# Canadian Agri-Science Cluster for Horticulture 3

# Update to Industry

## Final Report – 2018 – 2023

**Activity title:**
Generate and Evaluate Integrated Pest Management Tools for Wireworm Control in Potatoes in Canada

**Name of Lead Researcher:**
Dr. Christine Noronha, AAFC

**Names of Collaborators and Institutions:**
Dr. Wim Van Herk (AAFC- Agassiz Research and Development Centre)
Dr. Gerhard Greis (Simon Fraser University)
Dr. Haley Catton (AAFC- Lethbridge Research and Development Centre)
Jessica Vickruck (AAFC Fredericton Research and Development Centre)
Dr. Ian Scott (AAFC- London Research and Development Centre)
Dr. Andrew Mackenzie-Gopsill (AAFC- Charlottetown Research and Development Centre)

**Activity Objectives:**
Objective 1: Test the efficacy of new insecticides to control wireworms and click beetles.
Objective 2: Evaluate an integrated approach to manage wireworm damage.
Objective 3: Identify and apply novel click beetle monitoring tools.
Objective 4: Surveillance of click beetle expansion in Canadian potato growing regions.

**Research Progress & Results:**
Considerable progress was made over the five years duration of the project.

***Objective 1: Test the efficacy of new insecticides to control wireworms and click beetles***.
Field trials were conducted in PEI, ON and BC to evaluate the efficacy of the 8-10 registered and unregistered insecticide to reduce wireworm damage in potatoes and rotation crops. These candidate insecticides were evaluated against the industry standard for wireworm control Thimet (Phorate) and Titan (Clothianidin), Actara (Thiamethoxam) and Force (Tefluthrin). Results from these trials were used by PMRA and resulted in a new active Cimegra and Terraxa (Broflanilide) being registered for wireworm control in potatoes and cereal grain and corn. This Active was found to kill wireworms unlike other insecticides that only paralyze the insect. Efficacy evaluation of other registered and unregistered products continued over the duration of the project.

***Objective 2. Evaluate an integrated approach to manage wireworm damage.***
There were 6 areas of investigation under this objective.

Field trials were set up in Ontario and PEI to find the wireworm suppressive qualities of 5 rotational crops and crop mixes on different wireworm species. Results showed that growing Buckwheat, Brown Mustard and seed mixes including buckwheat prior to potatoes suppressed populations of Aeolus mellilus in Ontario and Agriotes sputator and hypnoidus abbreviates in PEI. Suppression of wireworms was seen irrespective of crop management practices e.g., crop

being mowed or disked into the soil as a green manure. Flax and Sorghum Sudangrass were also evaluated in field trials and compared with Buckwheat and Barley. Wireworm damage to potato tubers was lowest following buckwheat and sorghum sudangrass grown the year preceding potatoes. Flax and Barley did not decrease wireworm damage in PEI similarly, potato damage was 50% less in sorghum versus barley plots in Ontario.

Wireworm rotational crops, buckwheat and brown mustard, were evaluated for weed suppression and seedbank. Buckwheat was found to suppress the density of all weed species more than other cover crop treatments. Buckwheat showed a significant carry-over effect in the potato year with significantly less lamb's quarters. This trend continued 8 weeks after hilling where buckwheat and brown mustard continued to give greater suppression of lamb's quarters than other cover crop treatments.

To prevent buckwheat and brown mustard seed carryover, the termination method of these crops was studied. Buckwheat via mowing, discing or glyphosate gave significantly greater weed suppression than using a roller-crimper while brown mustard terminated by discing or glyphosate provided significantly greater weed suppression than mowing or use of a roller-crimper. Neither method of termination nor cover crop type had an impact on yield parameters of potato in the following season.

An approach to enhance wireworm damage protection by combining cover crops and entomopathogenic fungi was investigated. Seeds of three crops (buckwheat, and brown mustard and Barley were treated with the entomopathogenic fungi *Metarhizium brunneum*. Potato baits placed after termination of the cover crops revealed no difference in potato feeding damage by the presence of the entomopathogenic fungi.

The damage potential of three prairie wireworm species to wheat was studied. *L. californicus* and *S. a. destructor* were found to significantly reduced wheat biomass. Damage by *L. californicus* was more serious during the early stages of wheat growth and *S. a. destructor* damages larger seedlings. *Hypnoidus bicolor*, and *Aeolus mellillus* did not affect wheat seeds. This highlights the importance of developing monitoring tools to find the species present.

Our studies on movement found that wireworms can move 3.6 meters in 24h to a food source this information is helpful when placing bait traps to check wireworm populations. Studies on vertical movement found that in the Fall, wireworm move 80cm within the soil profile to overwinter, thus escaping freezing. They return to the surface in the spring when soil temperatures reach 10-12℃. thus to obtain accurate measurement of the population bait trapping should not be conducted until soil temperatures are above 12℃ in the spring.

Comparison of bait traps vs soil sampling for wireworm monitoring under different cover crop conditions showed that bait traps are a more effective wireworm sampling method.

***Objective 3: Objective 3: Identify click beetle monitoring tools.***

New sex pheromones for six key wireworm species i); ii) *L. californicus*; and iii) *L. infuscatus*; iv) *Agriotes mancus*; v) *A. ferrugineipennis*; vi) *Selatosomus destructor.* Limoniic acid and its analogue were evaluated in field experiments at 27 sites across North America. The data show that *L. californicus*, *L. canus*, *L. infuscatus*, and *L. agonus* are all attracted to limoniic acid and to the analogue and other elaterid pest species such as *Selatosomus aeripennis destructor*, *Hypnoidus bicolor*, *Aeolus mellillus*, and *Agriotes lineatus* that co-inhabit the same sites were not deterred. These results show that the development of generic pheromone-based monitoring and management tools for multiple click beetle species may be possible. Limoniic acid—the pheromone for various Limonius pest species—is now being used by Syngenta Crop Protection in Washington, and by crop consultants in central California. Pheromone for *Agriotes mancus* is now being used to monitor this species in Ontario, Quebec, Newfoundland, and Nova Scotia.

***Objective 4: Surveillance of click beetles.***

There are approximately 20 pest wireworm species on Canadian farmland, but their presence differs between regions. To determine where these species occur, grower and other collaborator sent larvae from areas where they caused crop damage, to Agassiz for identification. This resulted in a fairly complete picture of the areas where these species occur. Distribution maps, for the pest species of Alberta, Saskatchewan, and Manitoba have also been published on the Prairie Pest Monitoring Network website; for the invasive Agriotes pest species in BC were prepared for the Asia-Pacific Entomologist publication, and for the pest species of Ontario and Quebec have been completed.

In Prince Edward Island, two province wide surveys of click beetle's pest species were conducted in 2019 and 2022 and a distribution and population maps were created. Changes in the population in any given area were linked to the use of management tools. A significant decline in the population was noted in 2019 compared to earlier surveys, with a further decline in 2022.

**Key Message(s):**

1) A new insecticide to control wireworms was registered using efficacy data generated through research from this project.
2) A better understanding of management of wireworm suppressive cover crops, and evaluation of other potential suppressive cover crops.
3) Information on the weed suppressive qualities on Buckwheat.
4) Added information on the destructive ability of different wireworm species in small grain crops.
5) Added information on the movement of wireworms and best time to bait.
6) Found pheromones for 7 key wireworms' species.
7) Distribution maps of key wireworm species BC, AB, SK, MB, ON and Quebec and PEI.
8) Potential impact of IPM techniques on populations in PEI.
9) Guide for Prairie wireworms completed. Guide for wireworms' management is in preparation.

**Overall benefit to industry:**

1) The industry now has another insecticide to control wireworms in potatoes and in small grain crops use during the rotation year. This helps control wireworms not only in the potato year but also in the rotation crop year. This insecticide kills wireworms.
2) We now know that Buckwheat, mustard and sorghum Sudan grass suppress different wireworm species in Ontario and PEI. Flax does not suppress wireworm damage when grown one year prior to potatoes.
3) It was also found that Buckwheat's suppress effects on lamb's quarters carries over in the potato years. This crop also reduces the weed seed bank within the field. Knowledge was also increased on the best timing to mow buckwheat that will prevent seed maturity and prevent seed carryover for the following year.
4) Two prairie two species *L. californicus* and *S. a. destructor* were found to significantly reduced wheat biomass. *L. californicus* was found to be a serious pest of wheat during the early stages of growth and *S. a. destructor* appears to be able to harm larger seedlings while *L. californicus* did not. *Hypnoidus bicolor*, and the most active wireworm species (*Aeolus mellillus*) did not affect wheat seeds. This highlights the importance of developing monitoring tools for the different species. knowing the destructive species will help farmers plan on the crop put in certain fields.
5) Added information on movement of wireworms in the soil and their response traps. This information will help growers in knowing the best time to place a bait in the field. Studies on vertical movement has enabled the understanding of when wireworm come to the surface in the spring and move down in the fall this information will help in monitoring populations by knowing the right time and soil temperature that is needed when baits are placed in the field to estimate the population.
6) Found pheromones for 7 key pest species. This is a big breakthrough for industry as it is important to know the species in the field to make decisions on management techniques to implement. Pheromones play and key role in monitoring species in the area and getting a better idea of populations fluctuations and increases in a particular area and field. The discovery of limonic acid that can potentially be used to monitor many species at the same time is particularly important as it would require just one trap to monitor the presence and populations size of several beetle species.
7) The distribution maps help industry know the destructive species in their area and can help plan on management strategies.
8) In PEI, the distribution maps have helped farmers understand the spread of this invasive species and how effective of the management strategies were in reducing the population. In PEI, a decrease in the population back to 2012 levels was seen which may be attributed to the use of suppressive crops and insecticides during the potato phase.
9) A guide on Prairie wireworms identification was published and a new guide on the wireworm management based on the knowledge gained during the wireworm cluster project is in preparation and we expect to have it completed by the end of 2023.

This project is generously funded through the Canadian Agri-Science Cluster for Horticulture 3, in cooperation with Agriculture and Agri-Food Canada's AgriScience Program, a Canadian Agricultural Partnership initiative, The Fruit & Vegetable Growers of Canada and industry contributors.

CANADIAN AGRICULTURAL PARTNERSHIP
Innovate. Grow. Prosper.

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

GROWERS OF CANADA | PRODUCTEURS DU CANADA