Canadian Agri-Science Cluster for Horticulture 3

Update to Industry

Semi-Annual – Spring 2022

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 (Agassiz Research and Development Centre)
Dr. Gerhard Greis (Simon Fraser University)
Dr. Haley Catton (Lethbridge Research and Development Centre)
Dr. Ian Scott (London Research and Development Centre)
Dr. Andrew Mackenzie-Gopsill (Charlottetown Research and Development)
Dr. Jessica Vickruck (Fredericton Research and Development Centre)

Activity Objectives (as per approved workplan):
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 to Date (use plain language, not to exceed 500 words):
Objective 1: Insecticides efficacy trials were conducted in PEI and BC. Cimegra appeared to provide better tuber protection than thimet in BC and in PEI. No trails were conducted in Ontario.

Objective 2: PEI - Tuber damage following a two year rotation with barley, flax, sorghum sudangrass and buckwheat showed significantly lower damage and higher marketable yield following the buckwheat rotation. 2) A mixed cover crop trial (12.5% sorgham sudangrass, peas, fodder radish, and phacelia mixed with either 25% buckwheat, centennial mustard, terminator mustard, or barley (control)) and planted in a tilled and no-tilled plots was initiated. Preliminary results showed that Centennial mustard in the mix increase the biomass of sorghum sudangrass, buckwheat and phacelia. Potato damage will be assessed in 2022.
ON: Five cover crops treatments (barley, buckwheat, 50:50 barley: buckwheat, sorghum-Sudan grass, and brown mustard) were tested. Soil cores were collected in each plot to assess nutrients and the microbiome. Potato bait results indicate that potato damage was 50% less in sorghum versus barley plots. Potatoes will be planted in the same plots to assess wireworm population post-cover crops in 2022.
PEI: Buckwheat and brown mustard cropping sequence combinations effect on weed suppression were assessed. Weed density and biomass was highly suppressed in all four crop combinations. Preliminary data suggests that brown mustard when planted as the second crop in a season reduced weed seed germination in the subsequent crop. Thus, all combinations of buckwheat and brown mustard are effective at suppressing weeds and planting brown mustard as a second crop reduces the weed seedbank. To minimize volunteer buckwheat, a field trial to define the critical period for weed seed control (CPWSC) conducted in PEI showed that buckwheat produced seed 42 days after planting with maximum seed production at 70 days. Terminating the crop at the appropriate time can reduce volunteer buckwheat.
In Alberta wireworms were field-collected in the spring and stored live in the lab. Greenhouse experiment with multiple repetitions were initiated. The experiment measured and compared feeding damage of the 5 Prairie pest species on

wheat seeds and seedings and 1.5 repetitions were completed in January-March 2022.

Objective 3: Click beetles were collected and used for pheromone identification at Simon Fraser University. Prospective new pheromones were field tested for *Agriotes mancus* in QC and ON and *A. ferrugineipennis* in BC. Successful field tests were conducted for *L. canus, L. infuscatus, L. californicus* in BC, Alberta, Washington, and Montana and for *L. agonus* in Ontario. Light traps emitting different wavelengths were field tested in Pemberton BC to determine which are most attractive to click beetles. Pest species appear to differ in their response to different wavelengths.

Objective 4: Wireworm specimens (~200) from the Prairies were received for ID. Click beetle specimens (>250,000) collected in southern BC, Alberta, Ontario, Quebec, Washington, and Montana, are currently being identified to species by van Herk, with assistance from Dr. Hume Douglas and Drs. Frank Etzler, Frank Ramberg, and Scott Gilmore. Click beetle were collected and identified from 15 sites in New Brunswick.

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

Noronha, C., Lorraine MacKinnon, Carol Banks and Sebastian Ibarra. 2021. Surveillance Of Click Beetle Populations On PEI. Entomological Society of Canada Annual Meeting (virtual meeting), November 17th 2021. (30 participants)

J Saguez, K Singleton, E Lemke, L Nadeau-Lachance, A Cornellier, S Chaussé, M Neau, W van Herk. Utilisation de pièges à phéromones pour la capture de taupins. La Société d'entomologie du Québec (November 25 2021) (virtual meeting) (50 participants)

K Singleton, R Gries, SK Alamsetti, W van Herk, J Saguez, E Lemke, G Gries. Identification of sex-pheromones of two Nearctic *Agriotes* species (Coleoptera: Elateridae). Entomological Society of Canada (18 November 2021) (virtual meeting) (60 participants)

E Lemke, W van Herk, G Gries, K Singleton, J Saguez. Investigating mechanisms of reproductive isolation between *Limonius* congeners (Coleoptera: Elateridae) and testing of 'catch-all' click beetle pheromone lures. Entomological Society of Canada (18 November 2021) (virtual meeting) (60 participants)

E Lemke, W van Herk, G Gries, K Singleton. Investigating mechanisms of reproductive isolation between *Limonius* congeners (Coleoptera: Elateridae) and testing of 'catch-all' click beetle pheromone lures. Entomological Society of America (31 October – 3 November 2021) (virtual meeting) (60 participants)

K Singleton, R Gries, SK Alamsetti, W van Herk, J Saguez, I Scott, E Lemke, G Gries. Identification of sex-pheromones of two Nearctic *Agriotes* species (Coleoptera: Elateridae). Entomological Society of America (31 October – 3 November 2021) (virtual meeting) (60 participants)

W van Herk, B Vernon, EA Lemke, G Gries, K Singleton. Use of sex pheromones for wireworm (Coleoptera: Elateridae) management in Canada. Entomological Society of America (31 October – 3 November 2021) (virtual meeting) (60 participants)

E Lemke, W van Herk, G Gries, K Singleton. Investigating mechanisms of reproductive isolation between *Limonius* congeners (Coleoptera: Elateridae) and testing of 'catch-all' click beetle pheromone lures. Entomological Society of BC (20 October 2021) (virtual meeting) (75 participants)

K Singleton, R Gries, J Saguez, E Lemke, W van Herk, G Gries. Identification of sex-pheromones of two Nearctic *Agriotes* species (Coleoptera: Elateridae). Entomological Society of BC (21 October 2021) (virtual meeting) (75 participants)

K Furtado, K Singleton, A Blake, W van Herk, G Gries. Testing attraction of click beetles (Coleoptera: Elateridae) to green and UV light. Entomological Society of BC (19 October 2021) (virtual meeting) (75 participants)

K Singleton, A Blake, W van Herk, G Gries. Spectral sensitivity of North American pest click beetle species (Coleoptera: Elateridae). Early Career Living Light Conference (22-23 September 2021) (virtual meeting) (40 participants)

E Lemke, W van Herk, G Gries, K Singleton. Communication ecology of pest *Limonius* species (Coleoptera: Elateridae) in North America. International Society of Chemical Ecology (virtual meeting) 9 Sept 2021. (40 participants)

K Singleton, R Gries, S Alamsetti, J Saguez, E Lemke, W van Herk, G Gries. Identification of candidate sex-pheromone components of two Nearctic *Agriotes* species (Coleoptera: Elateridae). International Society of Chemical Ecology (virtual meeting) 9 Sept 2021. (40 participants)

W van Herk, B Vernon, G Gries, R Gries, E Lemke, K Singleton. Use of sex pheromones for wireworm (Coleoptera: Elateridae) management in Canada. International Society of Chemical Ecology (virtual meeting). 9 Sept 2021. (40 participants)

W van Herk, T Mitchell, B Vernon, E Lemke, J Serrano "New tools for wireworm monitoring and management" Entomological Society of America—Pacific Branch (online). 5 April 2021. (40 participants)

EA Lemke, W van Herk, G Gries, R Gries, J Serrano, H Catton, K Wanner, P Landolt, W Cooper, S Meers, A Rashed, J Smith, S Kumar,F Etzler. "Limoniic acid as a sex attractant of *Limonius* spp. (Coleoptera: Elateridae) pests across North America" Entomological Society of America—Pacific Branch (online). 5 April 2021. (40 participants).

McKenzie-Gopsill A, MacDonald N, Anderson L, White S, Noronha C (2022) The potato vine crusher – A new tool for harvest weed seed control. Canadian Weed Science Society/Weed Science Society of America Joint Meeting, Feb 22-24th 2022, online. (50 participants)

INDUSTRY PRESENTATIONS

Noronha C, W van Herk. Integrated Wireworm Management in Potatoes. SSPGA Saskatoon (10 August 2021) (virtual meeting) (50 participants)

Christine Noronha 2022. A Sustainable Approach To Wireworm Management In Agricultural Crops SaskOrganics, and Organic Alberta virtual meeting March 3 & 4 virtual. (50 participants)

Christine Noronha, W van Herk, H. Catton, I, Scott, A, Mackenzie Gopsill, J. Vickruck . 2022. Wireworm Management Strategies – A Cross-Country Look. 64th annual Lower Mainland Horticultural Improvement Association (LMHIA short course). March 31- April 2. (50 participants)

Christine Noronha. 2022. A review of tools available for wireworm control and monitoring. International Potato Expo PEI. March 30-31. (100 participants)

W van Herk. Wireworm management in field vegetables. Lower Mainland Horticultural Improvement Association, Growers' Short Course (Abbotsford, BC) 31 March 2022. (hybrid meeting). (50 participants)

T Wist, W van Herk. The ravagers of wheat: from midge to wireworm. Saskatchewan Soils and Crops (March 9 2022) (hybrid meeting). (200 participants)

K Singleton, W van Herk. Pheromone lures to monitor displacements of native click beetle pests on BC farmland by invasive click beetle species. Invasive Species Council of BC (February 16 2022) (virtual meeting) (50 participants)

McKenzie-Gopsill AG. 2022. Weed management from the market garden to the watershed. Pisquid River Enhancement Project Annual General Meeting. Apr 11th 2022, St Joaquim's Chapel, Vernon River PE Canada (35 participants)

Catton, H. 2021. Wireworms: what's new and what's next. Invited speaker at 2021 Saskatchewan Insect Management Council Annual Meeting, Virtual. December 8, 2021.

van Herk W, Catton H, van Herk. 2022. Wireworm management in Canada: new tools. Invited talk. University of Saskatchewan Soils and Crop Workshop. Virtual. March 8, 2022. (200 participants)

Catton H, van Herk. 2022. Biology and management of pest wireworms in Canadian crops. Invited talk. Canadian Society of Agronomy Brown Bagger Agronomy Series: Pest Management. Virtual. March 25, 2022. (60 participants)

MEDIA INTERVIEWS

P.E.I. research digs into wireworm behaviour to help fight costly pest Nancy Russell · CBC News June 18, 2021
https://www.cbc.ca/news/canada/prince-edward-island/pei-wireworm-behaviour-research-1.6069053

P.E.I. potato growers have new pesticide to fight wireworm Nancy Russell · CBC March 4, 2021
https://www.cbc.ca/news/canada/prince-edward-island/pei-new-pesticide-wireworm-potatoes-1.5935366

The life cycle, management, and research of wireworms with Dr. Haley Catton. Podcast interview. Sask Wheat, Wheat Profit Podcast, March 24, 2021.
https://anchor.fm/saskwheat/episodes/The-lifecycle--management--and-research-of-wireworms-with-Dr--Haley-Catton-ete6ja/a-a51rch5

Wily wireworms and tips for managing them. Podcast interview. Inputs: the Podcast, by Top Crop Manager. Episode 33, July 6, 2021.
https://inputs-by-top-crop-ma.captivate.fm/episode/wily-wireworms-and-tips-for-manage-them

RealAg Radio, May 31: Flea beetles, scouting, wireworms, and assessing frost. Episode 122, May 31, 2021.
https://www.realagriculture.com/2021/05/realag-radio-may-31-flea-beetles-scouting-wireworms-and-assessing-frost/

Oosterhuis, K. 2021. Wheat School: Scouting for wireworms is key for future control. Wheat school, Season 12 (2021) Episode 21. Real Agriculture, May 26, 2021.
https://www.realagriculture.com/2021/05/wheat-school-scouting-for-wireworms-is-key-for-future-control/
https://www.youtube.com/watch?v=P37lPAxl3WM

Barnard, A. 2021. Know your enemy. Top Crop Manager West Magazine April 2021: 22-24.
http://magazine.topcropmanager.com/publication/?m=1031&i=700327&p=22&pp=1
https://www.topcropmanager.com/know-your-enemy/

Arnason R (2021) Drones put to work studying wireworm damage in Alberta. Western Producer. May 20, 2021.
https://www.producer.com/news/drones-put-to-work-studying-wireworm-damage-in-alberta/

Arnason R (2021) Got wireworms? There's a guide for that. Western Producer. September 30, 2021.
https://www.producer.com/crops/got-wireworms-theres-a-guide-for-that-2/

Cottee E (2021) Bug bible: visual guide will he lp Prairie farmers monitor and manage wireworms. GrainsWest Magazine. November 10, 2021.
https://grainswest.com/2021/11/bug-bible/

Prairie wireworm field guide. Bug of the Month, Farming Smarter. (text adapted from AAFC Weekly Science Story)
https://www.farmingsmarter.com/new-prairie-wireworms-field-guide/
November 22, 2021.

Unglesbee, E. (2021). How wireworms play the long game. Progressive Farmer magazine Featured in article in USA agricultural media. June 2, 2021.
https://www.dtnpf.com/agriculture/web/ag/crops/article/2021/06/02/trouble-kicking-fields-wireworm

Arnason A (2022) Science looks for new ways to control wireworms. Western Producer. March 31, 2022.
https://www.producer.com/news/science-looks-for-new-way-to-control-wireworms/

Kalinowski, T. 2021. Wireworm a threat to local cereal crops. Lethbridge Herald, June 2, 2021.
https://lethbridgeherald.com/news/lethbridge-news/2021/06/02/wireworm-a-threat-to-local-cereal-crops/

Campbell Q (2022) Study examining wireworms and impact on southern Alberta farmers. Global News Lethbridge (video and article), March 22, 2022.

https://globalnews.ca/news/8702204/wireworm-study-southern-alberta-farm-crops/

Products developed

Catton H, van Herk W, Saguez J and Svendsen E (2021) Guide to pest wireworms in Canadian Prairie field crop production. Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada.
English: https://publications.gc.ca/site/eng/9.900365/publication.html
French: https://publications.gc.ca/site/eng/9.900369/publication.html
1,827 hard copies copies distributed as of May 10, 2022 (1,781 English copies, 46 French copies).
Download numbers on publications.gc.ca are not available. Number of reads on ResearchGate are 318 (English) and 65 (French).

SCIENTIFIC PUBLICATIONS

van Herk W, Vernon B, Bourassa-Tait G, Tóth M, Kovacs E. (2022) Field evaluation of selected plant volatiles and conspecific pheromones as attractants for *Agriotes obscurus* and *A. lineatus* (Coleoptera: Elateridae). Insects *13*(2), 173 https://doi.org/10.3390/insects13020173

van Herk WG, Vernon RS, Borden JH, Ryan K, Mercer G. (2022) Comparative evaluation of pitfall traps for click beetles (Coleoptera: Elateridae). J. Econ. Entomol. 115(2): 582-591 https://doi.org/10.1093/jee/toab259

Drahun I, Wiebe FK, Gohl P, Koloski CW, Koiter AJ, van Herk WG, Cassone BJ. (2021) Three years of surveillance associates agro-environmental factors with wireworm infestations in Manitoba, Canada. Pest Management Science 78: 369-378 http://doi.org/10.1002/ps.6650

Gries R, van Herk W, Alamsetti SK., Catton H, Meers S, Otani J, Gries G (2021). (*Z*,*E*)-α-Farnesene – sex pheromone component of female click beetle *Selatosomus aeripennis destructor* (Brown) with intra- and inter-sexual communication function. Entomol. Exp. Appl. https://doi.org/10.1111/eea.13142

van Herk WG, Lemke E, Gries G, Gries R, Serrano JM, Catton H, Wanner K, Landolt PJ, Cooper WR, Meers S, Nikoukar A, Smith JL, Alamsetti SK, Etzler FE. (2021) Limoniic acid and its analogue as trap lures for pest *Limonius* species (Coleoptera: Elateridae) in North America. J. Econ. Entomol. 114: 2108-2120. https://doi.org/10.1093/jee/toab154

van Herk WG, Vernon RS, Acheampong S, Otani J, Uloth K. (2021) Distribution of two European elaterids, *Agriotes obscurus* and *A. lineatus* in British Columba: New records, and potential implications of their spread. Journal of Asia-Pacific Entomology 24: 688-694. https://doi.org/10.1016/j.aspen.2021.06.001

van Herk WG, Vernon RS, Richardson J, Richardson M, Beaton A. (2021) Evaluation of pheromone traps and lures for trapping male *Agriotes sputator* (Coleoptera: Elateridae) beetles in eastern Canada. Florida Entomologist 104: 42-50. https://doi.org/10.1653/024.104.0107

van Herk WG, Vernon RS, Labun T, Sevcik M, Schwinghamer T. (2021) Distribution of pest wireworm (Coleoptera: Elateridae) species in Alberta, Saskatchewan, and Manitoba (Canada) Environmental Entomology 50: 663-672. https://doi.org/10.1093/ee/nvab006

Gries, R, Alamsetti S.K., van Herk, W.G., Catton, H, Meers, S., Lemke, E., Gries G. (2021). Limoniic acid - major sex pheromone component of the click beetles *Limonius canus* and *L. californicus.* Journal of Chemical Ecology https://doi.org/10.1007/s10886-020-01241-y.

Drahun I, Wiebe K, Koloski C, van Herk W, Cassone B. (2021) Genetic structure and population demographics of *Hypnoidus bicolor* (Coleoptera: Elateridae) in the Canadian Prairies. Pest Management Science https://doi.org/10.1002/ps.6255

COVID-19 Related Challenges:
COVID induced restrictions to field work and laboratory access continued to be a challenge. It impacted planned greenhouse experiments at Lethbridge RDC which were delayed until January 2022. Longer wireworm development experiments were too high risk and were changed into shorter feeding experiments.
Action Plan: 1.5 repetitions were completed in January-March 2022, and will be repeated again in fall 2022.

Key Message(s):
The sex pheromones for **six** native click beetle pest species have been identified to date, thanks to the funding received for this project. This is a huge advance in our understanding of the attractants for these pest species, and will enable us to develop new tools for monitoring and managing them in the future.
- In the process of completing this work, we have also shown that *Agriotes sputator*, the key wireworm pest species in PEI and Nova Scotia, is now present (and well established!) in western Quebec (i.e. Montreal), and likely to pose a significant risk to agriculture in central Canada and adjacent regions in the USA.
- Also in the process of this work, we have developed a new monitoring trap for click beetles (particularly for flying species such as *Limonius* spp.), to be commercially available later in 2022.

Field guide for pest wireworms on the Prairies published in 2021. Lots of interest from producers and agricultural media in the guide.

This project under the Canadian Agri-Science Cluster for Horticulture 3 is funded in part by the Government of Canada through the Canadian Agricultural Partnership's AgriScience Program, a federal, provincial, territorial initiative, with support from the Fruit and Vegetable Growers of Canada (formerly the Canadian Horticultural Council) and industry contributors.

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