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Aster Yellows and Aster Leafhopper

Aster yellows is a phytoplasma organism. Phytoplasmas are specialized wall-less bacteria that are parasites known only to multiply in plant phloem tissue and insect vectors. There are 28 groups of phytoplasmas worldwide and seven known groups in Canada.

In Canada, approximately 20 insect species can transmit aster yellows to more than 200 plant species. In Alberta, the most common insect vector is the aster leafhopper (*Macrosteles quadrilineatus*), also known as the six-spotted leafhopper.

The leafhopper species *Amplicephalus inimicus* is also an important aster yellows vector in cereals.

About 20 insect species can transmit aster yellows in Canada.

Background

Aster yellows disease is common in Alberta, but usually at very low incidence and severity. However, outbreaks have been recorded in 1957, 2001, 2007 and 2012. The most recent outbreak in 2012 was much more severe than past outbreaks.

Generally, aster yellows infection is considered to have a minimal effect on crops on the Prairies, with disease incidence lower than one per cent in canola. In a research study conducted in Saskatchewan at 7 locations from 2001 through 2008, the aster yellows disease incidence in canola fields was less than 0.1 per cent, similar to the provincial average, based on visual symptoms.

In Saskatchewan, visual symptoms on canola in the 2007 epidemic year found aster yellows incidence was at 2.5 per cent, with exceptions for several sites north and east of Saskatchewan where visual symptoms reached an average of 10 per cent.

However, visual observations underestimate the incidence. When Polymerase Chain Reaction (PCR) analysis was used to detect aster yellows DNA, phytoplasma DNA was detected in 4.7 per cent of canola plants on average.

While visual symptoms are rare in cereals, PCR testing found the incidence ranged from 6.4 to 30.4 per cent in years with no epidemics. In 2007, the aster yellows incidence reached 11.2 per cent in canola, 66.6 per cent in barley, 38.8 per cent in wheat and 25.4 per cent in oats.

In the 2012 outbreak, aster yellows symptoms on canola were observed on average on 10 per cent of the plants (range of 3 - 80%) while PCR analysis found an average aster yellows incidence close to 25 per cent (range 12 - 90%) in Saskatchewan plots.

Life/disease cycle

The phytoplasma requires a living plant host and insect host to survive, spread and reproduce. The aster yellows phytoplasma survives in the phloem (nutrient-carrying vessels) of infected plants. Sap-sucking insect vectors carry it from plant to plant.

Aster leafhopper

As the primary insect vector, the aster leafhopper is responsible for the spread of most aster yellows. In Saskatchewan research, the aster leafhopper had the highest infection rate with an average of 8.3 per cent of specimens collected from 2001 through 2008 infected with aster yellows, with a range of 1.1 per cent to 19.8 per cent.

In 2012, approximately 12 per cent of leafhoppers collected in Saskatchewan tested positive for phytoplasma DNA, with a range of 3 to 46 per cent.

As many as three generations of aster leafhopper may occur on the Prairies per year.

Adults

While aster leafhopper has been found to overwinter on the Prairies as adults or else hatch from overwintering eggs, the majority overwinter in the southern and central United States. They then migrate to the Canadian Prairies on southern winds.

The adults usually arrive in early to mid-May to mid-June. However, aster yellows outbreaks are usually associated with arrival of aster leafhopper in early April.

Adults are 3.5 to 4 mm long, light green or yellowish and have 6 dark spots arranged in 3 rows on the head. The adult is narrow and wedge-shaped, with a beak and tiny antennae. It has long hind legs fringed with hairs.

Leafhoppers jump and fly readily at temperatures above 15° C. Rain and cool temperatures will slow migration, and in these conditions, the insects are more concentrated at field edges and in patches.

Eggs

Eggs are laid in plant tissue, and nymphs emerge within a few days.

Nymphs

Nymphs hatch from eggs and go through five nymphal stages before adulthood is reached. Nymphs are small, wingless versions of the adults about 0.6 to 3 mm in size.

Aster yellows phytoplasma

Aster yellows phytoplasma can overwinter in plant roots. Infected biennial and perennial crops and weeds can be a source of aster yellows phytoplasma in the spring.

The phytoplasma also survives in insect vectors. Phytoplasma transmission through leafhopper eggs has not been found under Prairie conditions.

When a leafhopper feeds on an infected plant, the insect can pick up the phytoplasma. An incubation period of 10 to 18 days is necessary for the phytoplasma to circulate and reproduce within the insect before it becomes infective. The infective leafhopper must then feed on a healthy plant for a substantial period (8 hours for 50 per cent success) to pass on the phytoplasma.

Aster yellows has been detected in canola seeds harvested from infected plants and in the subsequent seedlings, but not in the mature plants. However, seeds are not seen as a significant contributor to disease transmission.

Host plants and damage

Aster leafhopper feeding does not cause the damage to plants. Rather, the infection of aster yellows phytoplasma produces negative effects on the crop.

Many crops can be infected:

- canola
- camelina
- flax
- cereals
- pea
- chickpea
- sunflower
- herbs and spices
- alfalfa
- bromegrass

General symptoms include stunting, excessive branching (witch's broom), smaller leaves and poor or no seed set. The symptoms of aster yel¬lows may vary in severity and intensity, depending on many factors, including phytoplasma strains and plant species. Yellow discolouration of leaves occurs in many plants.

Canola

In canola, infected plants may be blue-green with purplish stems and leaves. Flowers may be replaced by green, leafy structures, and pods may be replaced by oval, bladder-like structures.

Infected plants can produce 30 to 60 per cent misshapen seed, but in the 2012 outbreak, 8 to 10 per cent of plants did not produce any seed at all. Immature canola seed may also germinate in the pod.

Yield loss occurs when normal pods fail to be produced as well as when misshapen seeds form. A sample of 100 plants across the field will indicate a percentage incidence of symptomatic plants.

Be sure to scout the crop rather than estimating incidence as the actual number of infected plants is usually less than first appears due to the striking visual symptoms. Assuming that 1 infected plant may produce 30 to 70 per cent misshapen seeds, producers may expect 0.3 to 0.7 per cent yield loss for every 1 per cent incidence of aster yellows in the field.

Camelina

Symptoms include stunting, greenish-yellow or reddish-purple leaves, stems and pods as well as distorted inflorescences.

Flax

Infected flax plants may be yellow, particularly on the top part of the plant, with high numbers of malformed, sterile flowers that fail to form bolls or seeds.

Cereals

While cereals are commonly infected by aster yellows, they seldom show visual signs of infection. Symptoms on cereals may include water-soak marks on leaves, leaf rolling and witch's broom. Yellowing, red and purple pigmentations may be evident. The head may be small, sterile, distorted or twisted.

Symptoms can be very similar to Barley Yellow Dwarf virus, and the only way to differentiate is with a PCR test.

Potato

The incidence of potato purple top is usually low, but the disease can be devastating when leafhopper populations are high. Phytoplasmas may also be transmitted by infected tubers. Potatoes infected with phytoplasma may have purple leaves and produce aerial tubers. The tubers may become dark when cooked and be rejected by the industry.

Vegetable crops

Carrot, celery and lettuce are the vegetable crops most susceptible to aster yellows. The disease in carrots is called "red top," and plants show yellow to red or purple young foliage. The carrot root can show witch's broom, increased root hair and stunted growth.

Celery may have yellow, elongated, twisted and upright leaves. Lettuce heads may have latex spots.

Monitoring

Sticky traps and sweep nets can be utilized for early detection and monitoring of leafhoppers to give producers an early warning of potential problems.

However, in field crops, few management options are available, so monitoring for the arrival and scouting for aster leafhopper infestations are not useful. In addition, without PCR testing, producers are unable to determine if leafhoppers are affected with aster yellows.

When scouting fields, aster yellow symptoms can be confused with other symptoms:

- nutrient deficiencies,
- Group 4 herbicides containing growth regulators
- drought
- other environmental stresses

Purpling of canola plants can be triggered by stress, which causes anthocyanin production.

Root rot, "take-all," fusarium head blight, insects, herbicides, hail damage and environmental stress can cause white heads in cereals.

Barley Yellow Dwarf Virus can cause stunting and yellowing in cereals.

Economic thresholds

No economic threshold exists for leafhoppers in canola. When symptoms are observed in the field, insecticide application to control leafhopper infestations in field crops will not produce an economic return as the crop is already infected with aster yellows.

Control

Environmental

Hot, dry conditions are not conducive to the spread of aster yellows, whereas abundant rainfall will make plants more suc¬culent and attractive to leafhoppers.

Biological

In Canada, several species of parasitoid wasps attack the aster leafhopper, but may not provide effective control because of the migratory nature of the vector.

Chemical

Insecticidal control of leafhoppers is not practical in field crops since several applications would be required to control multiple waves and generations of leafhoppers. Insecticide application can also have a negative effect on beneficial insects.

Cultural

Crop rotation is not effective as many crops are affected by aster yellows, and it is not a soil-borne disease. Currently, no commercial varieties of canola contain resistance to aster yellows. Based on field observations, *B. rapa* (Polish-type) canola seems to be more susceptible than *B. napus* (Argentine-type canola), *B. juncea* (brown mustard) or *S. alba* (white mustard), but this finding has not been verified in the laboratory.

Best management practices

- Insecticide application is not recommended for leafhopper control.
- Protect beneficial insects by only spraying for other pests when economic thresholds are reached.

- Maintain clean fields without weeds to remove food sources and reproductive sites for leafhoppers.
- Early seeded crops may mature and be less attractive to migrating leafhoppers.
- Do not plant near infected perennial forages, herbs or spices.
- Control perennial and biannual weeds.
- In perennial crops:
  - Remove and destroy visibly infected plants, including roots, if possible.
  - Till or mow around the crop to reduce leafhopper habitat.
  - Use healthy plants for propagation.

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