CAN PSYLL NET

Newsletter of the
Canadian Potato Psyllid and Zebra Chip Monitoring Network

- August 2017 -

- Photo by Dan Johnson -

Growing Forward 2, Project: Zebra Chip and Potato Psyllid Survey and Monitoring

Dan Johnson, Larry Kawchuk, Scott Meers, and Network Participants

To Current and Potential Participants

We are continuing monitoring for potato psyllid across Canada in 2017. Thank you for your efforts, and special thanks to those who have already sent in cards for us to examine. The sampling has been successful in finding potato psyllids in Saskatchewan and Manitoba, in addition to a continuing low incidence in Alberta. Help us update and add to the list of network participants. If you have questions or need cards, contact dan.johnson@uLeth.ca, 403 634-7213.

Our project has been in the news lately. Here are some examples:

Bruce Barker, Some good, some bad: news on potato psyllid, Top Crop Manager West, Feb, 2017
Sarah Lawrynuik, Spud-based research taking root at University of Lethbridge, CBC, Jan 15, 2017
Karen Davidson, Proactive monitoring stays ahead of zebra chip disease, The Grower, Mar, 2017
Barb Glen, Sticky traps test for psyllid insects. Insects can carry a pathogen-causing bacteria that makes potatoes unappealing. Western Producer, Mar 10, 2016
Barb Glen, Insect found in Alberta but disease not present, Western Producer, Sep 25, 2015.
Julienne Isaacs, Zebra Chip Update, Spudsmart, Jan 20, 2016
Trevor Kenney, ...monitoring network keeping an eye out for potato 'zebra chip' disease, University of Lethbridge Communications, Jul 28, 2016
J.W. Schnarr, ...researcher tracking psyllids, Bow Island Commentator Newspaper, Aug 9, 2016

▲ Potato psyllid, *Bactericera cockerelli*

▲ Adult potato psyllid found in Manitoba. (Bisht, Vikram, Johnson, Dan, Kawchuk, Larry, and Meers, Scott. Occurrence of potato psyllids in Manitoba, PMR Report: Section C- Insect Pests 2016)

Background

Zebra chip is a disease of potatoes documented in the western USA, Mexico, Central America, and New Zealand. The disease severely disrupts carbohydrate flow in potato plants, resulting in a striped appearance in tubers. The pathogen, *Candidatus* Liberibacter solanacearum (Lso), is transmitted by the potato psyllid, *Bactericera cockerelli*, a flying insect 2-3 mm in length. Feeding by immature stages of potato psyllid can also causes a disease called 'psyllid yellows'.

The objective of this project and network is to survey fields for populations of the potato psyllid in Canada, and test captured potato psyllids and symptomatic tubers for the presence of the disease agent, Lso. The network of researchers and collaborators participates in 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, constructing a geographic forecasting model of the insect life history and development, and developing a management plan. We have located the potato psyllid, previously rare or unknown, in Alberta at numerous locations during 2015-2017, and in 2016 we found it in Manitoba and Saskatchewan. In 2017, potato psyllids were found in Alberta in the June 13-23 field samples. Sample cards have arrived from New Brunswick, and additional sample cards are expected to arrive from Manitoba, Saskatchewan, Ontario, Quebec, and British Columbia.

Adult specimens of potato psyllids collected during 2015-2017 did not appear to have undergone long-distance flights. Timing indicated probable local populations, with possible augmentation by migrants in special cases. Accidental importation has occurred in the past. So far, no immature potato psyllids or potato psyllid eggs have been found in leaf examinations, but we will watch for reproduction later in the season. Analysis of cytochrome c oxidase subunit 1 (COI) of individual potato psyllids (Kawchuk lab, Lethbridge Research Centre) indicated that Central and Western haplotypes are both present in southern Alberta. PCR analysis indicated that all potato psyllids were negative for Lso. Sampling and monitoring of diseased plant samples and potato psyllids and potential natural enemies of psyllids will continue in 2017, with DNA analysis of specimens to detect presence of Lso and to determine *Bactericera cockerelli* haplotypes. Experiments and collections of potential natural enemies have been conducted, and weather variables have been compiled for application in forecasting.

▲ Immature potato psyllid

▲ Potato psyllid eggs are laid on short stalks.

How to sample

Potato psyllids can be sampled with a gas-powered vacuum, or with a fine-mesh insect net. The immature stages and eggs can be counted on the undersides of leaves. However, a more standard, passive sampling method involves staking yellow sticky cards above the crop so that leaves do not touch the card. The cards are placed on stakes, four per field and usually about 5 to 20 m into the crop from the edge. After one week, or longer in cool or cloudy weather, the cards are picked up and replaced with new cards. Potato psyllids may be found during examination under the microscope. We examine up to 2000 cards per year at the University of Lethbridge.

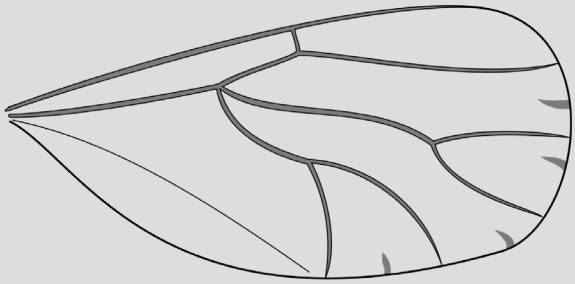
Potato psyllids have a one-into-three main branch in the wing venation, white stripes on abdomen, and light sculpturing on the thorax.

◂ When potato psyllid adults emerge, they are often white or yellow. During the first few hours they dry and darken, and the usual pattern with sculptured lines on the thorax and head and two white strips on the abdomen is apparent.

▲ Psyllidae (not potato psyllid)

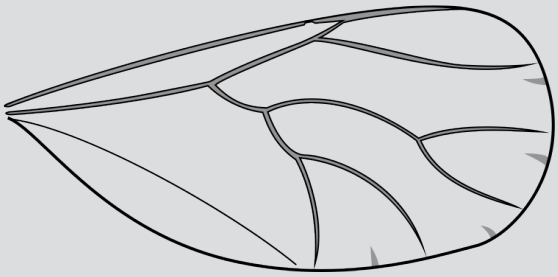
Psyllids have a head that is separate from the thorax, and long, clearly segmented antennae (unlike leafhoppers, which typically have heads that are more continuous with the body, and short, fine antennae).

◀ Triozidae (potato psyllid)



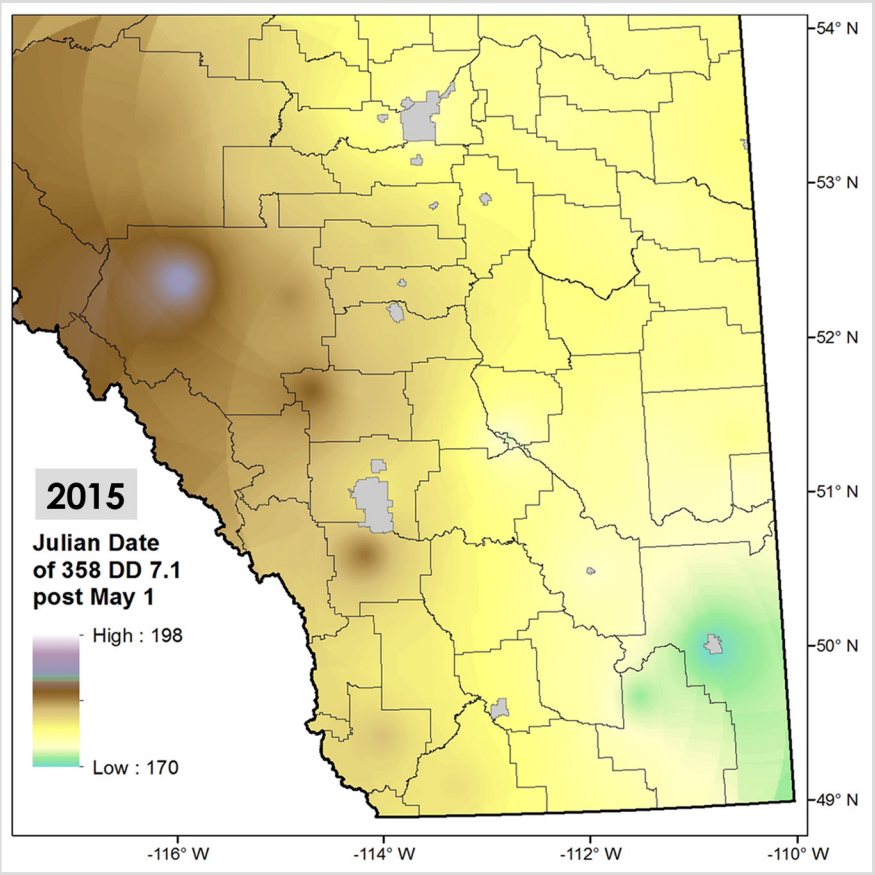
◀ Potato psyllids are in the family Triozidae, which have wing venation that branches into three.

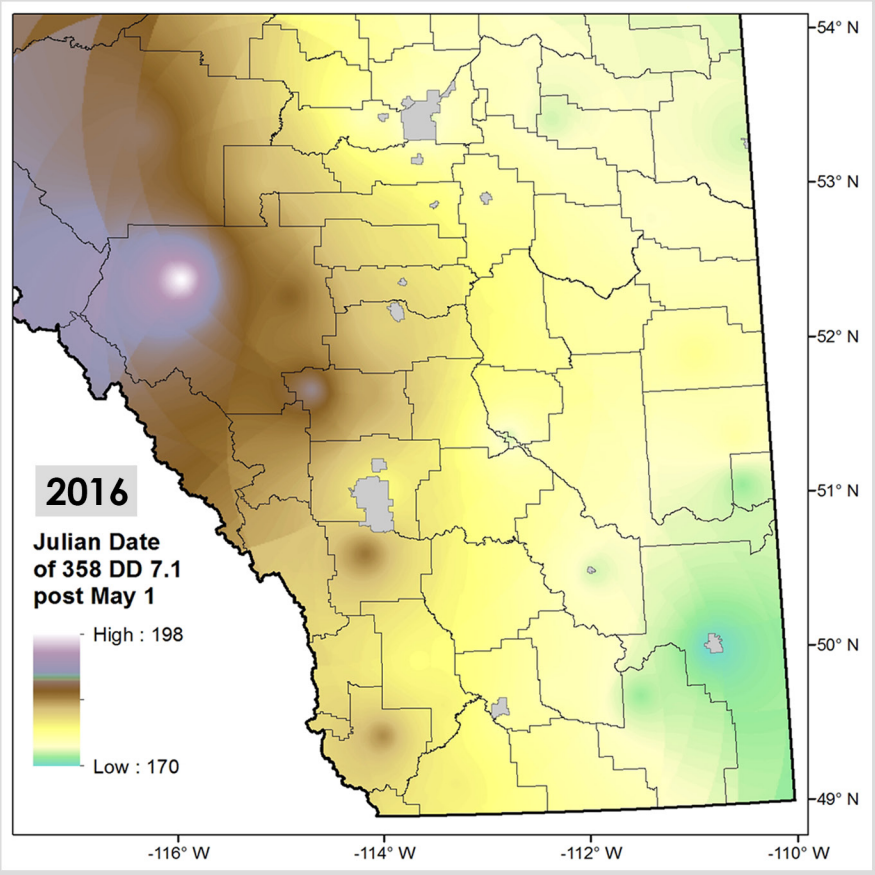
(Image Source: Wikipedia)



◀ There are many psyllids in the family Psyllidae, easily recognized by the branching into two.

(Image Source: Wikipedia)





The body temperature of insects determines rates of development, maturation, feeding, and egg-laying. Insects can seek warmer or cooler habitat in vegetation, but in general the daily air temperature is an estimate of insect body temperature. Lab experiments indicate how much heat is required to complete a stage or a generation. Tran et al. (2012) estimated a potato psyllid life requirement of 358 degree-days above 7.1 °C. Degree-day accumulations are mapped and compared. The Julian date (count from January 1) on which 358 DD7.1 is reached serves as an index.

Tran, L.T., Worner, S.P., Hale, R.J. and Teulon, D.A. (2012). Estimating development rate and thermal requirements of *Bactericera cockerelli* (Hemiptera: Triozidae) reared on potato and tomato by using linear and nonlinear models. Environmental Entomology, 41, 1190-1198.

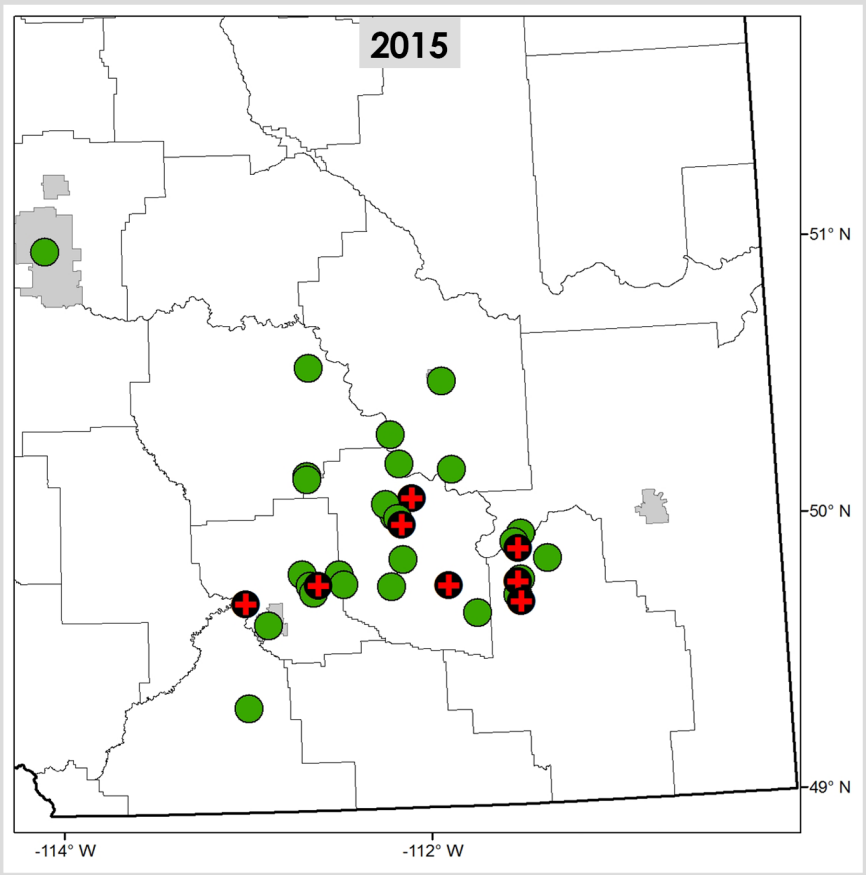
Kilometers
0 25 50 100

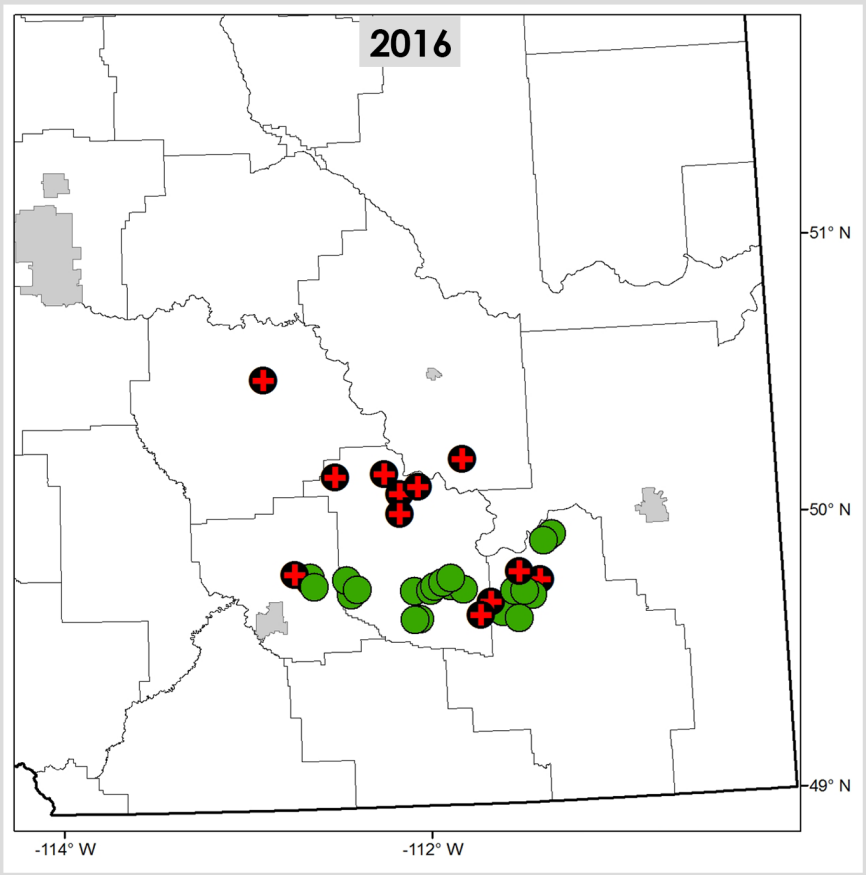
Alberta Degree Days.

Data Sources:
2015-2016:
Alberta Government

Agriculture and Agri-Food Canada
Growing Forward 2
Canadian Horticultural Council
PGA Potato Growers of Alberta
Alberta Government
ACIDF
University of Lethbridge
FIAT LUX

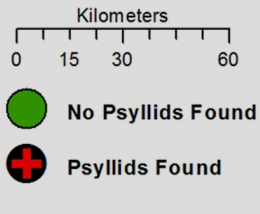
▲ Maps: Dan Johnson, Celeste Barnes, Christian Sapsford, Qing Xia





These maps show the locations of the sites monitored in Alberta, for which locations and results were provided to the network. We thank the growers and landowners for access permission.

At each site, four yellow sticky cards were placed on stakes in a potato crop. We change the cards every week or two, depending on weather. The red crosses on these maps indicate fields in which potato psyllids were captured during the year shown. Potato psyllid captures have occurred during the period June 13 to Sept 30.



Alberta Psyllid Survey
Data Sources:
2015-2016:
University of Lethbridge

Agriculture and Agri-Food Canada
Growing Forward 2
Canadian Horticultural Council
PGA Potato Growers of Alberta
Alberta Government
ACIDF Alberta Crop Industry Development Fund Ltd.
University of Lethbridge
Fiat Lux

▲ Maps: Dan Johnson, Celeste Barnes, Christian Sapsford, Qing Xia, Scott Meers, Lary Kawchuk

Update on sampling in Canada

1. Alberta: Over 200 potato psyllids were found in 2016, plus additional captures from non-potato sources. No Lso (zebra chip) pathogen was detected (DNA testing in the lab of Larry Kawchuk, AAFC, Lethbridge). From the University of Lethbridge lab, we set up and monitored 29 potato fields in 2016 and 42 fields in 2017, plus field sites by Alberta Agriculture and Forestry. Network participants sampled across Canada, and sent the cards to be examined. Additional sampling was conducted in Alberta by Promax Agronomy, a private company in AB, and gardeners.
2. Manitoba and Saskatchewan: The network received cards from Manitoba and from sites in Saskatchewan (see network list). We found potato psyllids on cards from both.
3. Other provinces: Potato psyllids tend to have a mainly western distribution, but sampling east of Manitoba provides valuable data on range and possible expansion. We have extensive data from New Brunswick, and smaller samples from other provinces.

Sampling card examined at the University of Lethbridge in 2016:

	cards	percentage
AB	1384	66
BC	73	4; increased in 2017
MB	113	5
QC	3	<1; increased in 2017
ON	sampling planned for 2017	
NL	3	<1
PEI	8	<1
SK	14	1; increased in 2017
NB	486	23
	2084	100%

We prepared draft maps (GIS) of the potato psyllids found so far and are comparing to sampling effort and the locations monitored. Environment Canada and Alberta Agriculture and Forestry have provided weather data for current and historical analysis.

▲ Three adult potato psyllids line up to feed. The white material is excess sugar produced by the feeding psyllids, and may build up to levels that are noticed on leaves during heavy infestations.

Natural Enemies

Natural enemies play a role in regulating numbers of leafhoppers, aphids, psyllids, and other small insects. Low level of insecticide use in potato fields allows a diverse community of natural enemies to exist. The immatures and adults of small insects, including psyllids, are attacked by jumping spiders, crab spiders, large and small predaceous beetles, lacewings, ladybird beetles (multiple species), several species of predaceous bugs, ants, and hymenopterous parasitoids.

Green Lacewing

Two-spotted Ladybird Beetle

Damsel Bug

Damsel Bug preying on Hoverfly

Rove Beetle and parasitoid wasps

wasp

Minute Pirate Bug

- *Brumoides septentrionis*
- Winter lady beetle

- *Hippodamia sinuata*
- Sinuate lady beetle

- *Hippodamia parenthesis*
- Parenthesis lady beetle

- *Hippodamia convergens*
- Convergent lady beetle

- *Hippodamia glacialis*
- Glacial lady beetle

- *Hippodamia expurgata*
- Expurgate lady beetle

- *Coccinella transversoguttata*
- Transverse lady beetle

- *Psyllobora vigintimaculata*
- Wee-tiny Lady Beetle

- *Hippodamia tredecimpunctata*
- Thirteen-spotted lady beetle

- *Coccinella septempunctata*
- Seven-spotted lady beetle

- *Adalia bipunctata*
- Two-spotted lady beetle

- *Hyperaspis undulata*
- Undulate lady beetle

We have also monitored thirty species of common predators of small insects in potato fields. Minute Pirate Bugs and Lady beetles (a.k.a. ladybug or ladybird) are known to eat large numbers of immature potato psyllids (confirmed in the lab). Our samples (three-year field study by Christian Sapsford and Dan Johnson) indicate that these predators are at levels that could significantly reduce psyllid numbers. The numbers of these predators declined in 2017, cause unknown. Among lady beetle species, Thirteen-spotted lady beetle, Convergent lady beetle, Seven-spotted lady beetle, and Parenthesis lady beetle were the most common.

Why Monitor Psyllids and Lso Pathogen?

Zebra chip (ZC) is an economically costly disease of potatoes, documented mainly in the western USA, Mexico, Central America, and New Zealand (Horton et al., 2015). It is caused by a pathogen, *Candidatus* Liberibacter solanacearum, transmitted during feeding by the potato psyllid, but not by other insects. Plant growth, yield and quality are strongly affected, and the striped appearance of affected tubers reduces value for processing. Other symptoms of the infected plant include leaf deformity, chlorosis, bud proliferation, and yellow or purple discoloration (Munyaneza et al., 2007; Munyaneza 2012). The disease can result in loss of crops, and infection of stored tubers. Potato psyllid populations are now found in Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oregon, Texas, Utah, Washington, Wyoming, and, since this study, Alberta, Saskatchewan, and Manitoba.

Zebra chip presents a potential high economic risk to potato production. Estimates in other regions indicate severe impacts. For example, Greenway (2014) found that Eastern Idaho would suffer a 55% reduction in returns for potato producers, and predicts an "inability of Pacific Northwest growers to sustain a profit if they adopt a routine insecticide program for ZC protection that begins at plant emergence."Annual losses in Texas have been reported in the range US $25 to $30 million (Texas A&M AgriLife Research & Extension, 2016).

Potato psyllids are known to move in response to warm weather. Warmer conditions may allow expanded movement into Canada, and better establishment because of accelerated development and increased survival.

In 2013, we began field sampling and organized monitoring in order to support a more informed response if the insect vector becomes established in potato-growing regions in Canada. An efficient pest surveillance program would reduce or prevent yield and quality losses caused by the transmitted zebra chip disease, and provide a more competitive product. Small numbers of adult potato psyllids were found in Alberta in 2015, incresing in 2016. So far in 2017, numbers are very low, with collection rates of only 10 potato psyllids captured from hundreds of sampling cards in fields across the potato-growing region in Alberta. Detection of the Lso bacterium is done in the lab with PCR DNA analysis. All of the potato psyllids have been negative for Lso.

Network participants are currently sampling for potato psyllids across Canada, from coast to coast. Other research includes analysis to predict the likely zones of establishment, and consideration of alternate host plants. Potato psyllids are capable of living on some weeds and other vegetation, and in some cases have been shown to transmit Lso to them (Murphy et al., 2014). We do not yet know how they might interact with weeds and native plants found in Canada.

To obtain sampling cards, contact dan.johnson@uleth.ca

References Cited

- Greenway, G. 2014. Economic impact of zebra chip control costs on grower returns in seven US states. American Journal of Potato Research 91:714-719.
- Horton, D.R., W.R. Cooper, J.E. Munyaneza, K.D. Swisher, E. Echegaray, A. Murphy, S. Rondon, C. Wohleb, T. Waters, A. Jensen. 2015. A new problem and old questions: potato psyllid in the Pacific Northwest. American Entomologist. 61(4): 234-244.
- Munyaneza, J.E., J.M. Crosslin, and J.E. Upton. 2007. Association of *Bactericera cockerelli* (Homoptera: Psyllidae) with "zebra chip," a new potato disease in southwestern United States and Mexico. Journal of Economic Entomology 100: 656-663.
- Munyaneza, J.E. 2012. Zebra Chip Disease of Potato: Biology, Epidemiology, and Management. American Journal of Potato Research 89(5): 329-350.
- Murphy, A.F., R. Cating, A. Goyer, P.B. Hamm, and S.I. Rondon. 2014. First report of natural infection by *Candidatus* Liberibatcer solanacearum in bittersweet nightshade (*Solanum dulcamara L.*) in the Columbia Basin of eastern Oregon. Plant Disease Note 05-14-0497PDNRI. Plant Disease 98(10): 1425.
- Texas A&M AgriLife Research & Extension. 2016. SCRI Zebra Chip. Integrated Research & Management Program.

List of Network Participants in Canada.

Alberta:

Dan Johnson, (Network Coordinator), University of Lethbridge
- Qing Xia (MSc student on the project)
- Sampath Walgama (Research Assistant)
- Christian Sapsford (Research Assistant)
- Mahsa Miri (Graphic Design)
- Celeste Barnes (GIS)

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Kathrin Sim, Alberta Agriculture and Forestry
Larry Kawchuk, Agriculture and Agri-Food Canada Research Centre, Lethbridge
Lindsay Fletcher, Crop Production Services, High River
Mike Duell, Taber Home and Farm, Taber
Ross May, McCain Foods
Shelley Barkley, Alberta Agriculture and Forestry
Scott Gillespie, S-Scan Farms, Taber
Scott Meers, Alberta Agriculture and Forestry
Terence Hochstein, Potato Growers of Alberta, Taber
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Vikram Bisht, Manitoba Agriculture Food and Rural Initiatives, Carman
Zack Frederick, CMCDC, Carberry

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Loretta Mikitzel, New Brunswick Department of Agriculture Aquaculture and Fisheries, Wicklow

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Mary Kay Sonier, Prince Edward Island Potato Board, Charlottetown

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Beaudoin Marie-Pascale (DRSLSJ) (Alma)
Gosselin Bruno (DP) (Québec)
Guy Roy, Groupe Gosselin, Saint-Augustin de Desmaures
Jean-Philippe Légaré, Laboratoire d'expertise et de diagnostic en phytoprotection, Québec
Joseph Moisan-De Serres, Laboratoire d'expertise et de diagnostic en phytoprotection, Québec
Laure Boulet, Conseillère régionale en horticulture, Ministère de l'Agriculture, Rivière-du Loup
Patricia Masse, Les Fermes MVG Inc., Nadia Surdek, Saint-Thomas de Joliette

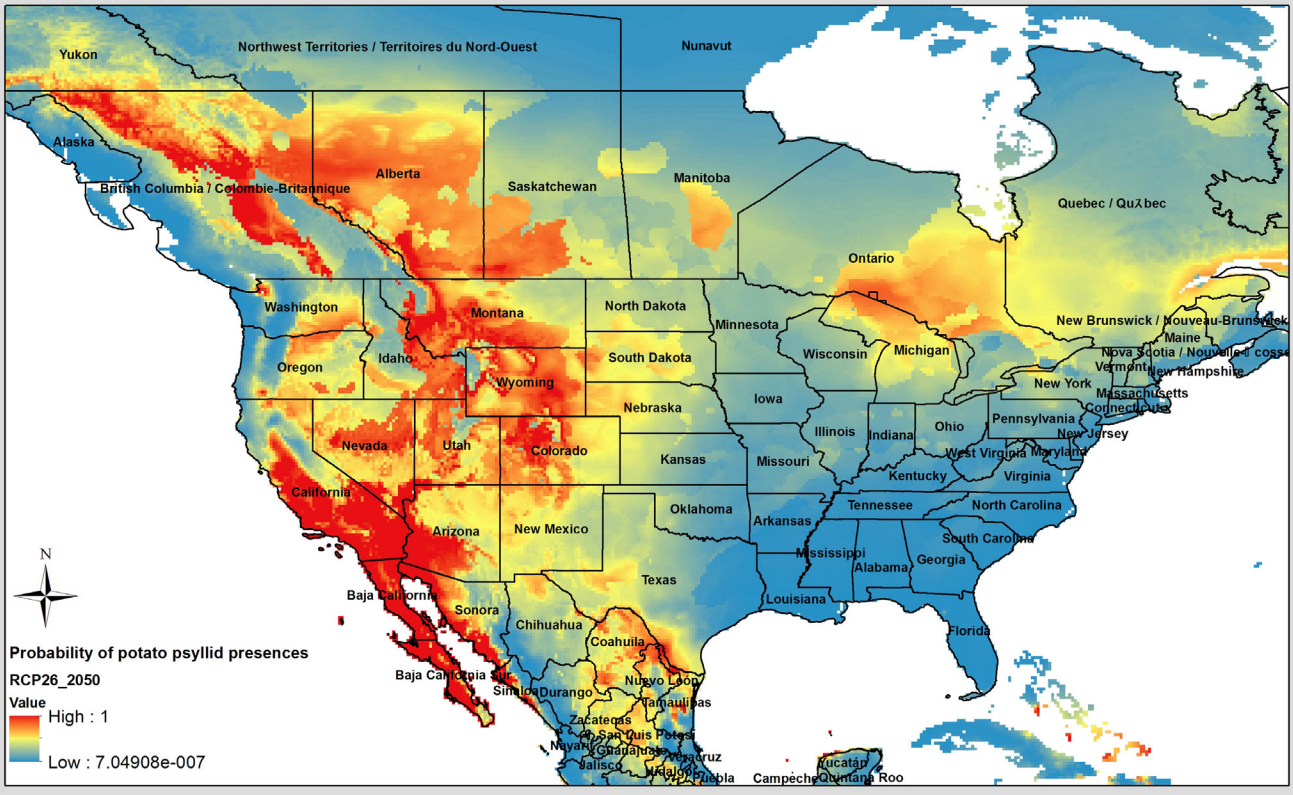
Saskatchewan:

Jazeem Wahab, Saskatoon Research and Development Centre, AAFC, Saskatoon
Sean Prager, Department of Plant Sciences, University of Saskatchewan, Regina

And Canadian Horticultural Council: David Jones, Amy Argentino, and staff

Even without the Lso bacteria, potato psyllids have been known to cause severe yellowing of leaves.

Graduate student Qing Xia (Summer Xia) at the University of Lethbridge used historical field survey records of the plant disease psyllid yellows as a way to find and compile the locations and dates of potato psyllid infestations of previous years back to the 1930's, and then compare the presence and absence of the condition (caused by immature potato psyllids) to weather and climate. She is using the results to determine whether climate variables, like annual temperature and precipitation, can be used to identify regions in which the potato psyllid is most likely to invade. Finer-scale weather data could then be used to model the timing and development of the populations where they can be found.



▲ This map is an example of simulation projections of how the area that will allow survival of potato psyllids could move north under standard climate forecast scenarios (example model output based on WorldClim and CLIMDEX databses). This shows the geographical distribution of potato psyllid presence probability in North America, projected to the BIOCLIM layers generated using the RCP2.6, 2050 climate data.

Example of other studies

Minute Pirate Bug (*Orius insidiosus*) is a small predaceous bug that is known for killing large numbers of thrips, mites, aphids, and psyllids of all kinds. We have been monitoring the numbers of this predator on the same cards that collect potato psyllid samples. Most cards have 0, 1, or 2 Minute Pirate Bugs, but in some cases up to 20 per card are recorded, indicating very healthy and active predator populations.

2016	MPB	Cards	MPB/Card
June	53	224	0.237
July	259	265	0.977
August	330	188	1.755
Sept	0	0	

2017	MPB	Cards	MPB/Card
June	15	158	0.095
July	88	108	0.815

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Agriculture and Agri-Food Canada

Growing Forward 2

Canadian Horticultural Council

PGA Potato Growers of Alberta

Alberta Government

ACIDF Alberta Crop Industry Development Fund Ltd.

University of Lethbridge

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