Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

2012 Aster yellow outbreak in Saskatchewan

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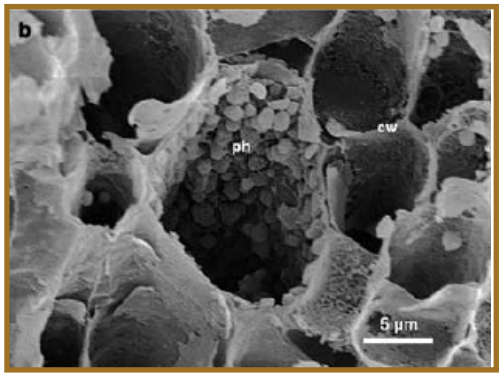
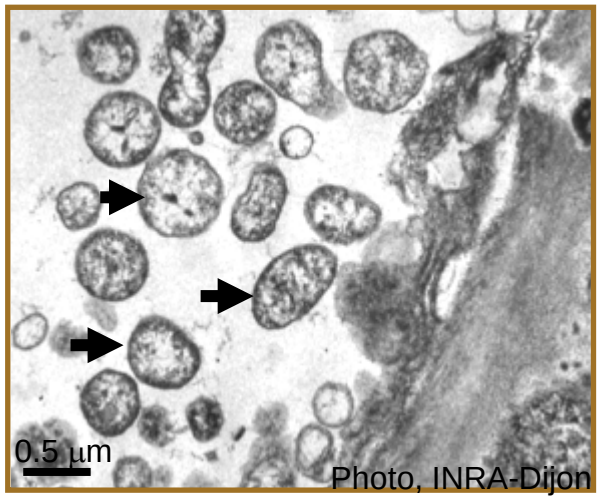
Canada

AY phytoplasma

Phytoplasmas are specialised wall-less bacteria that are obligate parasites of plant phloem tissue and of insect vectors.





Photo, INRA-Dijon

Characteristics

- 28 groups worldwide, 7 groups in Canada
- AY the most common and widespread: + 100 host plant species,

AY symptoms on other plants

AY phytoplasma

Important characteristics

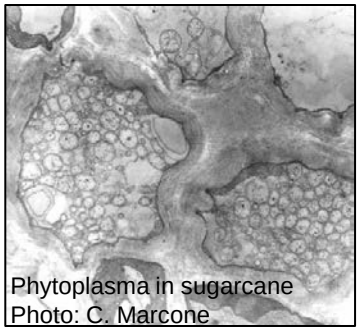
- Live and reproduce in insect organs and in plant phloem.
  - **Insects and plants are infected for life**
- Can overwinter
  - in overwintering insect adults
  - in roots and dormant woods of perennial plants (dandelions, quackgrass, shrubs, trees, ...).

Disease reservoir
(abundance?)

AY phytoplasma

Symptom expression (poorly understood)

After a latent period: 6-8 weeks, depending on the weather/strain, varieties, stresses, … (parameters?)


Phytoplasma in sugarcane
Photo: C. Marcone

Up/down gene regulation

Phytoplasmas

Pump all the metabolites from the plant & multiply

Chlorosis, stunting, poor growth
Flowers become leaf-like structures

Poor seed production

AY symptoms on canola

- Sterile bladder like pods
- Small witches'-broom
- Yellowing, purpling
- Other causes for purpling:
    - Varieties
    - Deficiency in minerals
    - Herbicide injuries

AY symptoms in 2012

Presence of symptomatic branches at the base, after harvest

AY symptoms on Camelina sativa & Sinapis alba

Yield losses: AY symptoms on seeds

- Sterile bladder-like pods.
- Normal looking pods with germinated seeds.
- Normal looking pods with normal-looking & misshapen seeds.

Healthy

AY-infected

Photo: E. DeMilliano, AB

Photo: E. DeMilliano, AB

~30-60% misshapen seeds in AY infected canola (2002-05).

Same in 2012 ?

8-10% plants with no seeds

AY phytoplasma

Transmission

- By insects, mostly leafhoppers (a few planthoppers, psyllids)

  By feeding from plant to plant

  By seeds? (**PCR tests – DNA detection**)

  - 2002-2005: < 1% infected seeds / 2012: 8% (AAFC plots)
  - 2002-2005: 1.5% of infected seedlings growing from infected seeds

AY symptoms in 2012

-Canola Council of Canada, AB canola producers

-Inoculation of canola plants at cotyledons, 2 leaf, 4-5 leaves, pre-bolting and bolting stage with leafhopper infected with AY.

- 400 plants, inoculation started mid-December.

AY symptoms in 2012

First results: 60 plants tested, 45 infected, 5 with symptoms

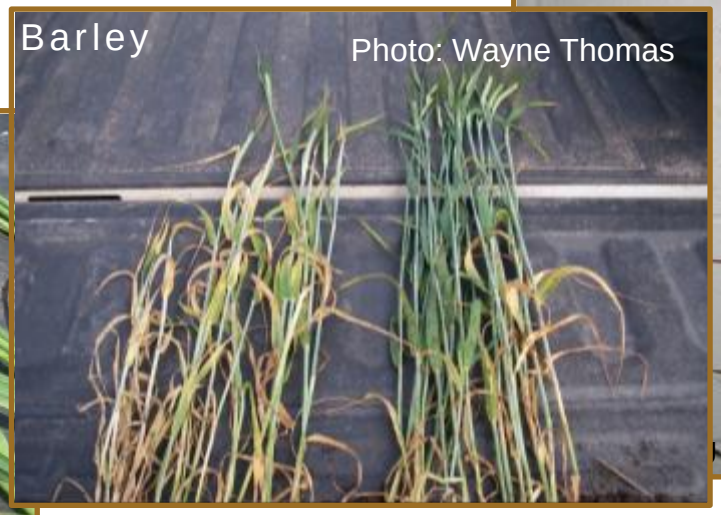
- Infection at cotyledon stage: no seeds.
- Infection at 2 leaf stage: some seeds, flower abortion, ...
- Other: in progress.....

AY symptoms on cereals

- Yellowing, red & purple pigmentation
- Leaf rolling, erect habit and necrosis
- Head small, sterile, distorted, twisted.
- *Very similar to BYDV....only way to differentiate: PCR*

AY symptoms on cereals

AY or BYDV ?



PCR on cereal samples:

- *Wheat: <5%*
- *Barley:~25%*
- *Oats: 17%*
- *More PCRs to do…*

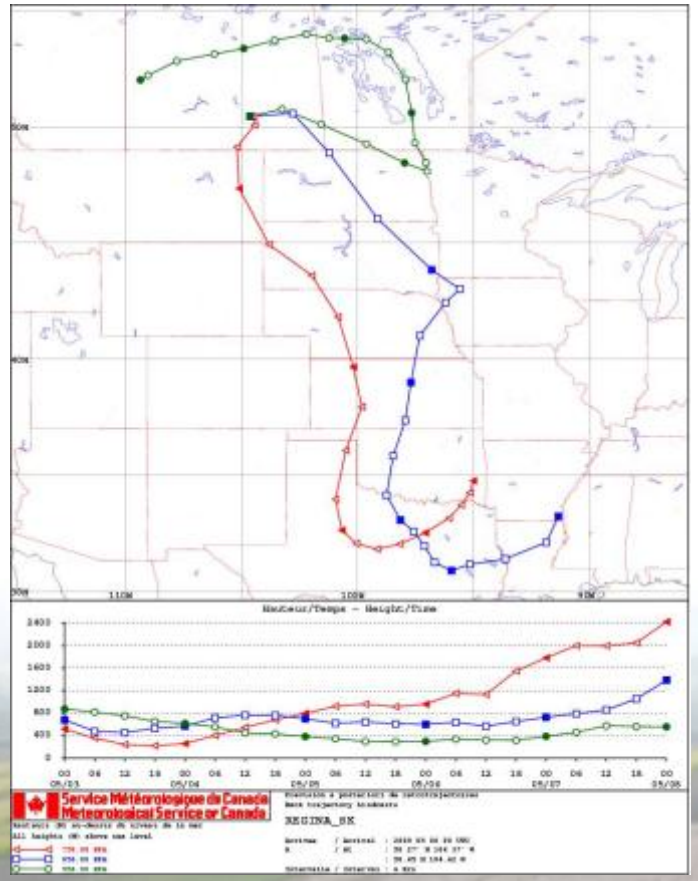
AY phytoplasma

Aster Yellows phytoplasma (16SrI)

Main vector: Aster leafhopper (*Macrosteles quadrilineatus, formerly M. fascifrons)*

Migratory: South winds in spring
- High number of leafhoppers
- Infection in South USA
- Several South winds

Local pop.: abundance?



AY phytoplasma

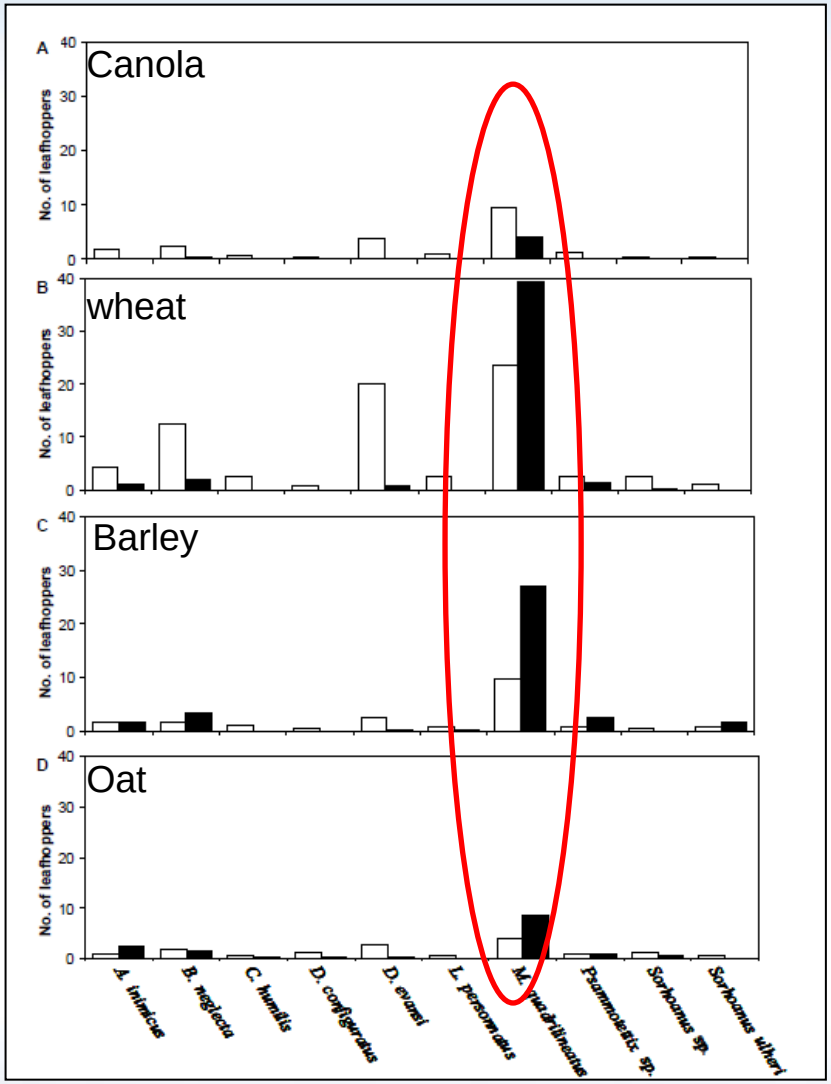
AY phytoplasma

Aster Yellows phytoplasma (16SrI)

- 7 other potential leafhopper vectors (role in outbreak, maintain reservoir?, abundance?)

Potential vectors in oilseeds
Endria inimica
Colladonus montanus
Colladonus geminatus
Euscelis maculipennis
Scaphytopius acutus
Exitianus exitiosius
Paraphlesius irroratus

Leafhopper distribution

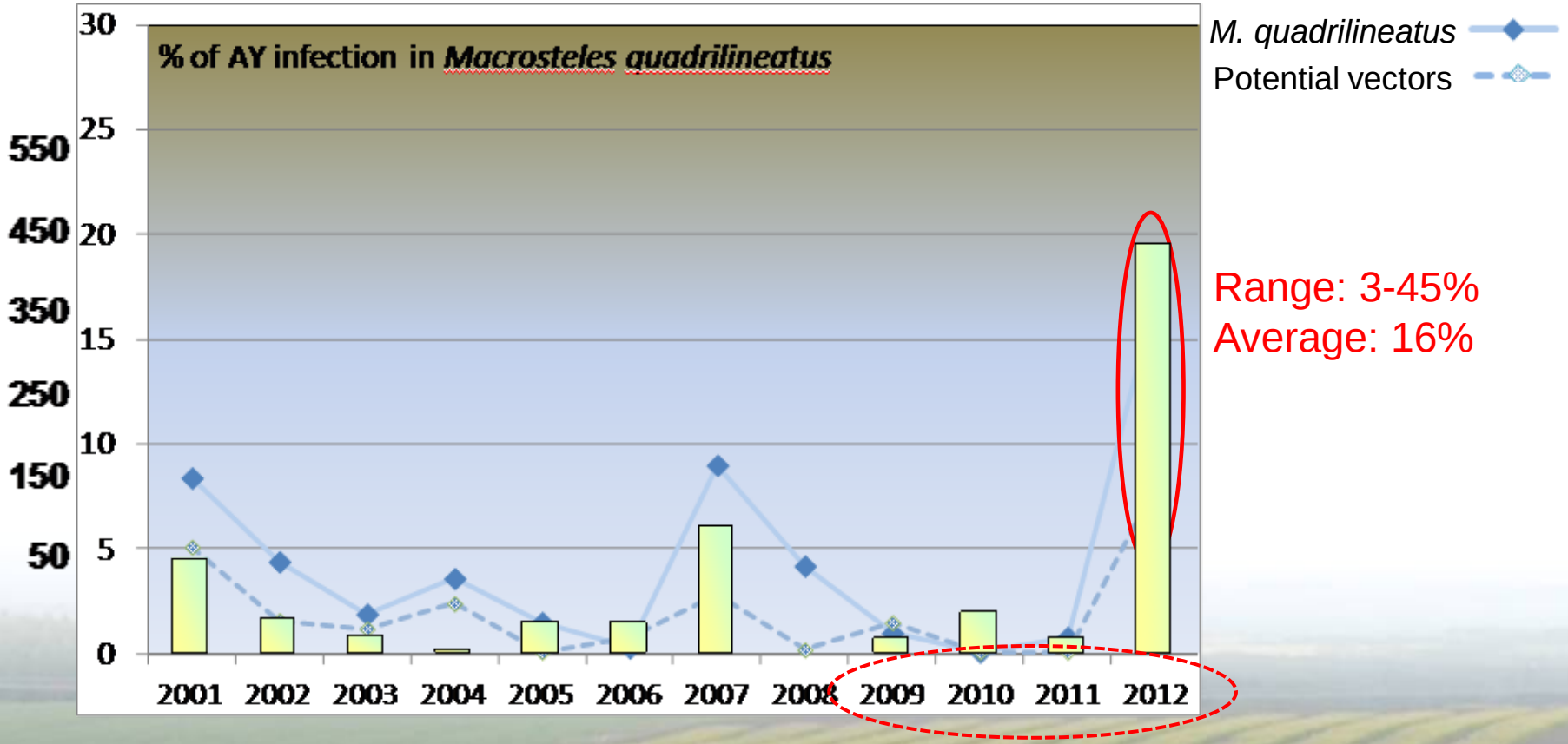


Based on the average no of leafhoppers in 2004-2008.

M. quadrilineatus is more abundant in cereal, as compared to canola.

Olivier et al., 2011

Leafhopper infection and number



AY epidemiology

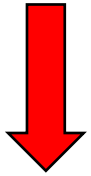
Next outbreaks????

Cannot forecast the date...

need to monitor winds, and leafhopper arrival and infection.

Are we at risk of more outbreaks? YES!

- Local population of vectors on the increase, AY in weeds
- Warmer winters: higher survival of phytoplasmas and overwintered leafhopper adults and eggs.
- Southerly winds coming earlier ?



Inoculum coming earlier, with higher probability of survival

	Date
2001	April 29
2002	May 22
2003	June 20
2004	May 9
2005	May 7
2006	April 1
2007	**April1**
2008	April 10
2009	April 11
2010	April 13
2011	April 10
2012	**April 1**

AY phytoplasma control

Phytoplasma control

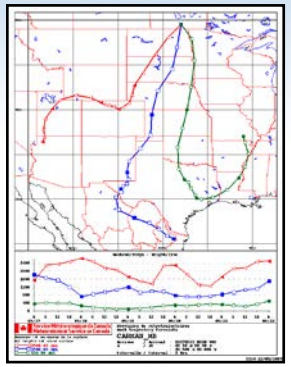
- Antibiotic
- Heat (>32C for several days)
- No commercially available products that can control the phytoplasma

Insecticides to control the vector population.

- Need several sprayings (waves of southerly winds).
- Negative impact on beneficial insects and environment.
- Leafhoppers are mobile, can transmit the disease before being killed.
- Latent period of 6-10 weeks for symptom development on canola (& most annual plants) after inoculation by leafhoppers.

When symptoms are observed, it is too late to spray

AY phytoplasma control



Other control measures:

- Resistance or disease avoidance
- Early warning system...feasible but lots of unknowns.
    - Ratio local / migratory population of *M. quadrilineatus*
    - Role of other vectors & of reservoir plants
    - Leafhopper movement crop-to-crop.
    - .....
- Weed management: weed abundance and diversity favors leafhopper population.
- Predators / parasitoids...not well known for AY vectors in the prairies
- Seed treatments (research funded by Saskcanola...starts April 2013)
- ...

Conclusion

- Phytoplasma diseases: difficult to study & to control.
  - Many unknowns…strains ID, role of vectors, symptom expression
- Risks of increased AY incidence in the future
  - Due to (?) climate change, increased number of leafhoppers, …
- Solutions?...few!
  - Insecticides: controversial
  - Early warning system and resistance / avoidance: need further study
  - Other options (symbionts, seed treatment…?)

Song dynasty, China, 960-1227.
Yao-yellow peonies at the imperial court.
(Maramorosch, 2011)

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