Canadian Agri-Science Cluster for Horticulture 2

Progress Report April 2016

Activity 16, Potato 15

Zebra Chip and Potato Psyllid Survey and Monitoring

Lead Researcher

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Collaborators

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Potato Psyllid and Zebra Chip Monitoring Network

Activity Objectives

To survey the occurrence of zebra chip disease of potatoes in Canada, and test symptomatic tubers for the presence of the causative agent *Candidatus* Liberibacter solanacearum; and to survey for the insect vector, potato psyllid, by conducting field sampling, identifying species and stages, mapping occurrence if found, developing and implementing a monitoring program, assessing the effects of weather and regional variations and movements, determining potential geographic range, and constructing a geographic forecasting model of the insect life history and development.

Additional research goals that were added in 2015:
Increase sampling coverage and frequency. (Goal met; further expanded plan for 2016)
Solve problem of unknown sample locations. (Goal resolved by not including this data for maps)
Detect potato psyllid, if occurs, and determine species and condition. (Goal met)
Conduct DNA analysis of potato psyllids to determine whether contain Lso pathogen. (Goal met)
Begin geographic analysis of probable distribution and timing of potato psyllid. (Goal met; in progress)
Assemble and verify list of related psyllids and prepare photo guide (Goal met; in progress)
Conduct DNA analysis of potato psyllids to find origin and relationship to USA populations (Goal met; in progress)
Begin assessment of potential alternate host plants for the potato psyllid (Goal met; investigation begun)

Key goals and activities in 2016:

- Survey invasive potato psyllids, and test for zebra chip disease. Coordinate survey across Canada, and distinguish types of psyllids and other insects

- Test symptomatic tubers for the presence of *Candidatus* Liberibacter *solanacearum*
- Survey and map insect vectors; provide guides, population analysis, and forecasts
- Assess the effects of weather and movement; assess possible importance of alternate host plants
- Develop control strategies when needed (chemical, cultural, microbial, biological)
- Build information on potato psyllid sources and activities
- Develop methods of forecasting psyllid development and survival

Research Progress to Date

The potato psyllid, *Bactericera cockerelli*, specializes on crop and non-crop plants in the solanaceous family (potato/pepper/tomato and night-shade, respectively). This insect is on the move in several nations, and has caused extensive losses in New Zealand and the USA. It does not cause significant harm itself, but it carries a pathogen that causes zebra chip disease, with the main damaging symptom being dark stripes in the flesh of potatoes. Potato psyllid was detected in Canada in 2015, but not in sampling during 2013-2014. DNA analysis of the captured specimens showed that they were negative for the zebra chip pathogen. Sampling for the potato psyllid will be expanded in 2016 (with collaborators Larry Kawchuk, Scott Meers, and network participants) to include more sites and greater numbers of cards per location (in keeping with the original sampling plan prepared in 2013), and methods for forecasting and monitoring will be developed and refined.

A volunteer monitoring network for Canada was organized, and supplied with yellow sticky cards. A minimum of 4 yellow cards has been recommended to participants, but up to 16 cards per field are used in locations in which potato psyllids have been found. Cards are examined with microscopes. Additional sampling was conducted by gas-powered vacuum sampler, sweep nets, and close examination of leaves.

Beginning in late June and early July, 2015, very small numbers were found, typically 16 cards in a field yield zero, or in rare cases one potato psyllid collected per field. So far, they have been found only in southern Alberta and not in other provinces. No potato psyllids were found in sampling across Canada in 2013-2014 (New Brunswick to British Columbia; over 1,000 cards per year). No eggs or immature stages were found in 2015, despite examination of thousands of potato plant leaves in the field and lab.

A total of 1,782 yellow sampling cards were examined at the University of Lethbridge lab, by entomologist Dan Johnson, student research assistant Bradley Big Swallow, and (beginning in September), Sampath Walgama, who brings additional entomology expertise. Over 5,000 non-potato psyllids were noted and counted on the cards. Potato psyllids were found in only 6 fields, for a total of less than 20 individuals (the number of fields sampled by University staff and most network members is known, but in Alberta some key network participants do not reveal the number or location of sampling sites, so these are not known).

Yellow Cards placed in fields for sampling potato psyllids in Canada
Cards received to October, 2015

Prov.	Cards	percentage
AB	998	56.0
BC	42	2.4
MB	141	7.9
NB	546	30.6
ON	6	0.3
SK	11	0.6
QC	38	2.1
	1782	100

Additional cards received after Nov 10, 2016: BC; 1,110 cards

Potato psyllids were tested with DNA analysis (PCR) for the presence of the Lso pathogen that is responsible for Zebra Chip. None were positive for the pathogen, and so far there are no records of Zebra Chip in Canada.

Subpopulations of potato psyllid may differ in their regional source, history, and adaptations (for example, survival in harsh weather), and are distinguished genetically into haplotypes. Analysis of the potato psyllid DNA, using standard, reliable, and tested methods of analysis of Cytochrome c oxidase subunit 1 (COI) indicated that southern Alberta has two haplotypes present. These are genetic variants that give clues regarding the sources of psyllids that invaded and established low populations in Canada. Four potato psyllid haplotypes have been recognized and noted in studies in the USA, based on COI DNA sequence. The three most common haplotypes are monitored in US potato-growing regions. "Northwestern" haplotype is found mainly in Washington, and some in Idaho. "Western" is found in Washington, Oregon, Idaho, and California, with smaller numbers in other states. "Central" predominates in Texas, Kansas, Colorado, Wyoming, and Nebraska.

Results: We found the Central and Western potato psyllid haplotypes in Alberta, by using COI analysis (which is based on a 100% accurate match of DNA sequence) conducted in collaborative research at the Lethbridge Research Centre. Only adult potato psyllids that were collected on yellow cards in potato fields were tested. So far, the Central haplotype is more common and has been found in the general area south of Bow Island, Alberta, and the Western haplotype has been found in the general area north of Coaldale, Alberta.

Data analysis regarding projections and forecasting

Three approaches are being investigated:

a. A population model of the growth and development of potato psyllid as a function of weather and other environmental variables is being developed, based on published lab and field studies.

b. A climate-matching analysis, somewhat similar to Climex and related methods widely used for other insects, is underway in the research of graduate student Summer Xia (Qing Xia). Species distribution modelling and statistical analysis will be employed to make use of data being provided by researchers in the USA (mainly Idaho). Excellent progress was in software and statistical tool testing was made during January to March, 2016. We are waiting for contributions of data from US collaborators; approval has been granted in principle.

c. Knowledge of the distribution of alternate host plants is being improved and compiled with the help of plant and weed experts.

Priority areas of work for 2016-2017

a. Field sampling has been a limiting factor, and in many cases numbers of samples per field have been too low, numbers of fields sampled are too low, and information such as locations where sampling occurred are not provided. We filled in additional time and costs as much as possible in 2015, but more sampling is needed for 2016. Additional funding for field expenses, and paid field assistance, would offer great returns in precision and accuracy. More frequent and orderly sampling with rapid examinations is needed.

b. DNA analysis of the psyllids to determine the population source and to detect the Lso pathogen that causes Zebra Chip is central to the study, now that the insect has been found in Canada. The project is fortunate to have the collaboration and expertise of Dr. Larry Kawchuk and his staff, who work closely with University staff. D. Johnson learned DNA extraction, in support of future work. We will try to support the lab costs and time needed for this important area of research. If Lso does appear, we need additional materials and time for DNA analysis and an isolation hood.

c. Yellow cards ($1.50 each) will be placed in fields across Canada. We may use up to 3,000 in 2016 and more in 2017. Each card is examined by microscope and insect numbers recorded.

d. Design a spatial and geographical monitoring system, beginning with Alberta and Manitoba.

e. Present results and submit scientific papers on sampling results (2016), haplotype analysis and results (2016), and forecasting of probable locations of establishment and population growth (2017).

Extension Activities

Johnson, D., Kawchuk, L., Meers, S., Xia, Q., and network participants. 2015. "Canadian zebra chip and potato psyllid monitoring network." Poster displayed at the American Phytopathological Society annual meeting, Pasadena, California. August 3, 2015

Johnson, D., Kawchuk, L., Meers, S., Xia, Q., Walgama, S., Big Swallow, B., Martin-Johnson, M., Sidoo, R., and network participants. 2015. "Potato psyllid, an invasive species in Canada: abundance, population characteristics, and vector status, 2015." Oral presentation (D. Johnson) Alberta Potato Conference & Trade Show, Potato Growers of Alberta, November 18, 2015.

Johnson, D., Kawchuk, L., Meers, S., Xia, Q., Walgama, S., and network participants. 2015. "Potato psyllid in Alberta, 2015." Grower Meeting, March 23, 2016, Taber, AB. Organized by Cavendish Farms.

Johnson, D. 2016. "Practical examples of sampling at a range of scales: two agricultural insect studies." Invited Course Seminar, Department of Mathematics and Computer Science, April 1, 2016.

A scientific manuscript on the results of sampling and DNA analysis is in preparation for submission to a scientific journal. A presentation abstract has been accepted for presentation at Potato Association of America annual meeting: “Sampling and DNA Analysis of Potato Psyllids (Bactericera cockerelli) in Alberta, Canada, 2013-2015”

News media:

- "Potatoes free of zebra chip — so far," by Barb Glen. Western Producer, July 10, 2015. Includes insect photo by Dan Johnson.
- "Insect found in Alberta but disease not present," by Barb Glen. Western Producer, September 25, 2015.
- "Zebra Chip Update," by Julienne Isaacs. Spudsmart, January 20, 2016. Includes insect photo by Dan Johnson.
- "Australian research into natural potato psyllid pathways", compiled by Staff. Spudsmart, March 3, 2016. Includes insect photo by Dan Johnson.
- "Sticky traps test for psyllid insects. Insects can carry a pathogen-causing bacteria that makes potatoes unappealing," by Barb Glen. Western Producer, March 10, 2016.

Early Outcomes (if any) or Challenges

The potato psyllid is a vector of the pathogen that causes Zebra Chip, a serious disease affecting marketability of potatoes. The potato psyllid has been found in Alberta in very low numbers, but the disease agent is not present, so far.

Key Message(s)

The evidence shows that this monitoring program, although based mainly on volunteer efforts and loosely organized by our joint efforts, is a success and should be continued. We have been able to find widely separated populations of very low numbers of potato psyllids, and assay those found using DNA methods to determine that they do not currently carry the zebra chip plant pathogen, and to determine the genetic types and possible ancestral sources of potato psyllids. Now, we need more sampling by experienced and trained samplers, that meets the specified minimum number of cards per field, and for which records of all sampling locations are reported. So far we have developed a sampling network based on the generous time of network members, but we have also used the funded program to develop methods and capacity in the supporting labs (pathology and molecular analysis, and also field sampling methods, statistics, and initiation of forecasting and model development).

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