ON THE WATCH FOR ZEBRA CHIP

Potato psyllids are able to transmit the bacterium that causes zebra chip disease.

An update on this potential disease threat, the insect that transmits it, and the natural enemies that prey on the insect.

BY [redacted]

Zebra chip is a serious disease that can kill potato plants, significantly reduce yields, and make infected tubers unmarketable. It was first documented in Mexico in 1994 and in Texas in 2000. Since then, it has spread northward through much of the Western United States, as well as to Central America and New Zealand. Serious losses from zebra chip in the U.S. Pacific Northwest in 2011 sparked increasing concerns in Canada.

In 2013, a five-year Canadian effort was launched to monitor for the disease and the potato psyllid, the insect that transmits the pathogen. Fortunately, only very small numbers of potato psyllids have been found, and of those psyllids, only a tiny percentage actually carried the pathogen. The disease has not yet been found in Canadian potato crops.

However, the potential threat of zebra chip remains. Monitoring is continuing in Alberta, where most of the psyllids were found, to ensure that growers will be ready if potato psyllid populations increase and the disease emerges. Plus, the monitoring effort is providing helpful information on the rest of the insect community in the province's potato fields.

"Zebra chip is caused by the bacterium *Candidatus* Liberibacter solanacearum (Lso). Its vector, the potato psyllid (*Bactericera cockerelli*), is a small flying insect about two to three millimetres in length. This phloem-feeding insect prefers to lay its eggs on potato plants and other plants in the same family like tomatoes, peppers and nightshade weeds," explains Dan Johnson of the University of Lethbridge, who led the national monitoring program from 2013 to 2018.

The psyllids acquire the Lso bacterium by feeding on infected potato plants, and they spread it to other plants when they feed on them. Infected adults can also pass Lso to their offspring.

Infected potato plants have such symptoms as stunting, and misshapen and discoloured leaves. They look similar to plants with diseases like psyllid yellows, which is also caused by the potato psyllid, and purple top.

Zebra chip was first documented in Mexico in 1994 and Texas in 2000. Now, it can be found through much of the Western United States.

Photos courtesy Of Dan Johnson.

Tuber symptoms of Lso include brown streaks and flecks. Infected tubers are safe to eat, but the disease causes a higher accumulation of sugars, which alters tuber flavour and colour. In particular, the streaks and flecks in the raw tubers turn into dark blotches or stripes when the potatoes are fried.

HIGHLIGHTS FROM 2013 TO 2017

The national program involved Canada-wide sample collection. In addition to Johnson, the primary applicants and research team included Larry Kawchuk with Agriculture and Agri-Food Canada (AAFC) and Scott Meers with Alberta Agriculture and Forestry. They and research staff collaborated with people across the country to carry out the sampling. The program was funded under Growing Forward 2, with support from AAFC, Canadian Horticultural Council, Potato Growers of Alberta (PGA), Alberta Agriculture and Forestry, and the University of Lethbridge. In addition, the PGA worked with Promax Agronomy Services to conduct extra monitoring in Alberta and provide weekly reports to growers.

Participants in the national and Alberta efforts used sticky cards, replaced on a weekly basis, to capture adult potato psyllids and other insects in potato fields. The national program also did some monitoring in roadsides, greenhouses and other areas, and supplemented the card sampling with leaf examination, sweep sampling and vacuum sampling to look at other stages in the psyllid's lifecycle.

In the national program, Johnson's group at the University identified the insects on the cards, including potato psyllids, other psyllids, other pest insects, and natural enemies of the psyllids. The various psyllid species look quite similar to each other, so a microscope is needed to identify the potato psyllid. Kawchuk's group tested the psyllids and plant samples for Lso using DNA. They also used DNA to identify the haplotypes (distinct genetic types) of the potato psyllids and the pathogen.

In 2013, sampling in the national program took place at locations across southern Alberta. No potato psyllids were found. In 2014, the monitoring expanded to more Alberta locations as well as locations in Manitoba, Quebec, New Brunswick and Prince Edward Island. Again, no potato psyllids were found.

From 2015 to 2017, most provinces had at least some sampling sites. Alberta and New Brunswick usually had the most sites, with about 500 cards per year from New Brunswick and about 1,000 or more from Alberta.

No potato psyllids were found east of Manitoba. A few were found in Manitoba and Saskatchewan but only in 2016. In Alberta, small but increasing numbers of potato psyllids were collected from 2015 to 2017. Then late in 2017, a few Lso-infected psyllids, or "hot" psyllids, were collected at several Alberta sites. Lso was not found in any plant tissue from any province during the monitoring program.

"We looked at roughly three million insects on almost 8,000 cards in order to find the few hundred potato psyllids that we collected in potato fields," says Johnson. "In the U.S. and other affected regions, zebra chip does not normally become a problem unless the potato psyllid numbers are much higher than we found."

The findings from the PGA's monitoring effort were similar to the national program's results for Alberta. "We saw very low numbers of potato psyllids. For example, in 2017 with our 70 monitoring locations, we found just over 190 potato psyllids in total in southern Alberta [over the course of the growing season]," explains Thomas McDade, PGA agricultural director. "When I talk to some of my counterparts in Idaho for example, in some cases they were finding about 80 to 100 potato psyllids on one card overnight. In that case, they were spraying to control the psyllid. We were finding just two or three psyllids per week."

McDade also notes, "We did not find any hot psyllids until right at the end of the 2017 growing season, when we found four over a two-week period. So the numbers were very, very small. We looked really closely at the production area where the hot psyllids were found and didn't find any evidence of zebra chip disease."

Johnson's group at the university also conducted some related research studies, including an evaluation of the potential for beneficial insects to control the psyllid. "Our field study showed that the communities of natural predators in potato fields were at levels that could significantly reduce potato psyllid numbers," says Johnson. "In our lab experiments, we found that some predators like ladybird beetles (also called ladybugs) can rapidly consume hundreds of psyllids per day."

Over the course of the five-year program, Johnson shared updates with the other network participants, growers and others who might be interested in the work. As well, he and Kawchuk have made many presentations at potato grower meetings and scientific conferences.

ALBERTA FINDINGS IN 2018

Although the national program ended in March 2018, the PGA has launched a new five-year insect monitoring program in

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Left: A microscope is needed to accurately identify potato psyllids. Centre: Potato psyllid nymphs are pale green and flat. Right: The five-year monitoring program examined several million insects on thousands of sticky cards and found a few hundred potato psyllids.

Alberta. This new program is a partnership between the PGA, Cavendish Farms, McCain, Lamb Weston, Old Dutch, Frito Lay, Promax Agronomy and Alberta Agriculture and Forestry.

The new program identifies all the insects on the sticky cards, and provides weekly updates to growers on potato pests, like potato psyllids and flea beetles, and beneficial insects. Any potato psyllids found on the cards are tested for Lso.

"With this monitoring network, we are able to give our growers, and all of the agronomists and processing partners that work with our growers, very good information about what is in their fields. It allows them to identify an affected area really quickly and make very good, timely decisions on whether or not to do some targeted, localized spraying," McDade explains.

"If you just spray everything, you could make your problems worse ultimately because you'll also kill the beneficial bugs that feed on some of these pests. For instance, when psyllids first hatch, ladybugs will feed aggressively on them, eating as many as they can possibly find."

He adds, "We want to know immediately if there is ever a flare-up of potato psyllids. We haven't had to spray for them and hopefully that holds, but the only way to know is to monitor. If you wait until the potatoes are processed to find out if the disease is present, then that is much too late."

In 2018, the PGA's program had 70 monitoring sites, located throughout the processed acres in southern Alberta and in the key seed growing regions near Lacombe and Edmonton.

"This year, we didn't find any potato psyllids at all and very few flea beetles," McDade notes. "Very little to no insecticide was sprayed on our potato fields because we knew it wasn't necessary."

In 2018, Johnson did some limited monitoring in Alberta just out of interest, regularly sampling only eight sites. Also, some monitoring was done in Manitoba and British Columbia. Although the insect identification is not quite finished, so far they have found almost no potato psyllids.

Comparing notes with his U.S. colleagues, Johnson learned that potato psyllid numbers had also really decreased in Idaho, Washington and Oregon in 2018.

At present, the reason for the population decline is unknown. Johnson says, "A lot of factors could influence it – a weather effect, something about the insect or its internal microbial environment, a population cycle of some kind."

He suspects the weather played an important part in the very low psyllid numbers in Alberta. "We had such a cold start to spring that anything cold-blooded that overwinters and has to get going in the spring had a hard time. The degree-day accumulation in April was lower than any other year in the past decade. Then, after it finally warmed up, the temperatures slammed back down again. I have a feeling those conditions might have hammered a lot of insects."

CONSIDERING THE LONG-TERM OUTLOOK

Although there are still many unknowns, the work so far is providing food for thought about the outlook for potato psyllid populations and zebra chip in Canada.

For instance, Johnson is pretty certain that some potato psyllids are overwintering in southern Alberta. He bases his opinion on several indicators. One is that the adult potato psyllids collected on the sticky cards did not appear to have undergone long-distance flights. "If you look at them under a microscope, you can see that all the little hairs and all the parts of the wings don't show a lot of wear. In other words, they look like they recently transitioned from a non-flying nymph to a winged adult."

Another indication of overwintering is that the psyllids tend to be found in the same areas from one year to the next. If the adults were dying off each fall and being replaced by a new batch of adults falling out of the jet stream the next year, then there would likely be a more varied distribution.

For now, Johnson's best guess is that potato psyllids and zebra chip will not be a serious problem under the current climate and natural enemy conditions in Prairie potato fields.

"When I sample potato fields, I am very impressed with the range and diversity of the natural enemy community. The community is pretty healthy because growers really haven't been spraying much insecticide. So potato psyllids have a lot of predators waiting and continually searching for them, and that is a good thing. I would not

want to see a lot of insecticide spraying," he says.

"Also, I think we're on the edge of the optimal climate range for potato psyllids, and that every few years, the weather probably knocks their populations back quite a bit. So I think they will remain as a resident population and will pop up in noticeable numbers around the Prairies. A certain proportion of those will carry the zebra chip bacterium. My gut feeling is that we probably won't see huge outbreaks like the ones that have occurred in some years in the U.S. and elsewhere."

However, he cautions, "With a changing climate, outbreaks might happen." Qing (Summer) Xia, in her 2017 University of Lethbridge master's thesis, compared weather and climate data with scientific records of potato psyllids and psyllid yellows in North America as far back as the early 1900s. Those records include some Canadian observations; most of those were southern Alberta observations occurring from 1928 to 1944. Xia's findings confirm that warm temperatures coupled with moderate precipitation favour higher potato psyllid populations. Her results from using various climate models suggest that ongoing climate warming would increase the psyllid's range in Canada, particularly in parts of Western Canada.

Ongoing research and monitoring would help to get a firmer handle on the potential risk level for potato psyllid and zebra chip problems in Western Canada. Johnson says, "I think continued monitoring with a scientific approach and some transparency of sharing the results with growers and researchers could achieve a lot with very little resources."

IF THE PSYLLIDS DO BECOME A PROBLEM…

In places like Texas, where zebra chip is an ongoing major problem, the main way to fight the disease is by insecticide applications to control potato psyllids. Because potato psyllid control has not been needed in Canada, only a few products are currently registered for it in this country.

One example is Movento, a Group 23 systemic insecticide that moves in the plant's xylem and phloem. "The psyllids feed right in the phloem, and few insecticides move through the phloem. Movento's activity is largely through ingestion. It works primarily on the potato psyllid nymphs but it also has activity on the adult females indirectly by causing them to lay less viable eggs," says Andrew Dornan with Bayer Crop Science Inc. Canada. He explains that, like a lot of new insecticide products, Movento has a narrow spectrum of activity, which is a good thing. For example, it has little activity on some natural enemies of potato psyllids such as ladybird beetles, parasitic wasps, lacewing larvae and predatory bugs like pirate bugs.

Like McDade and Johnson, Dornan stresses that potato psyllids are not a problem in Canada at present, and insecticides should only be used if the psyllids really become a problem.

McDade emphasizes, "Running a good monitoring program is far cheaper than widespread insecticide applications. The cost of our surveillance program averaged out to about 65 cents an acre. This program allows us to take a very targeted and scientific approach to insect management. Knowing what the total insect population is out there and knowing if it can maintain itself at a healthy, balanced level, allows far better decisions on spraying.

"We are also very aware of the importance of only using chemicals such as insecticides and fungicides strategically to reduce the risk of creating resistance to these chemicals. Particularly now with the increased regulatory pressures regarding a lot of chemicals, taking this surveillance approach shows we are sustainable and continuing to grow as healthy and as high quality products as we can."