifer Otani (co-PIs), Ross Weiss, John Gavloski, Shelley Barkley, James Tansey, Boyd Mori, Jon Williams, Carter Peru, and Owen Olfert

Funder(s): Saskatchewan Agriculture Development Fund, WGRF, Manitoba Canola Growers, SaskCanola (now SaskOilseeds), Alberta Canola, Saskatchewan Pulse Growers, Manitoba Pulse and Soybean Growers, SaskWheat, Alberta Grains, Manitoba Crop Alliance, POGA and significant in-kind support from Manitoba Agriculture, Saskatchewan Ministry of Agriculture, Alberta Agriculture and Irrigation, and SCIC.

Abstract: The Prairie Pest Monitoring Network (PPMN) conducts annual insect monitoring to provide important information regarding the distribution and phenology of insect pests. This information is used to help guide on-farm decision making and to create maps of pest distribution and relative abundance. Monitoring data also contributes to the development of models to predict the timing of pest development and this information is communicated to subscribers of the PPMN in Weekly Updates during the growing season.

Problem: Integrated insect pest management strategies require accurate forecasts of pest risk and pest scouting activities to be effective. Monitoring protocols and/or forecasts are available for some insect pests, but not for others. This project supports prairie-wide insect surveys and the development and refinement of monitoring protocols and risk models. The current iteration of the project, which started in April 2023, will also investigate insecticide resistance and factors that affect insect population dynamics.

Objectives:

1) Understand inset population dynamics and forecast pest populations,

2) Assess the current status of insecticide resistance in western Canada,

3) Develop new insect information resources.

Summary of results and continuing research: Annually, the PPMN team of collaborators conduct prairie-wide surveys of six key insect pests. Regional maps for 2024 pest distribution are expected to be available in January 2025. Insect survey data collected in 2024 (as well as past and future years) will be used to refine monitoring protocols and predictive models, and to meet the other project objectives. Visit https://prairiepest.ca for more information.

Contact: Meghan Vankosky (meghan.vankosky@agr.gc.ca)

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3. Title: *Delia* root maggot IPM in brassica vegetable production in Saskatchewan and Ontario

Authors and associates: Meghan Vankosky (co-PI), Ian Scott (co-PI), James Tansey, Carter Peru, Connie Achtymichuk, Doug Waterer

Funder(s): Agriculture and Agri-Food Canada Alternative Pest Management Solutions program and the AAFC Pest Management Centre (four years, starting spring 2022)

Abstract: This project will evaluate IPM programs for *Delia* root maggots in brassica vegetable crops in both SK and ON. IPM tactics for study in SK were chosen based on suitability and compatibility with provincial vegetable crop production and the economics and other benefits of IPM programs will be compared to conventional *Delia* management. The project will leverage field demonstrations, outreach, and other knowledge transfer approaches to facilitate the adoption of the IPM program by local growers.

Problem: *Delia* root maggots are important pests of brassica vegetables, especially root vegetables. In Canada, significant canola acreages serve as a refuge and breeding ground for *Delia* species; canola yields are not typically affected by root maggots as compared to other brassica crops. To grow marketable root vegetables, multiple, carefully timed insecticide applications are required. One of the primary insecticides registered for root maggot management is being deregistered, effective December 2023. Thus, alternative management options, potentially as part of an integrated pest management (IPM) program are needed to replace this insecticide.

Objectives:

1) Evaluate different combinations of IPM tactics for *Delia* root maggots in field conditions specific to Saskatchewan and Ontario;

2) Develop feasible and economical *Delia* IPM programs in both provinces; and

3) Facilitate grower adoption of the proposed IPM programs using in-field demonstration, economic analyses, outreach, and other knowledge and technology transfer tools.

Summary of research and continuing research: In 2024, plots to compare the conventional rutabaga variety (Laurentian) and a 'tolerant' rutabaga variety (Appalaches) were established at Outlook, SK at the Canada-Saskatchewan Irrigation Diversification Centre. Weekly assessments of plant health and *Delia* densities and damage were conducted until early September and the plots were harvested in late September 2024. Rutabaga are now being assessed in the lab and rated for root maggot damage. The trial will be repeated in 2025, with the additional application of nematodes as a biological control agent for root maggots.

Contact: Meghan Vankosky (meghan.vankosky@agr.gc.ca)

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4. Title: **Flea Beetle Resistance in Canola**

Authors: Dwayne Hegedus

Abstract: This project is building on work started by researchers at AAFC-SRC and the University of Saskatchewan that identified natural lines of *Brassica napus*, and the related *B. villosa* species, that exhibit resistance to flea beetles by producing hairs (trichomes) on their leaves and stems. Information pertaining to the genes responsible for trichome production, and markers to track the trait, will permit breeders to introduce it into next generation of canola varieties.

Problem: Neonicotinoids are the most common type of insecticide used to control flea beetles. Striped flea beetles have become the more prominent species in spring and are less affected by them than the crucifer flea beetle leading to higher levels of damage. Currently, there are no canola varieties with natural resistance to flea beetles.

Objectives of Research:

1) Identify the genomic regions controlling the production of hairs in Brassica species
2) Develop genetic markers to allow introgression of the trait into elite breeding material
3) Test the impact of increased hair density on flea beetle resistance and crop performance

Summary of Results:

1) A genomic region in *B. napus* has been identified that controls leaf and petiole trichome density
2) *B. villosa* genomic regions identified that control trichome density and length.
3) A permanent striped flea beetle colony has been established at AAFC-SRC

Continuing Research:

1) Determine the levels of trichomes necessary to reduce flea beetle feeding to tolerable levels
2) Introgress this trait into synthetic *B. napus* lines suitable for breeding.
3) Map other insect resistance traits segregating in the B. villosa population including leaf waxiness and anthocyanin levels.

Funders:

Canola Council of Canada through the Canola Cluster

Contact:

Dwayne Hegedus (Dwayne.Hegedus@agr.gc.ca)

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5. Title: Investigating the Role of Phytoplasma Infection and Different Host Plants in the Aster Leafhopper Microbiome

Authors: Sainey Ceesay (University of Saskatchewan) & Dr. Sean M Prager University of Saskatchewan)

Funders: NSERC & Sask Canola

Abstract: This research investigates the role of microbial communities in the ability of Aster leafhoppers (Macrosteles quadrilineatus) to vector Aster Yellows phytoplasma (AYp) and adapt to various host plants. It examines the effects of insect-symbiont relationships to understand the interplay between the leafhopper's microbiome, AYp infection, and host plants. The findings aim to provide insights into phytoplasma transmission and contribute to strategies for controlling the spread of AY.

Problem: Aster leafhoppers (*Macrosteles quadrilineatus*) are a significant threat to Canadian agriculture due to their role as primary vectors of Aster Yellows phytoplasma (AYp), a bacterial pathogen that negatively impacts crop yields, particularly in canola, barley, and oats. Their polyphagous nature and strong migratory abilities enable them to spread AYp rapidly, causing symptoms like yellowing, witches' broom, and yield loss in over 250 plant species. The economic impact of AYp has been severe, with canola farmers in Western Canada facing losses estimated between $270 million to $1 billion CAD in 2012 due to high infection rates in affected fields. Currently, little is known about the microbiome of the aster leafhopper and how it may be influenced by phytoplasma infection and different host plants. Thus, it is important to determine whether switching aster leafhoppers across various host—specifically barley, wheat, fleabane, and dandelion—affects the fitness and microbiome of transgenerational nymphs

Objectives:

1. Determine whether switching aster leafhoppers across different host plants affect the fitness and microbiome of transgenerational nymphs,

2. Investigate the influence of Aster Yellows (AY) infection in the Aster leafhopper microbiome.

Summary of results: Preliminary results suggest that among different host plants, barley is the most suitable for nymph production, followed by wheat and fleabane, while dandelion appears to be a poor host. Additionally, infected aster leafhoppers produced more nymphs than uninfected ones, indicating that infection may enhance their reproductive success.

Continuing Research:

1. Sequence DNA samples from transgenerational nymphs and infected aster leafhoppers using 16S rRNA and ITS markers to assess taxonomic diversity across different groups.
2. Correlate host fitness with microbiome composition and identify conserved microbial communities.

Contact: Sainey Ceesay, Department of Plant Sciences, Room 6E37, 51 Campus Drive, Saskatoon, SK, S7N 5A8. wul465@usask.ca

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6. Title: Developing Economic Thresholds and Sequential Sampling Plants for Lesser Clover Leaf Weevil in Red Clover Seed Production

Authors: Jeremy Irvine, Sean Prager

Funder(s): Saskatchewan Agriculture Development Fund, Saskatchewan Forage Seed Development Commission

Abstract: The lesser clover leaf weevil (H*ypera nigrirostris*) is a significant pest affecting red clover (*Trifolium pratense*) seed production. Current control strategies rely heavily on costly chemical insecticides, which can negatively impact beneficial arthropods, including pollinators and natural predators. To this end, economic thresholds and sequential sampling plans are being developed to ensure chemical insecticides are only applied when necessary to reduce environmental damage.

Problem: Red Clover is a legume grown for seed production, an essential commodity in the Canadian Prairies. However, the lesser clover leaf weevil (LCLW) can significantly decrease seed production by up to 50% due to feeding damage on developing shoots, flower heads, and seeds of red clover plants. The pest is traditionally controlled using insecticides, which are harmful to non-target species, notably bees, which are essential pollinators for red clover. Limited insecticide efficacy leads to multiple insecticide applications, increasing environmental damage and the risk of developing insecticide-resistant LCLW populations due to only one insecticide material being registered for use.

Objectives: This project aims to determine the economic injury level for the lesser clover leaf weevil in red clover seed production. The data will be used to develop economic thresholds and sequential sampling plans, providing growers with practical tools to effectively manage this pest.

Summary of results and continuing research: This project began in May 2023 with field trials to determine yield loss from varying LCLW population densities. Results from the second and final field season have been collected and are currently being analyzed. Preliminary analyses indicate that the economic threshold for the LCLW may be lower than the presently used nominal threshold of 4-6 LCLW/ten red clover shoots. The continuing research objectives of this project are to develop pheromone-baited traps that specifically target the LCLW to reduce its population without using environmentally harmful chemical insecticides that damage populations of beneficial insects.

Contact: Jeremy Irvine (Jeremy.irvine@usask.ca) or Sean Prager (Sean.prager@usask.ca)

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7. Title: Transmission of Pea-Seed borne Mosaic Virus (PSbMV) in Faba Bean via Pea Aphids: Assessing the Risk to Canadian Pulse Crops

Authors: Grace Onu-Odey (University of Saskatchewan) and Sean M. Prager (University of Saskatchewan)

Abstract: Faba beans (*Vicia faba* L) are vital to the Canadian pulse crop industry, serving as a significant source of protein and contributing to sustainable agricultural practices through nitrogen fixation. However, the productivity of Faba beans is threatened by the pea seed-borne mosaic virus (PSbMV), a pathogen transmitted primarily by the pea aphid (*Acyrthosiphon pisum*). This study aimed to investigate the transmission dynamics of PSbMV in Faba beans using different populations of pea aphids. Experiments were conducted with groups of 1, 5, 10, 15 and 20 aphids placed on separate sets of 10 Faba plant each for a 24-hour inoculation period. The results revealed that even a single aphid was capable of successfully transmitting PSbMV to healthy Faba within the given timeframe. Molecular diagnostics, including real-time PCR, were employed to confirm the presence of PSbMV in the infected plants. The findgings highlights the significant role of pea aphids as vectors of PSbMV, emphasizing the need for integrated pest and virus management strategies to mitigate the impact of viral diseases on pulse crops in Western Canada.

Problem: Pulse crops, such as Faba beans are increasingly vulnerable to viral infections transmitted by insect vectors like pea aphids (*Acyrthosiphon pisum*). These aphids not only cause direct feeding damage, which cause devasting yield loss, but they also spread viruses like the pea seed-borne mosaic virus (PSbMV). Early PSbMV infection has been linked to severe yield reductions, with Faba bean experiencing losses as high as 50%. Despite the significance of these threats, there remains a lack of comprehensive data on the impact of this virus on Western Canadian pulse crops. This knowledge gap limits our ability to develop targeted strategies to prevent and manage this viral disease effectively.

Objective of Research: This research investigates the role of pea aphids as vectors in transmitting PSbMV to Faba beans, to assess the impact of PSbMV infection on the growth and development of Faba beans, focusing on the symptoms and to contribute to the understanding of vector-mediated transmission of PSbMV in pulse crops, with the aim of developing improved management strategies for protecting Faba crops and other pulse crops in Canada.

Summary of Project: The results showed that even a single aphid could transmit the virus to a healthy plant, demonstrating the high efficiency of pea aphids in spreading PSbMV. This research highlights the threat posed by aphid-transmitted viral infections to pulse, emphasizing the need for effective pest and disease management strategies to protect pulse production in Western Canada.

Funders: Saskatchewan Pulse Growers, Western Grains Research Foundation.

Contact: Grace Onu-Odey (grace.onu-odey@usask.ca) or Sean Prager (sean.prager@usask.ca)

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8. Title: Evaluating *Lygus* Feeding Behavior, Preferences, And Patterns In Faba Bean Cultivation

Author and associates: Teresa Aguiar-Cordero (University of Saskatchewan), Sean M. Prager (University of Saskatchewan), Christian Willenborg (University of Saskatchewan), Hector Carcamo (Agriculture and Agri-Food Canada), and Kirstin Bett (University of Saskatchewan)

Funder(s): Saskatchewan Pulse Growers, Western Grains Research Foundation

Abstract: This project aims to address critical knowledge gaps regarding Lygus insects in faba beans through a comprehensive survey of Lygus densities and species across Saskatchewan, combined with laboratory bioassays. These bioassays, including choice, no-choice, and electrical penetration graph (EPG) techniques, were designed to quantify the relationship between Lygus insect numbers and the resulting damage to faba bean pods.

Problem: Faba bean (Vicia faba) is a major legume crop in western Canada with an estimated 55.9 thousand acres planted in Saskatchewan and 32.5 thousand acres in Alberta (Government of Canada, 2023). Faba bean production is threatened by multiple insect pests and pathogens, particularly several species of insect in the genus Lygus (Heteroptera: Miridae) (Government of Saskatchewan, 2023). Lygus feed by using their piercing-sucking mouthparts to inject salivary enzymes into the plant tissue (Williams et.al., 2005) On faba, their feeding can result in hull perforations, discoloration of the seed coat, seed pitting or localized tissue wilting and necrosis (Kaur, et.al., 2019). This damage results in both reduced yield and downgrades since faba for human consumption has a very low tolerance to such damage (< 1% for Grade No. 1) (Canadian Grain Commission, 2022).

Objectives: Establish correlations between the number of Lygus and scarring damage in faba beans.

Determine Lygus populations in faba beans.

Evaluate *Lygus* preferences for specific plant species.

Summary of results and continuing research: No-choice bioassay findings indicate that feeding duration significantly affects seed damage, with longer feeding periods (24 and 48 hours) leading to substantially more damage. The species of Lygus (*L. elisus* and *L. lineolaris*) did not significantly influence the outcome, and no significant interaction was found between species and feeding duration. These results underscore the importance of managing feeding durations in pest control strategies to minimize seed damage in crops.

Across alternative plant treatments (alfalfa, canola, and flax), the percentages of seed damage (SD) and weight damage (WD) were similar for both sexes. Faba beans adjacent to canola exhibited the highest damage, with males causing an average SD of 3.72 ± 2.55 and a WD of 4.35 ± 3.08. Notably, females caused no damage in faba beans next to canola. In the flax treatment, males caused a mean SD of 2.5 ± 2.5 and a WD of 3.52 ± 3.52, while females caused an SD of 1.15 ± 1.15 and a WD of 0.82 ± 0.82. In the pea treatment, females caused over 1% damage, with a mean SD of 1.80 ± 1.05 and a WD of 1.30 ± 0.81. Meanwhile, Lygus females in canola, males in peas, and both sexes in alfalfa caused less than 1% damage in both SD and WD metrics.

Although there were no statistically significant differences in the percentage of damage weight ($P = 0.47$) or seed damage ($P = 0.29$) between the plant treatments for either sex, modeling revealed a trend toward significance for canola. Specifically, the interaction between male Lygus and weight damage approached significance ($P = 0.0834$), while the percentage of seed damage for males also showed a near-significant trend ($P = 0.0578$).

According with the survey, several factors significantly influenced the overall composition of Lygus community. Year was a major factor, explaining 22.77% of the variation in species composition (PERMANOVA: F-value = 6.63, d.f. = XX, $P < 0.001$; Figures A1 to A5). There was also a significant interaction between Year and Crop District (CD), accounting for 40.74% of the variation (F-value = 1.76, $P = 0.002$). While Total Precipitation (TP) also played a role, its impact was less pronounced, explaining only 6.65% of the variation, suggesting that other factors, particularly Year and CD, had a stronger influence on species distribution. Conversely, Degree Days (DD) alone did not significantly affect species distribution ($P = 0.297$), and the interaction between Year, CD, and Soil was similarly insignificant ($P = 0.485$), indicating that these variables had a limited impact on the overall variation in Lygus species abundance.

However, the GLMM models reveal species-specific responses to DD, particularly for *Lygus lineolaris* and *Lygus borealis*. *L. lineolaris* showed a significant negative relationship with DD, indicating that higher temperatures may reduce its abundance, while *L. borealis* exhibited a positive response to DD. The contrasting responses of different species to DD highlight the need for species-specific management approaches. While temperature may not be a strong overall predictor of *Lygus* abundance, it can significantly affect individual species. These differences in thermal sensitivity suggest that climate change could differentially impact *Lygus species*, potentially leading to shifts in community composition over time.

Funders:

Western Grains Research Foundation, Saskatchewan Pulse Growers

Contact: teresa.ac@usask.ca , sean.prager@usask.ca

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9. Title: **Modelling High Priority Invasive Species Potential Range Expansion and Invasion Potential: Present and Future**

Authors: Tyler Wist, Sean Prager, Vivek Srivastava

Abstract: This project uses lab informed next-generation species distribution models (NG-SDMs) for the identification, surveying and monitoring of current and future risk areas under threat of invasion by agricultural insect pests that represent urgent threats in the Canadian prairie ecoregion. SDMs are a functional approach used to identify suitable areas for insect pest establishment. SDMs can be combined with climate models that project future conditions, providing forecasts for future potential of invasion and spread. Insect pest distribution maps generated from SDMs are effective risk depiction tools that inform farm managers about insect pest's probable outbreaks, establishment ranges, spread patterns and invasion potential to support strategic pest management. We've identified key insects in the top three field crops in Western Canada that could invade and are evaluating their potential to establish here.

Problem: The Canadian growing region is so large that we need to have best guesses to determine where to first look for potential insect establishments, such as spotted lanternfly, cabbage stem flea beetle, cereal grass aphids, lemon midge and established-in-Canada already insects like pollen beetle and pea aphids.

Objectives of Research: To model potential ranges, and range expansions under current and future climate conditions of established an not-yet-established insect pests.

Summary of Results:

We've modelled the distribution and spread of pea aphids under three future climate scenarios and under a cooling climate scenario, the range of pea aphids expands in North America but it contracts under both warming scenarios. We conducted growth chamber experiments to determine the minimum, optimum, and maximum temperatures to which pea aphids can survive at. We discovered that pea aphids can survive at temperatures as low as 6°C, and as high as 28°C, with 35°C resulting in nearly a 100% mortality rate. These findings were then incorporated into a "mechanistic" species distribution model, which was compared to a statistical correlative species distribution model mapped across North America. Additionally, we incorporated dispersal modelling into the correlative and mechanistic models to visualize how pea aphids are migrating into Saskatchewan from the state of Montana and spreading across the prairie provinces and throughout the United States. Finally, we evaluated how two future climate change scenarios (SSP 126 and 370) affect pea aphid habitat suitability. The models determined that as climate change intensifies, it negatively affects pea aphid survival and habitat suitability.

The potential of the recently introduced to North America, Cereal grass aphid, *Metapolophium cereaalium festucea*, was modeled for it's potential to establish in Canada based on 11 years of field data from the United States in the Pacific Northwest area where it has established. The results indicate a high likelihood of further eastward and southward expansion from the Pacific Northwest, particularly in wheat and cereal crop-producing regions, posing a threat to crop production.

We also modelled the potential distribution of invasive cabbage stem flea beetle (*Psylliodes chrysocephala*) and the pollen beetle (*Brassicogethes viridescens*). Species distribution models show increasing habitat suitability for both pests under current and future climate scenarios, with *B. viridescens* posing an elevated risk across the Canadian Prairies. However, phenological mismatches may limit *P. chrysocephala*'s long-term persistence.

Continuing Research: More field crop insects will be modelled for their potential to establish in Canada if they were accidently introduced.

Funders: Western Grains Research Foundation.

Contact: tyler.wist@agr.gc.ca or vivek.srivastava@agr.gc.ca

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10. Title: **Automated trap counting of Flea Beetles (FB), Aster Leafhoppers (AL) and Wheat Midge (WM), and automated FB damage assessment for canola crop.**

Authors: Abdul Bais (University of Regina), Shaun Sharpe (Agriculture and Agri-Food Canada), Tyler Wist (Agriculture and Agri-Food Canada)

Abstract:

Flea beetles damage canola leaves, stems, and flowers, significantly reducing yield. So it is necessary to take early steps to reduce the risk. For targeted treatment, the damaged crops' location and the severity of infection caused by FB need to be identified. This project proposes a method for detecting, classifying and counting FBs, ALs and WMs on insect traps. Additionally, it aims to assess the damage caused to canola plants by FBs for determining the economic thresholds through automatic means so that control strategies can be quickly implemented.

Problem: In Western Canada, FBs are the most critical pest for canola, leading to complete crop losses in unprotected canola. Only 1% damage per acre due to FBs can result in a $25 - $35 million crop loss. Annual control costs for FBs in North America exceed $300 Million (Knodel et al. 2017, North Dakota State Univ. Fact Sheet). Similarly, ALs can reduce canola crop production significantly. With growers and agronomists covering large areas, time is of the essence for insect (FBs, Aster leafhopper, and wheat midge) action, and any tool that can give growers an edge over them is essential. This research aims to replace traditional crop scouting with an automated image-based system.

Objective: This project develops deep learning models and image processing techniques for detecting and quantifying the damage caused by FBs to canola. Additionally, image-based insect detection and counting system will be developed, which will be able to monitor insect pest populations electronically. Additionally, a prototype solar-powered trap will be developed with a sensor mounted to take hourly images of the trap and be intelligent enough to recognize and count insects and transmit the results to a server over a cellular network. Finally, a correlational study of infestation with temperature, soil condition, and other weather conditions and their effects on these insect pest populations will be conducted. The proposed project will extend the work on FBs for other insects, such as ALs and WMs.

Summary of results:

1) Completed seedling-stage canola crop counting from RGB images captured with a ground-based camera system (3x years field data).
2) Drone images captured to assess the possibility of using drone-based imagery for flea beetle detection.
3) Developed models for detection and quantifying defoliation damage caused to canola due to FB feeding.
4) Tested the detection and counting of FBs captured on yellow sticky cards using solar powered traps.
5) Field deployment of Smart traps with the ability to generate counts to a CSV file confirmed. Two years of field data collected on flea beetle ecology with images and counts generated every 36 minutes
6) Wheat midge detection algorithm complete.
7) Aster leafhopper algorithm under development.

Continuing Research:

1) Algorithm for identification and detection of aster leafhoppers from yellow sticky card trap images ongoing.
2) Adding the FB damage quantification functionality into a mobile app for use on smart devices.

Funders: ADF

Contact: Abdul Bais (Abdul.bais@uregina.ca) and/or tyler.wist@agr.gc.ca

11. Title: **Continuing to Watch the Winds. Origin and arrival of migrant leafhoppers and diamondback moths to Canada.**

Authour and associates: Tyler Wist, (AAFC-Saskatoon), Tim Dumonceaux (AAFC Saskatoon), Chrystel Olivier (AAFC Saskatoon), Erl Svendsen (AAFC Saskatoon), Sean Prager (Dept of Plant Sciences, Usask) and Keith Hobson (Dept of Biology, University of Western Ontario).

Funder(s): Western Grains Research Foundation, Sask Canola

Abstract: Each year, aster leafhoppers (ALH) and diamondback moths (DBM) migrate into Western Canada and have the potential to spread aster yellows (ALH) and damage canola crops (DBM). ALH only damage canola if they are infected with the aster yellows phytoplasma (Ayp) and we've developed a highly sensitive and rapid method to detect the presence of Ayp in individual leafhoppers. In this continuation of the original project where we are determining the migratory source locations of ALH through wind trajectory monitoring, microsatellite markers and stable isotopes. We have identified **21 distinct haplotypes of diamondback moth using single nucleotide polymorphisms in the CO1 barcoding region.** Microsatellite markers indicated that aster leafhopper populations are mixed, likely due to migrations each year, and no genetically distinct populations were detected. The initial aster leafhopper migrants in 2021 had very low levels of aster yellows phytoplasma when they arrived, as did the 2022 migrants Into Saskatchewan. 2023 had a high percentage of infected aster leafhoppers. **36% of the 162 sweep samples had infected leafhoppers, with percentages where positive leafhoppers were found with a mean infection rate of 30.6 ±4.1 % ranging from 2.2% to 100%. When calculating the Aster Yellows Index this formula is used to create one number from leafhopper abundance and infectiveness (# ALH/100 sweeps x % infection = AY Risk)**, The AY Risk index that triggers a spray in carrots is 50 (Frost et el. 2013), and this was eclipsed by some of the AY Risk numbers of the migrant generation of aster leafhoppers in 2023, where there was a mean of **AY Risk of 433.5 ± 200.8 (range 33-6700, n-=33).**

Heavy hydrogen (deuterium) ratios in migrant leafhoppers as well as wind trajectories indicated an upper Great Plains origin of the migrating leafhoppers that come into Canada. Carbon isotope analysis indicated that 2020 and 2021 aster leafhopper populations grew on monocotyledonous plants like cereals and not broadleaf plants. **The winter wheat growing region of Kansas and Nebraska** is the likely source for aster leafhopper migrations into Canada each year with some variation on timing and distance of migration evident.

Problem/opportunity: Each year, aster leafhoppers (ALH) and diamondback moths (DBM) migrate into Western Canada and have the potential to spread aster yellows (ALH) and damage canola crops (DBM).

Objectives: Develop a rapid testing method for Ayp in aster leafhoppers and plants. Determine the migratory source origins of aster leafhoppers and diamondback moths. Determine the AY Risk index for Canola.

Summary of methods and results:

- Early season *M. quadrilineatus* immigration was monitored by 1) establishing a network of 40 sticky card sites in collaboration with the Saskatchewan Ministry of Agriculture's diamondback moth trap sites and 2) weekly sweep samples at sites around Saskatoon starting the last week in April. In 2022 and 2023, sweeps and yellow sticky cards were checked every two days on three driving loops for more precise data on leafhopper arrival.
- The typical migration of *M. quadrilineatus* to Saskatchewan occurs around the May long-weekend in most years. 2021 and 2022 aster yellows titers in aster leafhoppers were low and they were the highest that we've ever seen in 2023 (arrived May 23). Reports of higher-than-normal aster yellows in crops in 2024 suggests that we should have still been watching the winds in 2024 and that infected leafhoppers migrated that spring. The 2024 migration was in the first week of June with aster leafhoppers found on the 7th of June, 2024.
- Wind trajectories crossing over Saskatchewan were monitored throughout May and June using NOAA Hysplit Ready website. Great Plain wind trajectories blowing from South to North are the most likely winds that bring aster leafhoppers to the Canadian Prairies in all years and this was confirmed using deuterium ratios.
- 21 haplotypes within these samples. One main haplotype had 30 individuals and contained 54% of the total samples sequenced and it was the most common haplotype in all 4 years. Most of the other haplotypes had only a single individual.

Continuing research: We have finished "Watching the winds" and now finished "Still watching the winds…".

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12. Title: **Integrated pest management approaches for root aphids in quinoa**

Authour and associates: Tyler Wist, (AAFC-Saskatoon), Kaitlyn Watt (PMC Lethbridge"

Funder(s): Pest Management Research Centre PRR24-030

Abstract: *Pemphigus* sp. root aphids were widespread on all plants at all sites under quinoa production in Saskatchewan in the drought year of 2021. Little, not even a proper scientific name, is know about them. We attempted to establish a lab colony, which did not remain anholocyclic and had very little establishment of these root aphids in any of our field plots, rendering the treatments null.

Problem/opportunity:

Objectives: To evaluate various pest management tactics and develop integrated pest management solutions for quinoa root aphids and; to facilitate grower adoption through outreach materials and activities.

Quinoa (*Chenopodium quinoa*) is a specialty crop in Canada with the majority of production occurring in Saskatchewan. It is a commodity gaining popularity and increasing interest by growers, however, there is limited research on pests and pest control practices. At the 2023 Canadian Pest Management Priority Setting Workshop, root aphids (*Pemphigus* spp.) in quinoa were identified as a priority pest in need of integrated pest management (IPM) solutions. Root aphids feed on the roots of plants with their piercing and sucking mouthparts impacting the plants ability to uptake water and nutrients. The relationship between *Pemphigus* aphids and quinoa is poorly understood, and yield loss potential is unknown. The species naming is still pending.

To support quinoa growers with effective pest control options, this project is studying the interaction of root aphids with quinoa in Saskatchewan, and assess several management strategies currently used successfully to control sugar beet root aphids (a different species is present in quinoa, but same genus: *Pemphigus*) in sugar beet crops.

Field trials will be conducted in 2024 and 2025 at three locations in Saskatchewan to assess various approaches and combinations of IPM tactics to manage *Pemphigus* root aphids in quinoa. Controls and cultural practice treatments, including weed management, tillage, irrigation and a search for tolerant quinoa varieties, will be used to provide knowledge on the impacts of root aphids to quinoa production and effectiveness of control tactics. Greenhouse experiments will study the effect of varying water regimes to better understand the role of irrigation for root aphid suppression. This project will provide new knowledge on the impact of quinoa root aphids and the efficacy of using feasible management practices already adopted in sugar beets. Field days, factsheets, grower meetings, as well as media and scientific articles will facilitate outreach and knowledge sharing with the grower communities.

Summary of methods and results:

1.Conduct greenhouse trials to examine root aphid impacts on quinoa and better understand the role of water management in quinoa.

A root aphid lab colony was started from the few field-collected We determined the time that winged fundatrixs move onto quinoa when we found winged individuals on leaves, (July 5th 2024) and also the time that the winged individuals leave the quinoa. We observed that the winged root aphids burrowed into the soil around the roots, and so it is the winged adult fundatrixes that place the apterous root aphid nymphs onto the roots and do not simply leave nymphs on the surface to find their way to roots. Movement of these winged aphids was noted on roots July 5th 2024. Pan traps (lime green (RGB 74,243,41) with a peak spectrum at 525 nm was the most attractive pan trap colour for catching these aphids. The aphid colony was kept at 23 °C on summer light conditions (16:8 L:D) but this was not enough to keep them from getting wings and leaving the colony plants at the end of August. No lab experiments were possible.

2.Conduct field trials to develop IPM tactics (tillage, varieties, weed management, and irrigation) for the control of root aphids in Saskatchewan.

Two field sites were established to look at the effect of tillage, 4 commercially available varieties, presence/absence of alternate weed hosts (lambsquarters) and irrigation (Saskatoon only). Root aphid colonies did not establish at the Scott site and a very small number of colonies established at Saskatoon. No yield was taken from plots.

Engage in outreach and other knowledge and technology transfer activities.

Tyler spoke at the Scott field day (July 2024) about insects that afflict quinoa and highlighted this research trial.

Continuing research: Year two of this project will continue in 2025, hopefully with an irrigated site at Outlook as well.

Contact: Tyler.Wist@AGR.GC.CA or Caitlin.Watt@AGR.GC.CA

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13. Title: **Wheat Midge: Enhanced surveys and wheat resistance traits to preserve the *Sm*1 gene**

Authour and associates: Tyler Wist, (AAFC-Saskatoon), Curt McCartney, Alejandro Costamagna, Vincent Hervet

Funder(s): Canadian Wheat Research Coalition through the AgriScience Program - Cluster Component Project# SCAP-ASC-08 A17

Abstract: Two years of pheromone trapping data and data on midge larval abundance and kernel damage have been collected. Some novel forms of wheat-midge resistance are being added to current wheat varieties and two site years of Vesper x Carberry mapping population to discover a novel region for oviposition deterrence (OD).

Problem/opportunity: This project seeks to understand and incorporate several modes of resistance to wheat midge in spring wheat as well as investigate the ability of the wheat midge to overcome the *Sm*1 resistance gene and to clarify the nature of the interaction of resistance traits with the wheat midge. Enhancing surveillance of wheat midge across the Western Canadian wheat growing region will help us to better understand outbreaks and relate them to larvae and midge damaged kernels in fields as well as scout for potential populations of midge resistant to the *Sm*1 gene.

Objectives:

Objective 1: Enhanced surveillance of wheat midge and its parasitoids across the Western Canadian Prairies.

Objective 2. Pyramiding wheat midge resistance traits in a spring-wheat line.

Objective 2a. Create spring wheat lines that pyramid *Sm*1, EA, HG, and OD.

Enhanced antibiosis and *Sm*1 carrying lines are being selected as parent crosses with current spring wheat varieties that likely already have oviposition deterrence based on their parentage.

Objective 2b. Determine the impact of pyramiding Oviposition Deterrence (OD) + *Sm*1 plus EA, on the damage caused by wheat midge on newly created midge-tolerant DH lines compared to susceptible lines under field and laboratory conditions.

Objective 2c: Map novel oviposition deterrence in Vesper spring wheat.

Summary of methods and results:

Wheat midge pheromone traps were deployed at over 125 sites in 2023 and 2024. Trap cooperators entered data into a Google spreadsheet and we used that, in a newly created online ARC-GIS dashboard, to map the emergence timing and intensity of wheat midge populations. In 2023, we had 18 cooperators return wheat heads from fields for dissection for wheat midge larvae and midge-damaged kernels (MDK) and 37 in 2024.

The Vesper variety of wheat has a novel genetic region that gives it oviposition deterrence (OD) unlike other lines with OD. A mapping population of Vesper x Carberry crosses that have been genetically mapped previously were grown at the AAFC Brandon and Saskatoon farms to determine their midge-damaged kernel (MDK) profiles in 2024 following a seed increase in 2023 and are being dissected for MDK.

Continuing research: Three more years remain on this project. Contact: Tyler.Wist@AGR.GC.CA

14. Title: **Dissecting the molecular mechanism underlying the flea beetle resistance of *Camelina sativa***

Authors: Liyong Zhang, Isobel Parkin

Abstract: *Camelina sativa*, an oilseed crop from the Brassicaceae family, possesses a broad spectrum of resistance to common canola pests and pathogens. Especially, *C. sativa* is naturally immune to flea beetles, which commonly feed on brassica crops and cause devastating damage to young seedlings. However, there is very limited knowledge about the nature of *C. sativa's* complete resistance to flea beetles. Notably, *C. sativa* has a unique glucosinolate profile with longer carbon chain aliphatic glucosinolates (GSLs) compared to other brassica crops, however, *C. sativa* has almost no detectable GSLs present in the leaves (Czerniawski et al., 2021). We speculated that the unique tissue distribution and glucosinolate profile of *C. sativa* could play a role in its flea beetle resistance. The project uses CRISPR technology to modify the biosynthetic genes of the glucosinolate pathway in both *C. sativa* and *B. napus*.

Problem: As an allotetraploid and an allohexaploid, *B. napus* and *C. sativa,* respectively contain at least two or three orthologous copies corresponding to each glucosinolate biosynthetic gene identified from the model plant *Arabidopsis thaliana*.

Objectives of Research: Generate GSLs-free *C. sativa* and *B. napus* and/or modify the long carbon chain glucosinolate in *C. sativa*. And further to test the flea beetle feeding behavior on these gene edited lines.

Summary of Results: Comparison of glucosinolate-free *C. sativa* (courtesy Dr. Georg Holzl) and wild-type plants didn't reveal significant differences regarding flea beetle feeding. Ongoing experiments are assessing the impact of shortening the carbon chain for glucosinolate moieties on the glucosinolate profile in *C. sativa*. In addition, stark differences in flavonoid composition were noted between *C. sativa* and *B. napus* and gene edited lines have been developed in order to assess the role that flavonoids may play in insect resistance.

Continuing Research: Assessment of the feeding response of flea beetles on multiple gene edited lines of *C. sativa* and *B. napus* varying in their secondary metabolite profiles is continuing. In addition, very recent work, which stimulated flea beetle feeding on *C. sativa,* suggests that *C. sativa* may be missing a feeding cue. Further research is ongoing to confirm these preliminary results and to develop a strategy to remove the cue from *B. napus*.

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Contact: isobel.parkin@AGR.GC.CA