Canadian Agri-Science Cluster for Horticulture 3

Update to Industry

2020-21 – Semi-Annual

Activity title: CanPEDNet – The Canadian Potato Early Dying Network

Name of Lead Researcher: Mario Tenuta

Names of Collaborators and Institutions:
Non-AAFC: Khalil Al-Mughrabi, Department of Agriculture, Aquaculture and Fisheries; Ryan Barrett, Prince Edward Island Potato Board; Sebastian Ibarra, PEI Department of Agriculture and Fisheries; Katrina Jordan, University of Guelph; Mathuresh Singh, Agricultural Certification Services; Dmytro Yevtushenko, University of Lethbridge; Herve van der Heyden, Phytodata.

AAFC: Dahu Chen (lead for AAFC team), Fredericton Research and Development Centre; Tanya Arseneault, Saint-Jean-sur Richelieu Research and Development Centre; Louis-Pierre Comeau, Fredericton Research and Development Centre; Claudia Goyer, Fredericton Research and Development Centre; Benjamin Mimee, Saint-Jean-sur Richelieu Research and Development Centre; Oscar Molina, Morden Research and Development Centre; Judith Nyiraneza, Charlottetown Research and Development Centre; Cameron Wagg, Fredericton Research and Development Centre.

Activity Objectives (as per approved workplan):
Sub-activity 1 (SA1): Verticillium and root lesion nematode survey and relation to PED disease and yield [Barrett, Chen, Ibarra, Jordan, Tenuta, van der Heyden, Yevtushenko]
This activity aims to determine the species and population levels of the major causal agents of PED (Verticillium and root lesion nematode) in commercial potato fields and their impact on PED disease symptoms and yield.

Sub-activity 2 (SA2): characterization of isolates of V. dahliae and V. albo-atrum [Arsenault]
This sub-activity is to characterize isolates of *V. dahliae* and *V. albo-atrum* from the major potato producing provinces in Canada obtained in SA1 for aggressiveness to cause PED in cv. Russet Burbank.

Sub-activity 3 (SA3): Root lesion nematode species and interaction with V. dahliae isolates [Mimee]
This sub-activity is to identify parasitic nematodes to the species level in major potato production provinces of Canada. Determine if the population of *Pratylenchus penetrans* is genetically homogenous or if sub-populations could be related to PED disease symptoms.

Sub-activity 4 (SA4): Other soil-borne pathogens associated with the PED complex [van der Heyden]
This activity will determine the population levels, distribution and co-distribution of other soil-borne diseases associated with the PED complex.

Sub-activity 5 (SA5): Validation of real time PCR protocol for Verticillium quantification in soils across Canada [Singh]
This activity will validate the standardized polymerase chain reaction (PCR) protocol developed in GF2 for quantification of *Verticillium*'s deoxyribonucleic acid (DNA) in soil.

Sub-activity 6 (SA6): Reducing analysis variability through development of high-throughput system for large soil samples [van der Heyden]

This activity aims at developing a high through-put DNA-based platform for quantification of soil-borne pathogens using large sample sizes.

Sub-activity 7 (SA7): PED control through disease control products [Al-Mughrabi, Jordan, Molina]
This activity will assess the potential to control PED through newly registered fungicide and nematicide disease control products applied alone or in combination.

Sub-activity 8 (SA8): PED control through improved cropping systems [Chen, Nyiraneza]
This sub-activity aims to assess the potential to control PED through improved cropping systems.

Sub-activity 9 (SA9): Soil building and health: Preventing reliance on sustained chemical fumigation [Jordan, Tenuta]
This activity will develop a cropping system whereby fields with heavy PED disease pressure are brought to high levels of sustained productivity through a one-time only fumigation followed by soil building practices.

Sub-activity 10 (SA10): Field scale evaluation and demonstration of practices to manage PED [Cavendish, McCain]
This activity will evaluate selected PED control practices at the field-scale in commercial fields to obtain realistic estimates of the benefits of these practices to growers, to identify any practical limitations to the implementation of these practices, and to demonstrate the use of these practices to other growers.

Sub-activity 11 (SA11): Soil health property analysis [Comeau]
This sub-activity is to assess 1) which properties of soil health (physical, chemical or biological) correlate with PED pathogen populations and disease severity in the major potato production regions of Canada (SA1); and 2) how improved cropping systems and soil management practices (SA8 and SA9) influence soil properties, as measured by soil health assessment, in relation to PED control.

Sub-activity 12 (SA12): Soil microbial and micro-arthropod communities [Goyer]
This sub-activity is to obtain samples from field sites for future studies characterizing soil microbial, fungal and micro-arthropod community responses to management practices used to control PED.

Research Progress to Date (use plain language, not to exceed 500 words):

Sub-activity 1

Composite soil samples each from at least 20 commercial fields in Alberta, Quebec, New Brunswick and PEI were collected and analyzed for *Verticillium* and Nematodes species and densities in fall 2019. Samples were taken in spring 2020 from commercial fields in Manitoba and Ontario. Eight fields per province were revisited for disease ratings, yield and soil sampling.

Sub-activity 2

Soil samples collected from Sub-activity 1 were received by AAFC St-Jean RDC. Baiting tests with cv. Russet Burbank showed *Verticillium* could be retrieved from plants grown in the soil. Isolation of *Verticillium* cultures began but had to stop because of COVID-19.

Sub-activity 3

Soil samples collected from Sub-activity 1 were received by AAFC St-Jean RDC. Populations of root lesion nematodes from the soils was in progress until COVID-19 restrictions were introduced. Individual nematodes from the soils were hand-picked and frozen for genetic marker analysis of species. This work also had to stop with COVID-19 restrictions.

Sub-activity 4

A subsample of soils from Sub-activity 1 were transferred to Phytodata and analyzed by real-time PCR for various plant pathogens other than *Verticillium* and root lesion nematode. They included *Collectotrichum coccodes* (black dot of potato), *Spongospora subterranean* (powdery scab), *Helminthosporium solani* (silver scurf), *Rhizoctonia solani*, *Phytophthora erythroseptica* (pink rot), *Fusarium solani* (Fusarium dry rot), and *P. ultimum* (Pythium leak of potato). For the Quebec samples, all the pathogens except *H. solani* and *P. erythroseptica* were present in at least one of the soil samples.

Sub-activity 5

Several commercial DNA extraction kits were compared using potato soils from NB, PEI and Manitoba by ACS. The E.Z.N.A Soil DNA extraction kit from Omega Bio-Tek provided the best recovery of quality DNA. Soil samples from Sub-activity 1 were then extracted and quantified for Verticillium species (*V. dahliae, V. albo-atrum, V. tricorpus, and V. nonalfalfae*) based on real-time PCR. *Verticillium* DNA concentrations were low and varied with sample. Using the standard dilution plating method for colony counts for microsclerotial producing *Verticillium*, 44% of samples produced colony counts. However, the PCR method found that 86% of the samples had quantifiable *Verticillium* levels. The relationship between colonies and DNA levels in soil samples was not strong. There was a better relation between DNA levels and soil amended with microsclerotia of *V. dahliae*. DNA levels of soils from Sub-activity 1 matched well with quantification by Phytodata.

Sub-activity 6

This activity was not planned to begin in 2019-2020.

Sub-activity 7

Late funding allocation and wet soil conditions in 2019 preventing conducting a field trial in NB by AAFC. A replicated greenhouse trial was conducted in NB. The treatments included a control, the fungicide Aprovia (Syngenta), the nematicide and fungicide Velum Prime (Bayer), and the fungicide Senator PSPT (Nippon Soda Co.). Aprovia and Velum Prime were applied in-furrow at the recommended rate while Senator PSPT was applied as a dust on the surface of the potato seed. The cultivar Russet Burbank was grown. Soil samples (one soil sample/replicate) were collected at the beginning and at the end of the growth cycle. Verticillium wilt severity was also scored. Analysis of results continues.

Late funding allocation meant a field study in ON by the University of Guelph was not possible. Studies for May 2020 were done but there was bad emergence, and the trial didn't yield good data. It will be repeated in 2021.

Exceptionally late harvest and wet soil conditions prevented conducting a field study in MB. Two trials were carried out in MB in 2020 successfully by the University of Manitoba. The trials were to be done by AAFC according to the workplan but approval for field work wasn't available, so the University of Manitoba took on the work to insure this activity progressed.

Sub-activity 8

NB. Two-year rotation study: First cycle of crop rotation– potato was completed in 2018 and 2019 at the FRDC research Farm. A second two-year rotation study was initiated in 2020 to confirm the results obtained in the first cycle. Twelve rotation crop treatments were planted in June with a standard field management. Soil samples were taken prior to planting and in the fall after cropping for quantification of root lesion nematodes and *Verticillium dahliae.*

NB. Green Manure Study- a field study was initiated at the FRDC research farm in 2019. Fields were planted Pearl Millet, Brown Mustard and a mix of the two to compare to current land management and soil building practices (typical red clover-barley rotations and grain rotation crops). Biomass and yield data have been collected in plots where appropriate in 2019. The same green manures or crops were grown on plots in 2020. The biomass samples of the weeds and sown crops were taken during the growth. In the fall, soil samples were taken for pathogen density quantification and the rotation crops were remained in the plots to prevent from soil erosion.

PEI. Rotation Study- an experiment was initiated in 2017 at the Harrington Research Farm. Eight rotation systems and a control (bare soil) with and without manure were treatments in 2017 and potato in 2018 the test crop. In 2019 a second phase of a 3yr rotation was initiated and a potato test crop planned in 2021. Cover crop biomass and their total nitrogen and total carbon accumulations, soil nitrate dynamics during the potato phase were monitored monthly, selected physical-chemical soil properties and potato yield and quality were assessed. In 2020, the plots were in cover crop phase. Soil samples were also taken for V. dahliae and root lesion nematode assessments.

Sub-activity 9

ON: Late funding allocation did not allow establishment of a study. Establishment of the trial was done by the University of Guelph in 2020 but emergence was poor. The trial will be re-initiated in 2021.

MB: An exceptionally late harvest and wet soil conditions did not allow establishment of this study in 2019. The study was initiated in fall 2020 by the University of Manitoba with fumigation of treatment plots.

Sub-activity 10
Cavendish and McCain have conducted demonstration trials in PEI, NB, MB and AB since 2018 on various control products of Potato Early Dying.

Sub-activity 11
The soil samples from NB and were submitted to AAFC (Comeau lab) for soil property analysis.
Soil samples from the survey arrived at the soil carbon lab of the Fredericton RDC late in the fall 2019 and are currently been processed and analyzed. The expected end date for these analyses is still unknown. Due to the COVID-19 delay in funding, hiring students' helpers is challenging. In addition, the FRDC Associate Director haven't granted authorization to process samples from this PED Cluster activity in the Soil Carbon Lab (i.e. samples have to be processed in commercial labs).

Sub-activity 12
Samples from Sub-activity 8 have been frozen at -80 C. Analyses are scheduled to occur in 2021-2022 after potato test crops are completed in those studies.

Extension Activities (presentations to growers, articles, poster presentations, etc.):
Canada Invests in PED Research. Potatoes in Canada. March 26, 2020.

Dahu Chen, August 11, 2020. Progress on Management of Potato Early Dying Complex in NB and PEI. Virtual Presentation to PEI Potato Board.

Mario Tenuta, 2020. CanPEDNet Update. Manitoba Potato Research Meeting. Portage La Prairie, MB and by Zoom. Nov 17, 2020.

COVID-19 Related Challenges:
Activities have been affected by COVID restrictions. In laboratory activities within AAFC were limited to only essential activities. This meant experiments and analysis of samples could not be done. Our private partners (ACS and Phytodata) were not affected by restrictions and maintained on schedule. Our University researchers were challenged with restrictions on the number of personnel working and closure of laboratories over the summer. Field activities were maintained. However, approval for field work under COVID protocols came late for the University of Guelph resulting in poor trial establishments.

Key Message(s):
We have successfully continued the CanPEDNet project despite severe challenges presented by COVID restrictions. We have had several group meetings and many email and phone discussions among researchers. The project is moving along. Trials except for in Ontario have been established. COVID-19 restrictions have stopped particularly laboratory analyses and experiments. The soil survey and development of molecular diagnostic methods is nearing completion. Several control products examined show good results in improving yield and reducing PED.

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 Canadian Horticultural Council, and industry contributors.

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

CANADIAN AGRICULTURAL PARTNERSHIP
Innovate. Grow. Prosper.

Canadian Horticultural Council | Conseil canadien de l'horticulture
The voice of **Canadian fruit and vegetable growers**