Canadian Agri-Science Cluster for Horticulture 3

Update to Industry

Semi-Annual – Spring 2021

Activity title: Development of Regional Management Strategies and Decision Making Tools for Control of Colorado Potato Beetle

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Activity Objectives (as per approved workplan):
OBJECTIVES: Our overall objective is to reduce economic losses to potato in Canadian growing regions due to the Colorado potato beetle (CPB). Specifically, we aim to determine local susceptibility of CPB populations to several classes of insecticides through a national resistance-monitoring network, improve resistance management, better characterize the molecular basis of developing resistance, and develop novel extension tools to improve management practices. To accomplish this, the deliverables are divided into four objectives as follows:

1. Determine susceptibility of Colorado potato beetle populations to multiple classes of insecticides in different potato growing regions in Canada;
2. Develop an interactive online mapping tool for growers to access results of susceptibility surveys to inform local decision making for optimal insecticide selection;
3. Identify molecular signatures of insecticide resistance that can be used to monitor the occurrence and spread of resistance in regional CPB populations and identify new pest control targets;
4. Develop a novel resistance monitoring tool for extension and diagnostic labs as a within-season decision making tool, based on molecular signatures of developing resistance

Research Progress to Date (use plain language, not to exceed 500 words):
Objective 1: In the 2020 field season, we leveraged the regional monitoring network we had established with project partners over the last three years to made significant progress. We developed a plan in collaboration with project partners to focus on priority CPB populations to monitor annual insecticide resistance and to maximize the impact of prior years' work towards describing the molecular basis of insecticide resistance.

In the summer of 2020, 16 CPB populations were obtained from project partners; AAFC Fredericton had capacity to receive 9 populations - PEI (5), Quebec (3), NB (1) - and AAFC London to receive 6 populations - Ontario (3) and Manitoba (3). In ON, MB, QC, and NB, populations were collected from locations previously sampled in 2019. In PEI, populations were selected based on availability. To date, this totals 84 populations of beetles screened from across several potato growing regions. Insecticides for resistance testing are selected in consultation with project partners, and

are updated annually. For 2020, each population was exposed two neonicotinoids (Titan™ and Actara®), two spinosyns (Delegate® and Entrust™) and two anthranilic diamides (Exirel® and Coragen™). Interpreting data from tests with Exirel® is difficult due to issues with expected susceptible mortality, but testing with Exirel® will resume in 2021.

In Manitoba, all populations tested showed reduced susceptibility or resistance to Actara® and Coragen™, as well reduced susceptibility was shown to Titan™ in 2/3 populations, and to spinosyns in 2/3 populations. In Ontario, one of the three populations remained resistant to neonicotinoids, while two were resistant to diamides. Populations in Quebec continue to show reduced susceptibility and development of resistance to the spinosyns Delegate® and Entrust™ respectively. Populations from PEI are also showing reduced susceptibility to the spinosyns. More detailed survey data is available to project partners upon request.

Objective 2: Development of the interactive online mapping tool is ahead of schedule. The mapping application will provide growers/industry the ability to access and obtain detailed results from the susceptibility survey in an interactive format that is web-accessible and easy-to-navigate. We are preparing for initial releases to project partners in 2022.

Objective 3: For the insecticide resistant and susceptible populations collected in 2019 in Ontario and Quebec, data analysis was possible during the pandemic close-down since the work could be performed remotely. Preliminary analysis of differential gene expression in the samples yielded a group of transcripts whose increased expression was correlated with the presence of resistance. Three resistant populations from Manitoba were obtained in 2019 and expression of the seven genes that were correlated with resistance in Ontario and Quebec populations were analyzed. The results confirmed that some of the genes were also upregulated in the Manitoba populations, further suggesting possible involvement of the selected genes in conferring resistance. Our focus going forward is repeating testing for the most resistant groups from the previous year, to investigate how resistance persisted and whether it was associated with the same genetic events.

Objective 4: Originally planned to be initiated in 2021-2022, deferred to 2022-2023 due to COVID-19.

Extension Activities (presentations to growers, articles, poster presentations, etc.):

Presentations

1. Vickruck, J., Scott, I., Donly, C., Hann, S., MacKinley, P., Krolikowski, S., Morin, P.J., and C.E. Moffat. 2021. Canada-wide assessment of insecticide resistance in the Colorado Potato Beetle, *Lepinotasa decemlineata*. The Northeast Potato Technology Forum (virtual), 23-24 March, 2021.

2. Ben Youssef, M., Dumas, P., Vickruck, J. and Morin, P. Jr. November 2020, online. Expression status of targets relevant to miRNA synthesis in Colorado potato beetles exposed to heat, chlorantraniliprole or imidacloprid. Entomology 2020— Entomological Society of America's Virtual Annual Meeting.

Magazine articles

Halsall, Mark. 2021. Which ones are resistant, and to what: Potato growers could soon be better-equipped to manage Colorado potato beetle insecticide resistance, thanks to new tools from AAFC. National Potato Guide: Crop Protection Solutions. 24pp. (interviewed project lead and co-lead)

Peer-reviewed articles

1. Favell, G., McNeil, J.N., Donly, C. (2020). The ABCB multidrug resistance proteins do not contribute to ivermectin detoxification in the Colorado potato beetle, *Leptinotarsa decemlineata* (Say), 11(2), http://dx.doi.org/10.3390/insects11020135

2. Bastarache, P., Wajnberg, G., Dumas, P., Chacko, S., Lacroix, J., Crapoulet, N., Moffat, C.E., Morin, P. (2020). Transcriptomics-based approach identifies spinosad-associated targets in the Colorado potato beetle, *Leptinotarsa decemlineata*, 11(11), 1-16. https://doi.org/10.3390/insects11110820

3. Scott, I.M., Hatten, G., Tuncer, Y., Clarke, V.C., Jurcic, K., Yeung, K.K.C. (2021). Proteomic analyses detect higher expression of c-type lectins in imidacloprid-resistant Colorado potato beetle *Leptinotarsa decemlineata* say, 11(1), 1-16. http://dx.doi.org/10.3390/insects12010003

COVID-19 Related Challenges:

AAFC Research and Development Centres ceased all but critical services mid-March 2020due to COVID-19. Until July 2020, only limited on-site field work activities were approved for AAFC researchers, in addition to critical activities such as insect rearing which have continued through the closure. No laboratory activities were approved until fall 2020.

COVID-19 affected this activity primarily by impacting factors related to Objective 1. Specific impacts were: delayed timing of when we normally receive live insect populations (resulting in some cases in excess insect mortality prior to testing), a reduction in the number of insect populations we could receive (due to staffing shortages/reduced time permitted in the lab), and lack of laboratory access to conduct molecular diagnostics from 2020 insect collections. However, we were able to make very good progress on Objective 1 by completing insecticide resistance testing for five insecticides in three classes, for sixteen populations of Colorado potato beetle from five provinces. We were also able to advance the development of the online mapping tool (Objective 2), which is now ahead of schedule. Remote bioinformatics work enabled analytical characterizations of the molecular basis of insecticide resistance (Objective 3) using data generated from prior years' gene expression and sequencing data. These analyses generate new knowledge of the molecular basis of insecticide resistance, and inform the prioritization for insect population sampling for the 2020 and upcoming 2021 field season. However, cascading impacts of COVID-19 mean that we were required to defer work on Objective 4 to 2022-2023.

Successes in 2020 – 2021 were achieved by ensuring frequent and clear communication across the AAFC science teams, a variety of project partners, stakeholders, and local AAFC management teams at London RDC and Fredericton RDC. We engaged early with project partners in participating provinces to ensure up to date communication and to develop multiple contingency plans to accommodate for the changing requirements and restrictions imposed by COVID-19. We developed alternate strategies of collecting/receiving insect samples and explored options for our partners to increase their contributions to the project. Our commitment to engaging with partners, keeping communication open, and developing contingency plans paid dividends. We were able to make substantial progress on the project due to our creativity and communication plan.

Key Message(s):

Despite challenges, delays and resulting changes to the workplan due to COVID-19, we have made very good progress in 2020 towards all project objectives planned for 2020-2021. Our ongoing success is largely due to participation from project partners across Canadian potato growing regions and our fantastic technical staff and students. We continue to monitor insecticide resistance of Colorado potato beetle, work towards meeting each project deliverable on time and provide updates to industry. We are always happy to be contacted to further discuss regional stakeholder needs and how our workplans can be tailored to changing management practices.

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