Crop rotation and insects? The mysterious case of aster yellows

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Canola Discovery Forum

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Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

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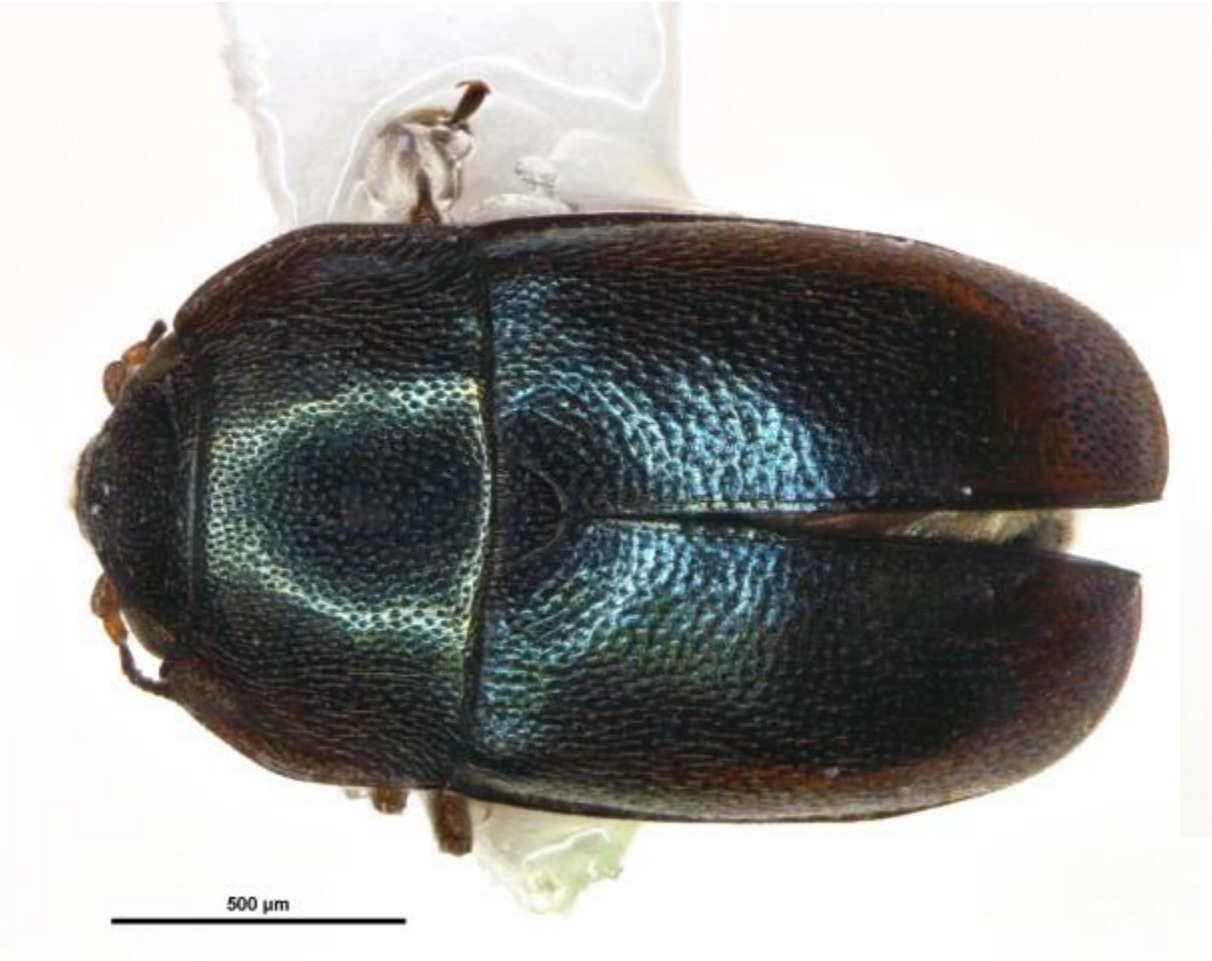
Canada

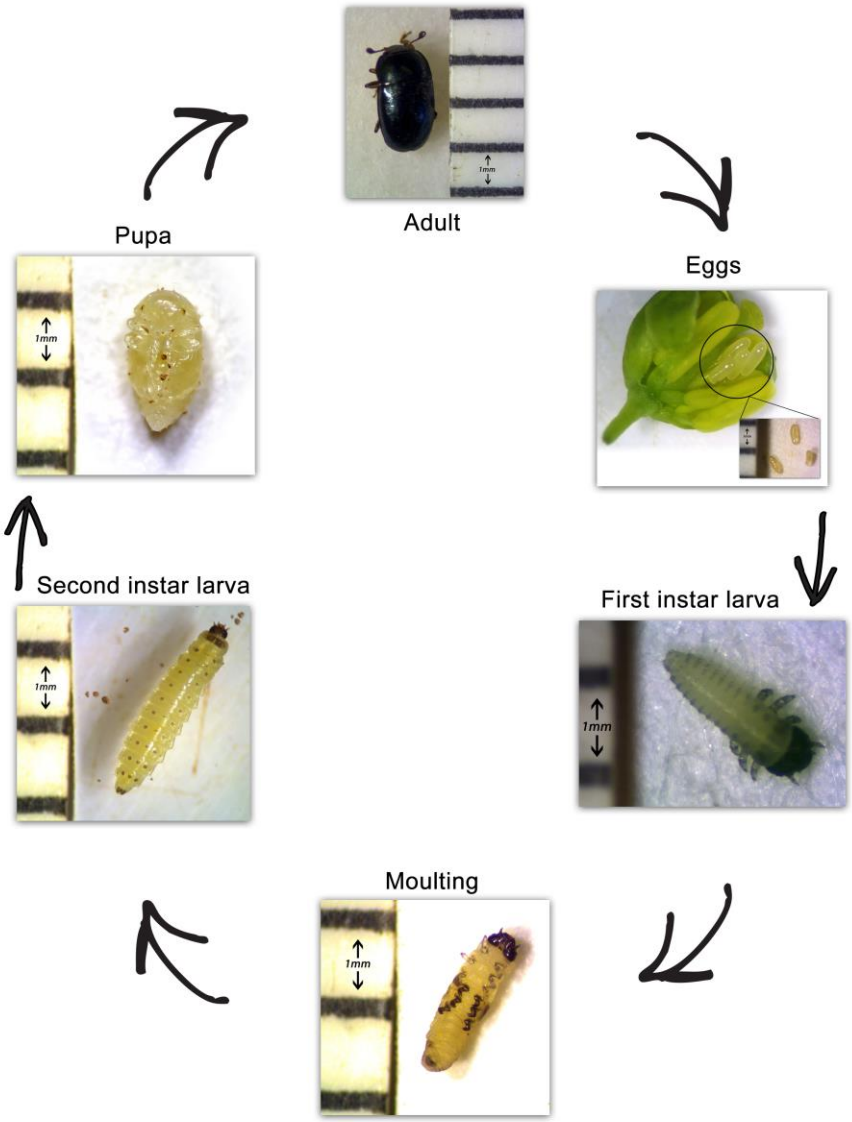
Pollen beetle

- *Brassicogethes viridescens*
- (Coleoptera: Nitidulidae)

Europe: 70% yield loss



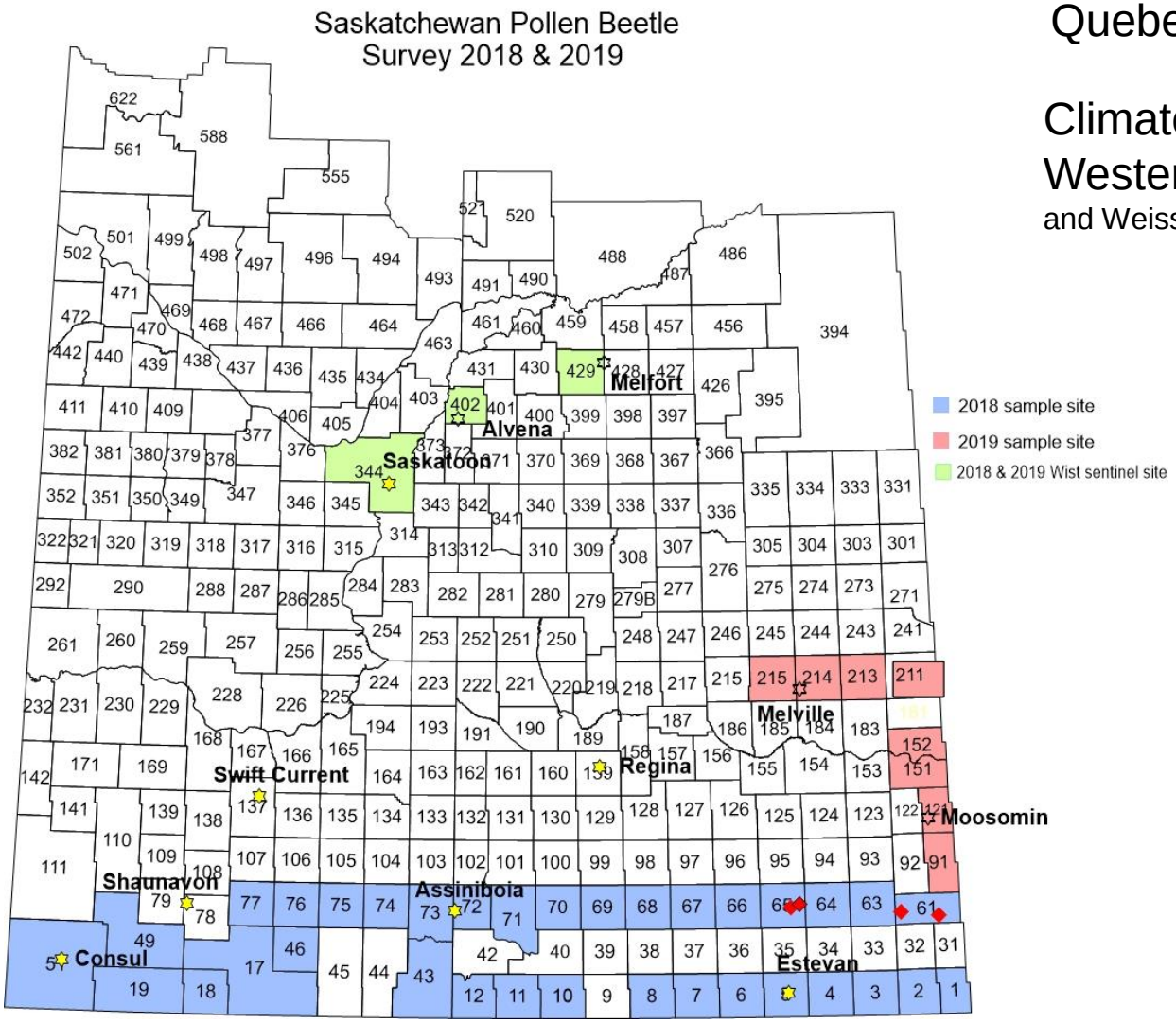
Obligatory diapause



Pollen feeding: larvae + adult =
Flower abortion

Pollen beetle in Nova Scotia 1967
Now established there, PEI and Quebec

Climate models = establishment in Western Canada (Mason et al. 2013; Olfert and Weiss, 2006)



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CARP funding

No pollen beetle in Alberta (Hector Carcamo) or Manitoba (John Gavloski)

CANADIAN AGRICULTURAL PARTNERSHIP

Flea beetles

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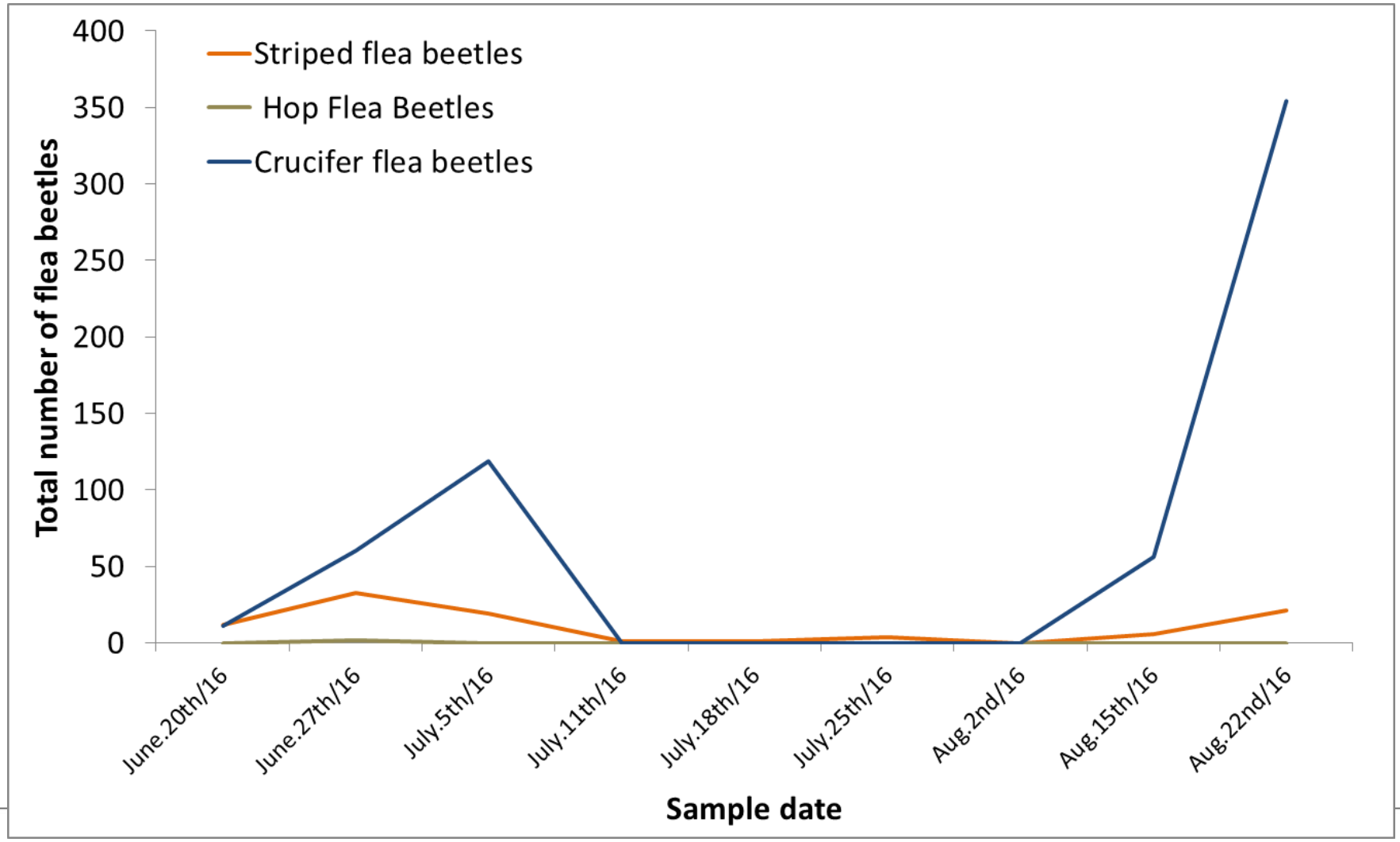
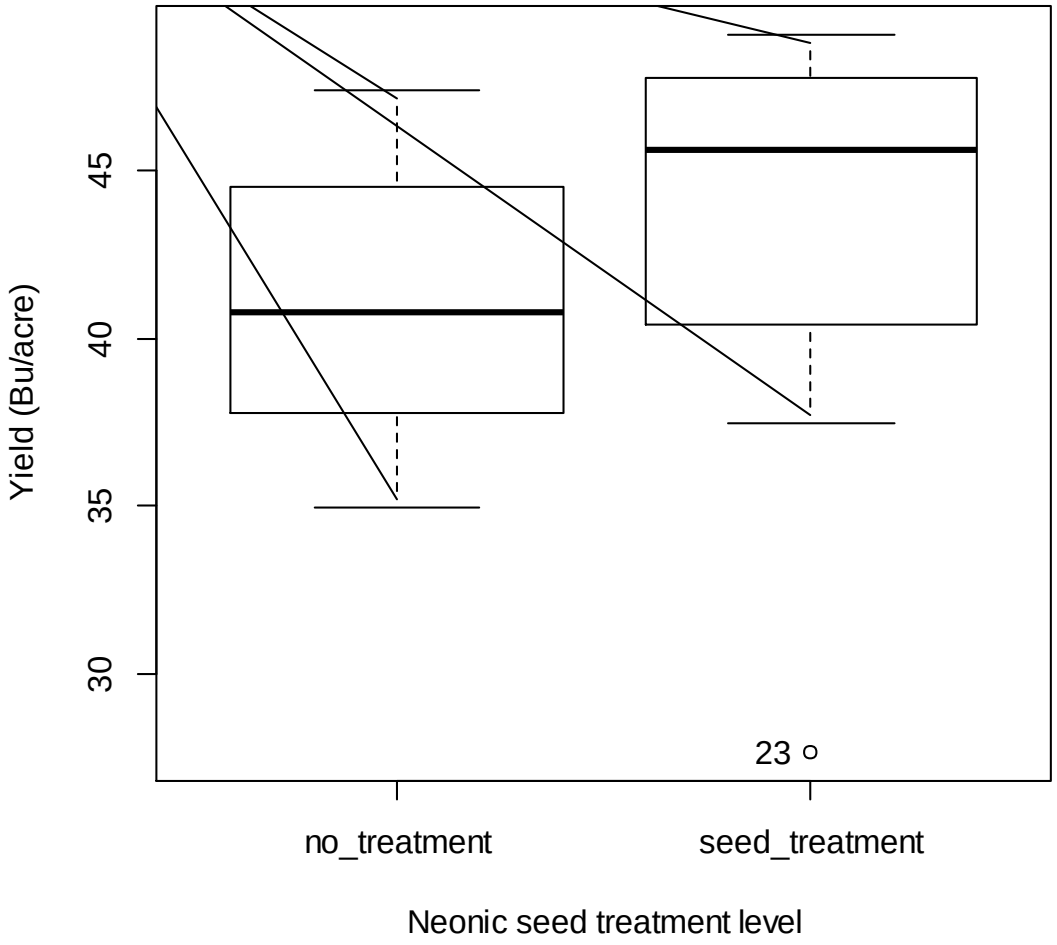
CARP
and CAP

Flea beetle populations: Saskatoon



Neonic treated canola seed vs untreated canola seed



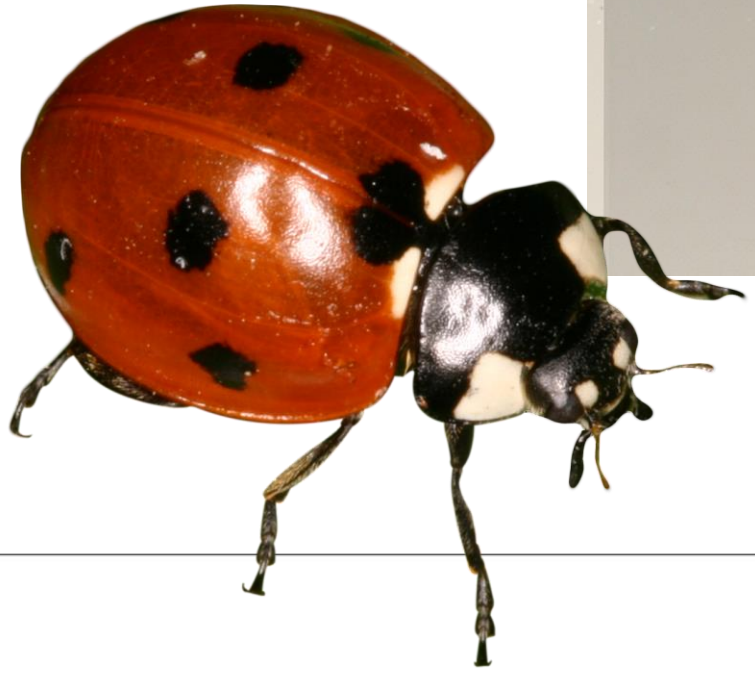
X^2 = 0.1817
GLM binomial,
Blocked by Range

N=16 N=12

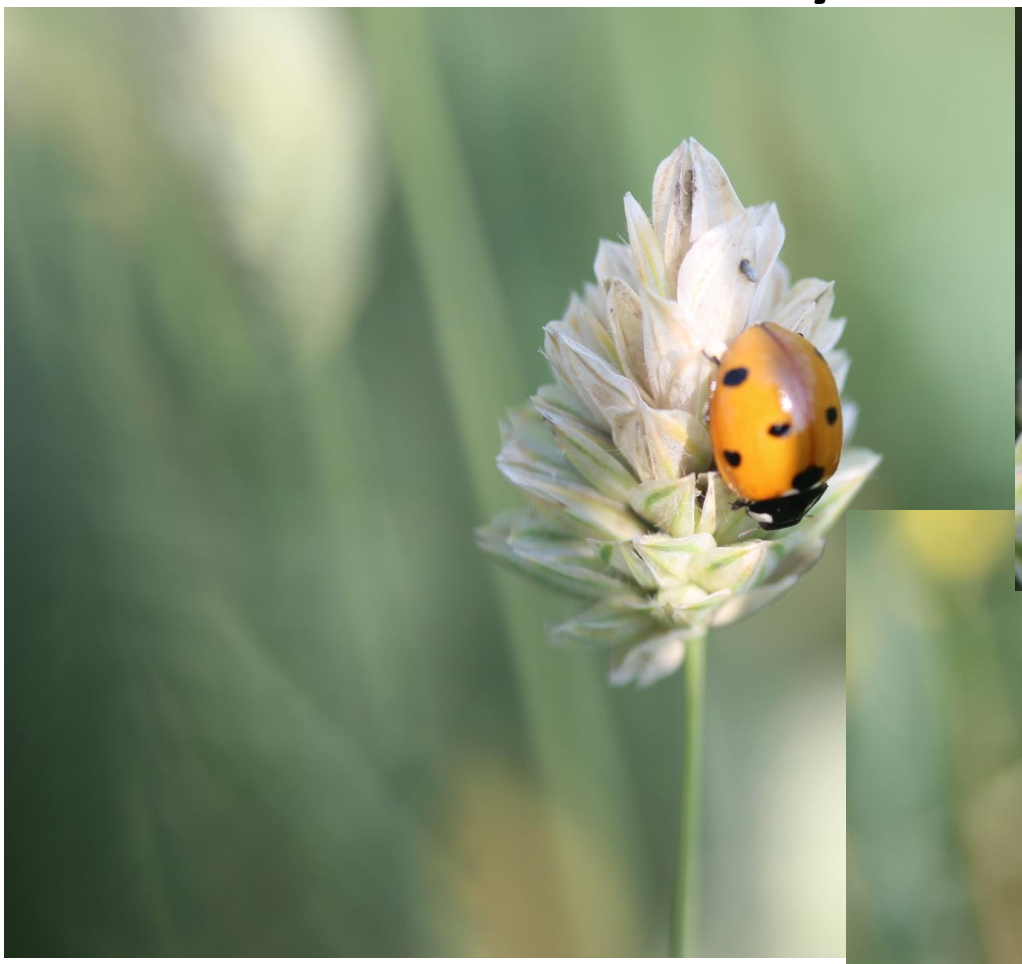
Beneficial insects

Ladybugs

- Overwinter as adults
- Near the crop that produced them



Lady beetles



Aster Yellows

Vectored by aster leafhoppers

Macrosteles quadrilineatus

Migratory.

Results in these…aster yellows infected canola plants

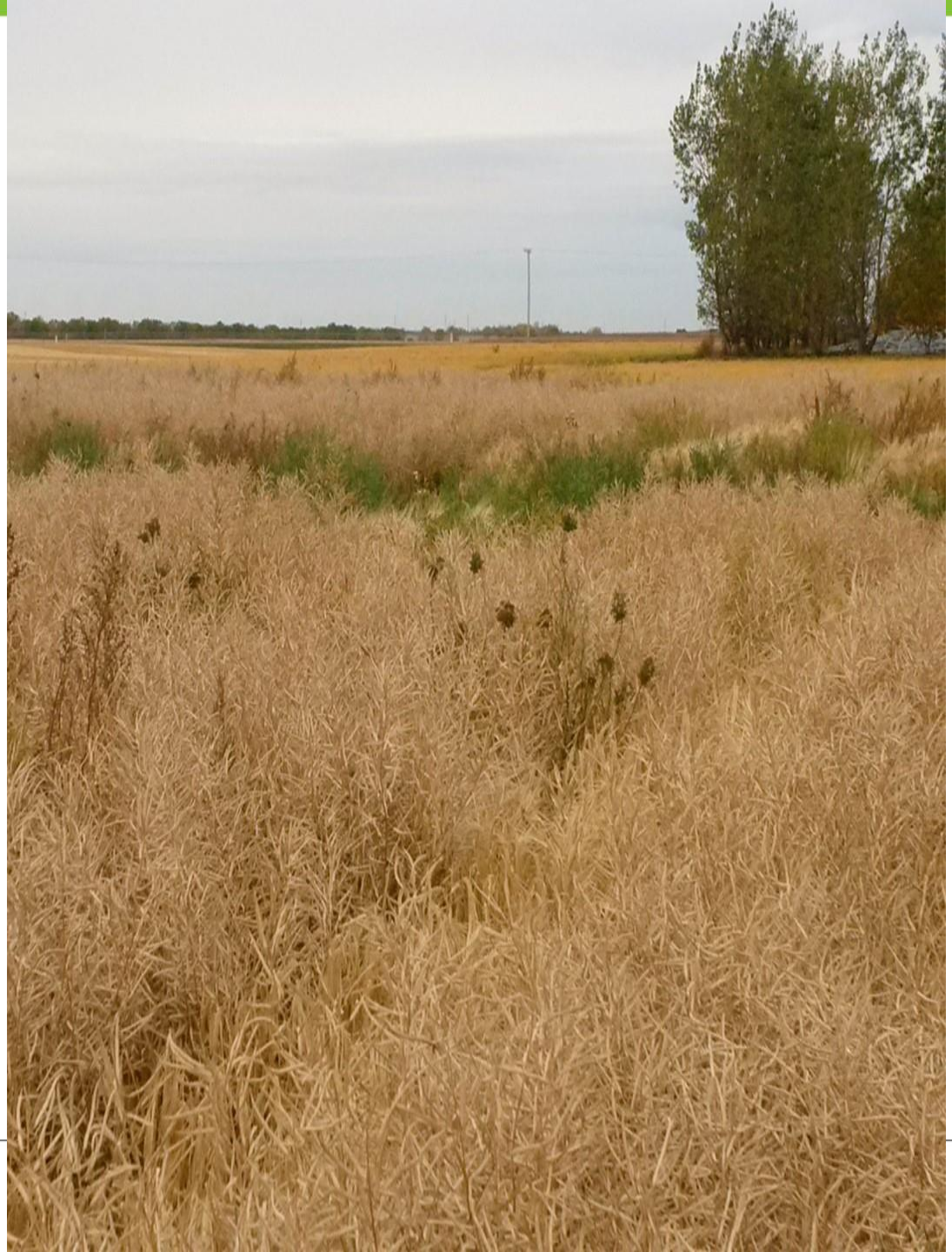
Migratory?

Aster yellows (AY) diseases

Chrystel Olivier, Bob Elliott
AAFC SRDC

Symptoms of Aster yellows disease in canola

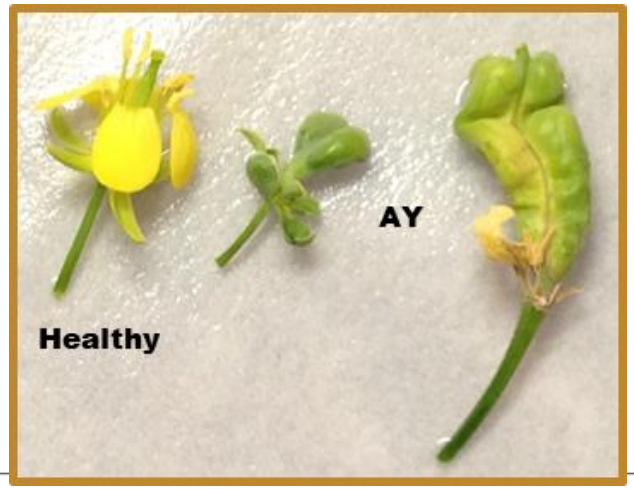
- Bladder-like pods
- Malformed, misshapen seeds



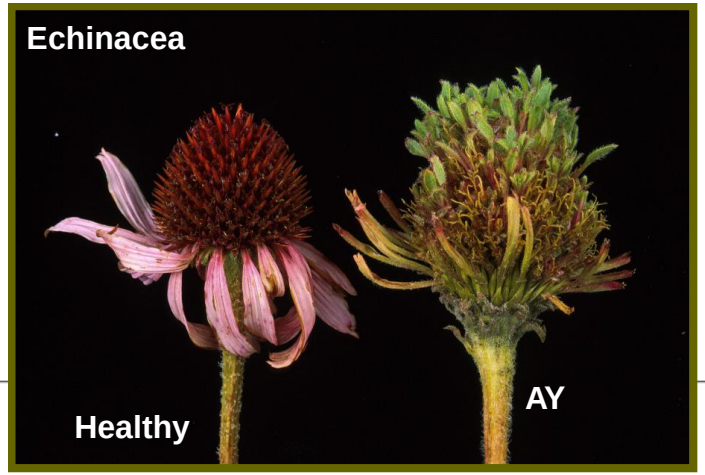
Aster yellows (AY) diseases

Characteristics of Phytoplasma

- Transform floral organs into leaf like structure (weeks/years post infection)
- Overwinter in roots of perennial plants (disease reservoir)
- Once insects and plants are infected, they are infected for life
- **No chemical to control phytoplasma** (except antibiotics)
- Use of insecticide to control the vector (uprooting for perennial).



Perennial

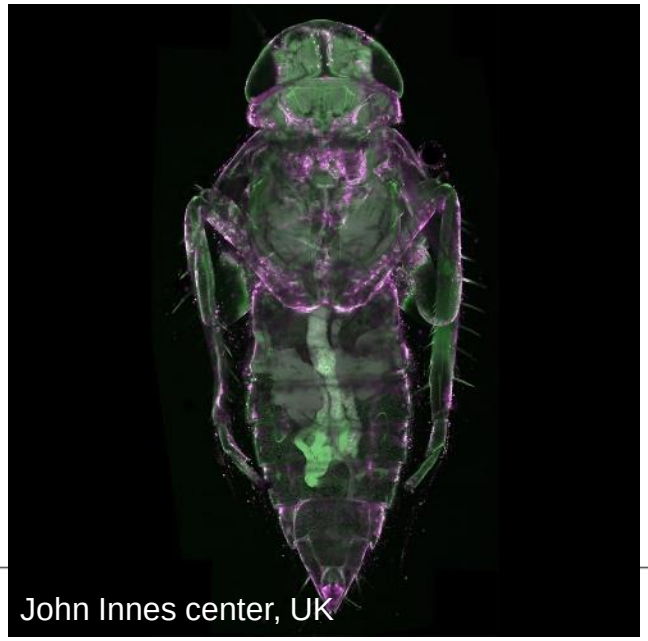


Aster yellows (AY) diseases

Phytoplasma are:

- Wall-less unculturable bacteria
- **Obligate parasites**: plant phloem and in insect vectors
  - can not survive outside their hosts

Phytoplasma in leafhopper
(fluorescence microscopy)



Phytoplasma in plant sap (electron microscopy)

AY outbreaks in canola?

- Most years: <0.1% incidence.
- Past 10 years: increase of incidence
- 2012: ~$400 millions losses

1957 2000 2007 2012 2019?

2-10% incidence
(Vanterpool 1957)

2000: 2-15% incidence
(Pearce et al., 2001)

2007: 2-25% incidence
(Olivier et al., 2011)

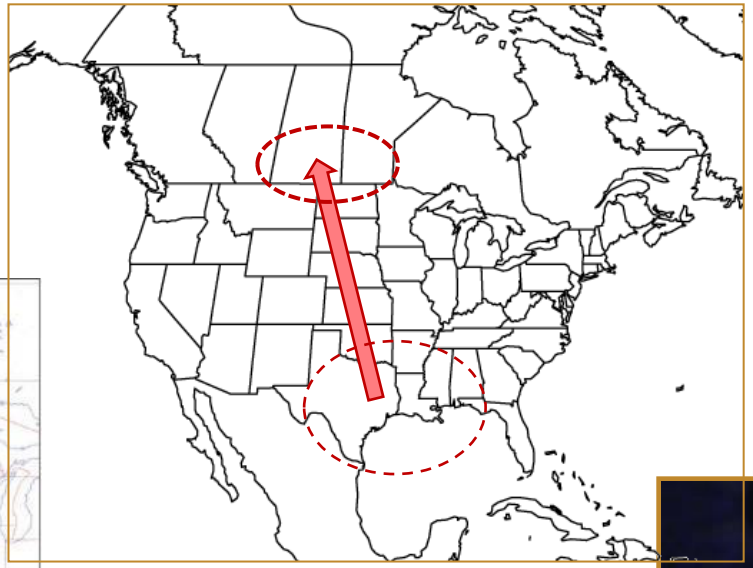
2012: 5-64% incidence
(Miller et al., 2013)

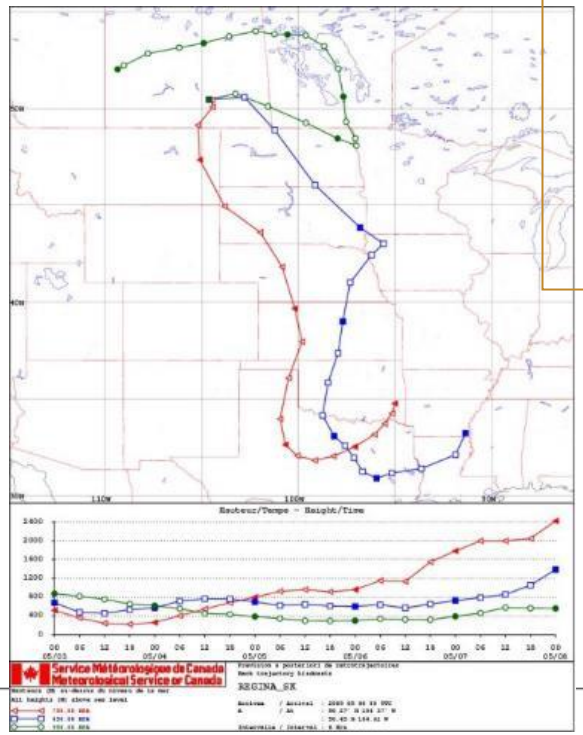
2019: ?
Atypical symptoms

Aster yellow vectors

Aster Yellows.

- Other potential vectors:11 leafhopper species.
- Aster leafhoppers follow migrations with wind trajectories

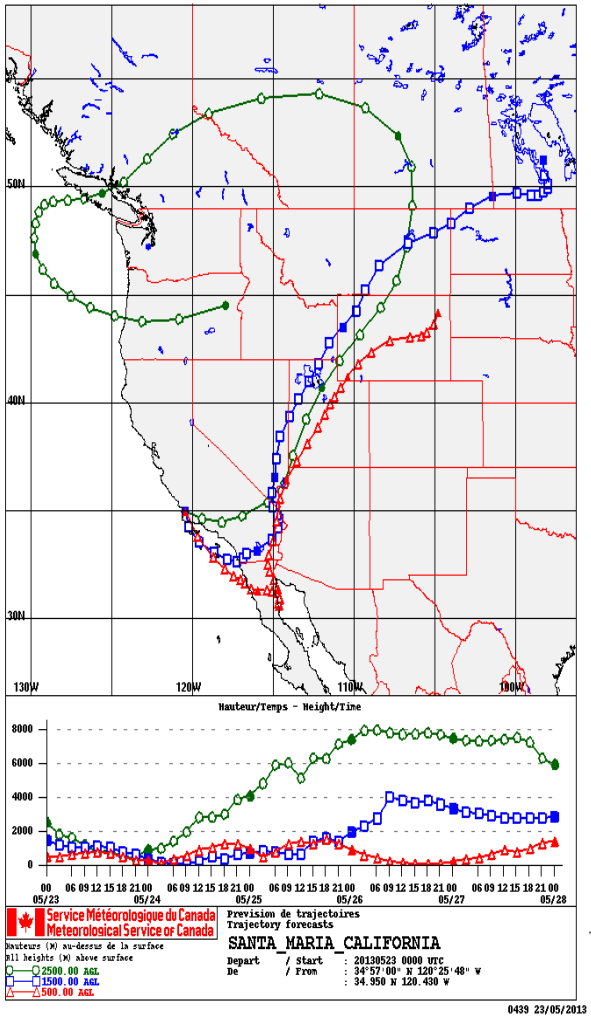




Aster Yellows predictions

South Wind: Reverse Trajectories

- PPMN monitors winds
- Env. Canada
- Migratory pests
  - Diamondback moths (DBM)
  - Aster leafhoppers
  - Aphids



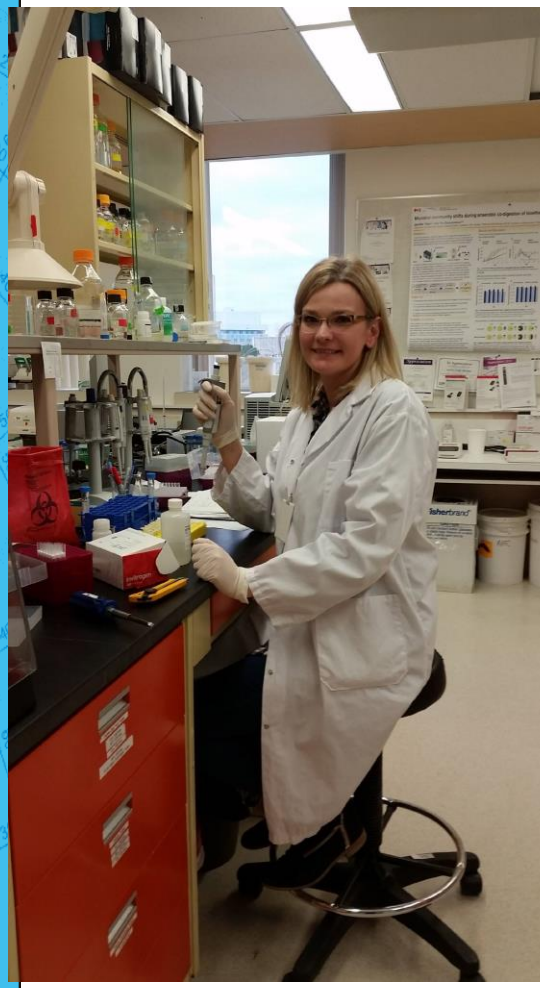
Owen Olfert[1], Ross Weiss[1], Meghan Vankosky[1] and Serge Trudel[2]

1 - AAFC

2 - ECCC

Genetic markers to ID popns of aster leafhoppers: CO1 and NADH

Le Roux and Rubinoff 2009 GenBank records



Western Grains Research Foundation

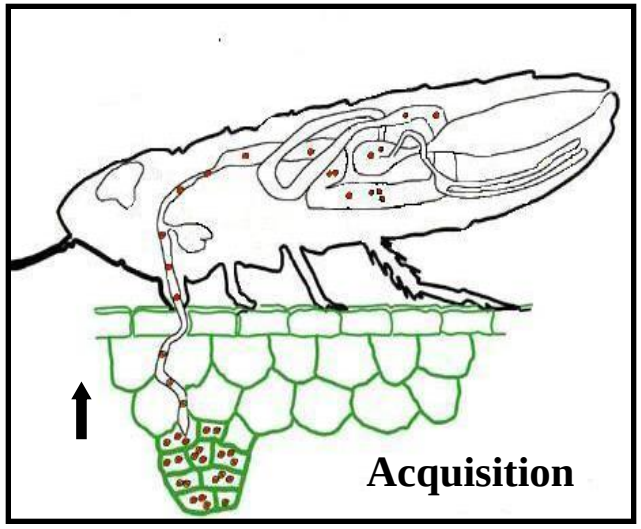
Stable isotope ratio Deuterium/Protium ratio
Keith Hobson: migratory birds and armyworms

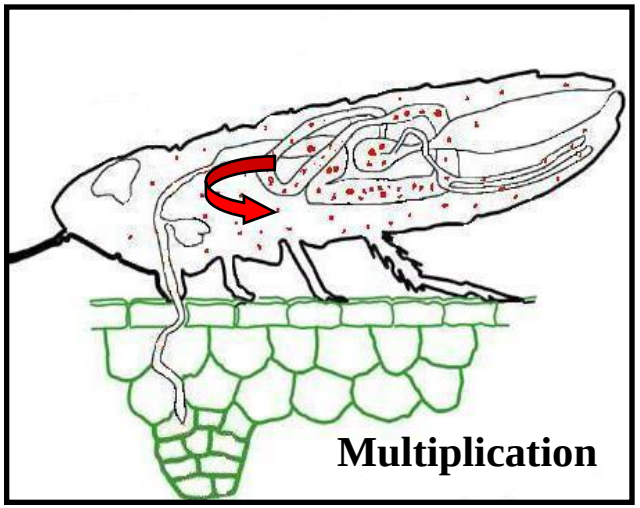
Determine the common sources of infected aster leafhoppers to better understand risk each year

…and when they get here?

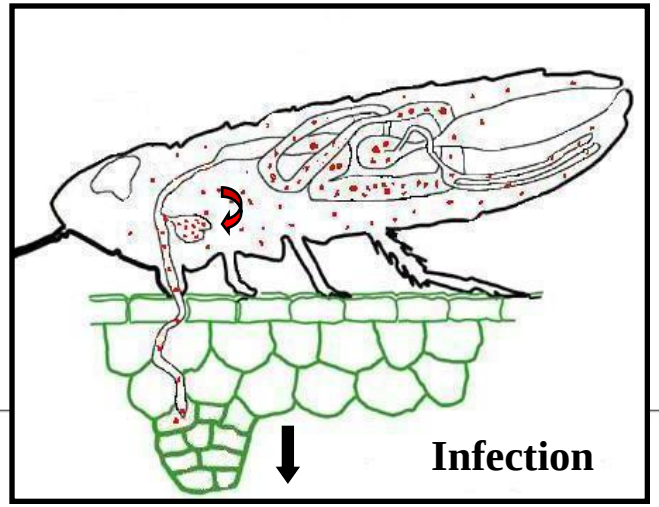
Western Grains Research Foundation

Phytoplasma Life cycle

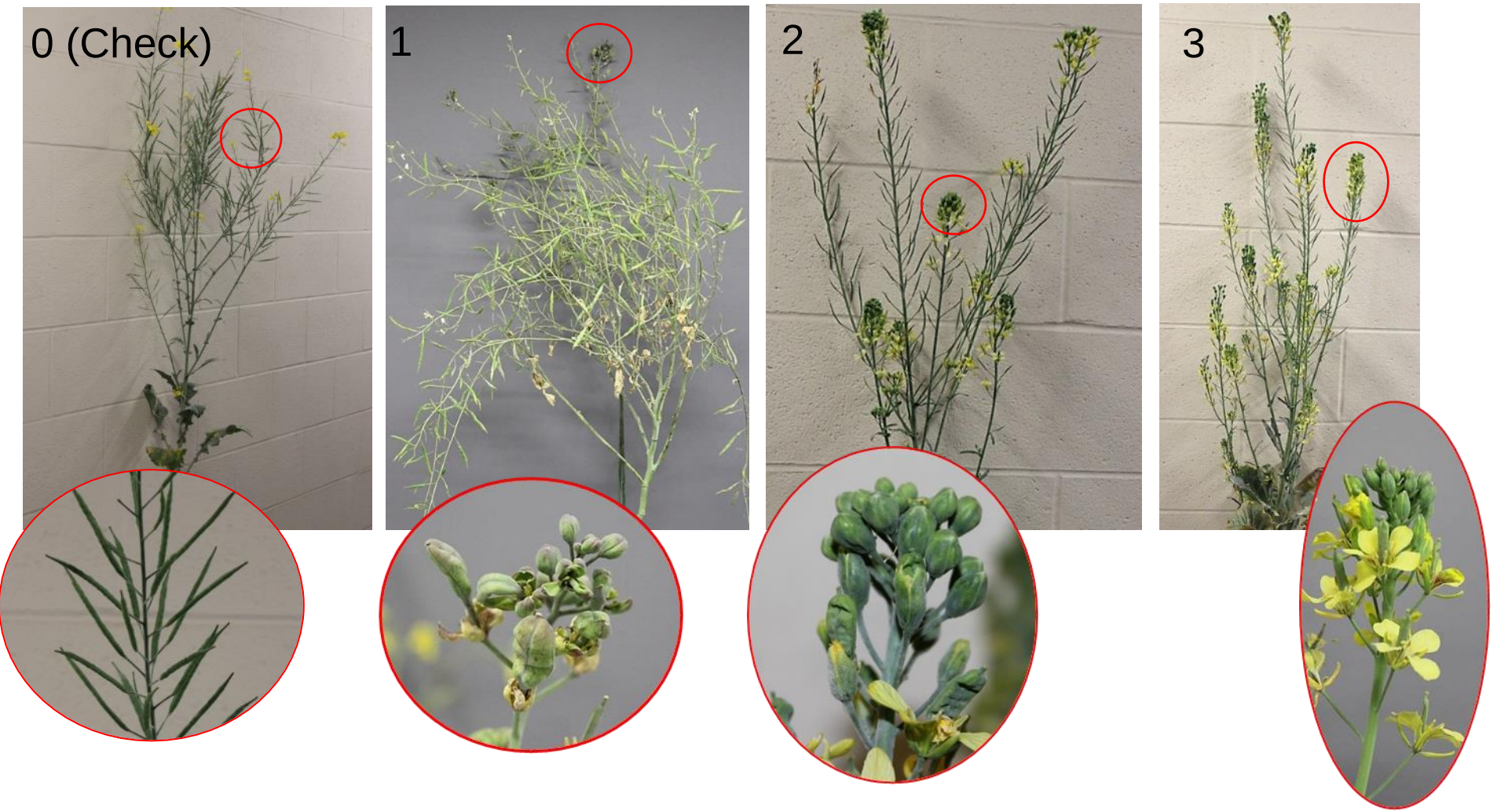




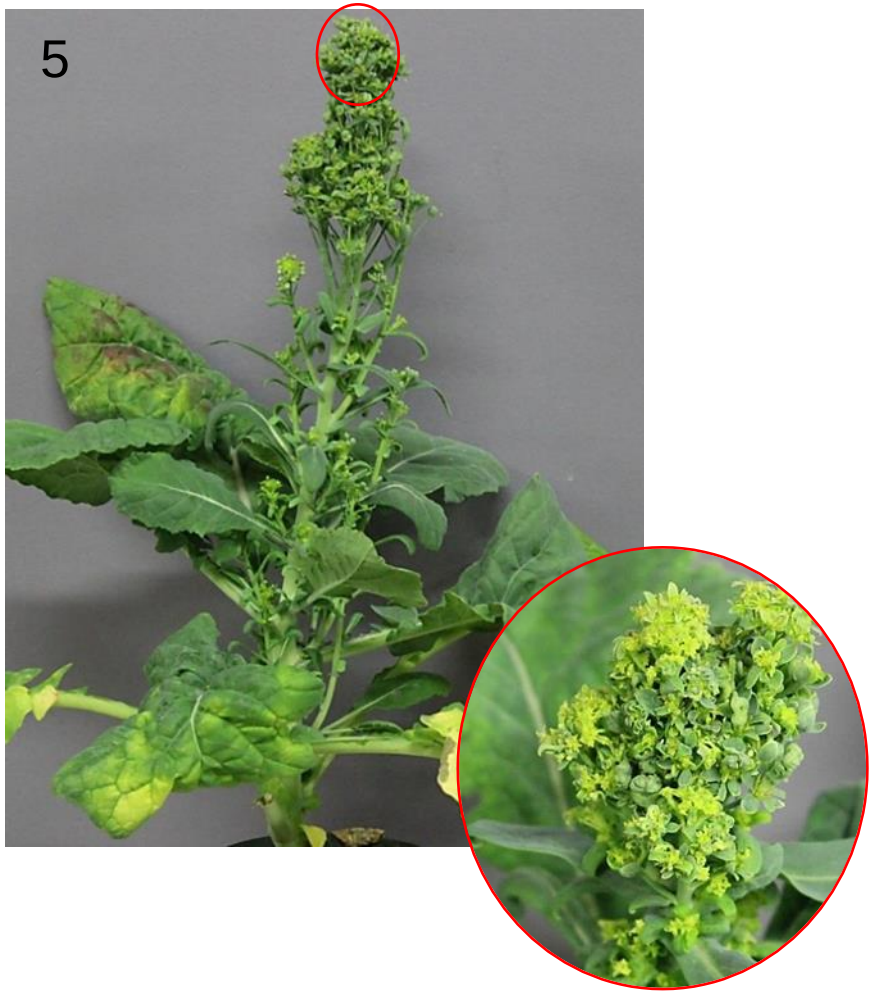
2-4 weeks



AY Rating Scale 0-3

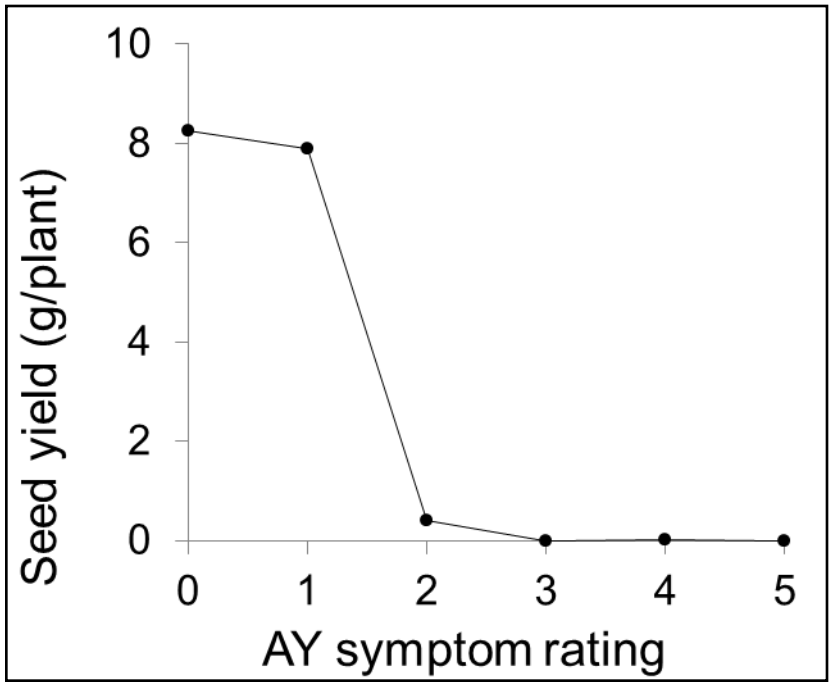


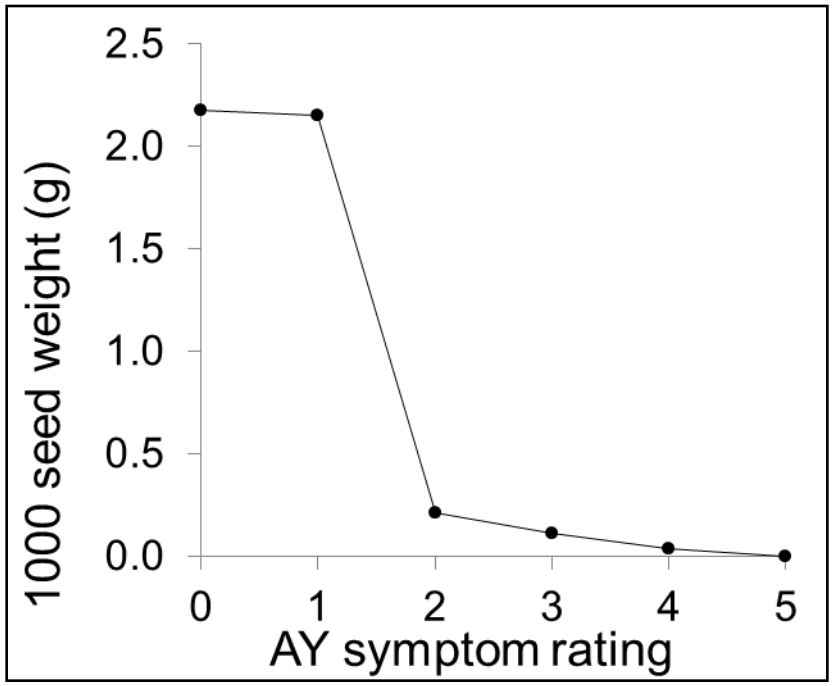
AY Rating Scale 4-5



Results – Wet soil, 20C, early infection, 10 hrs

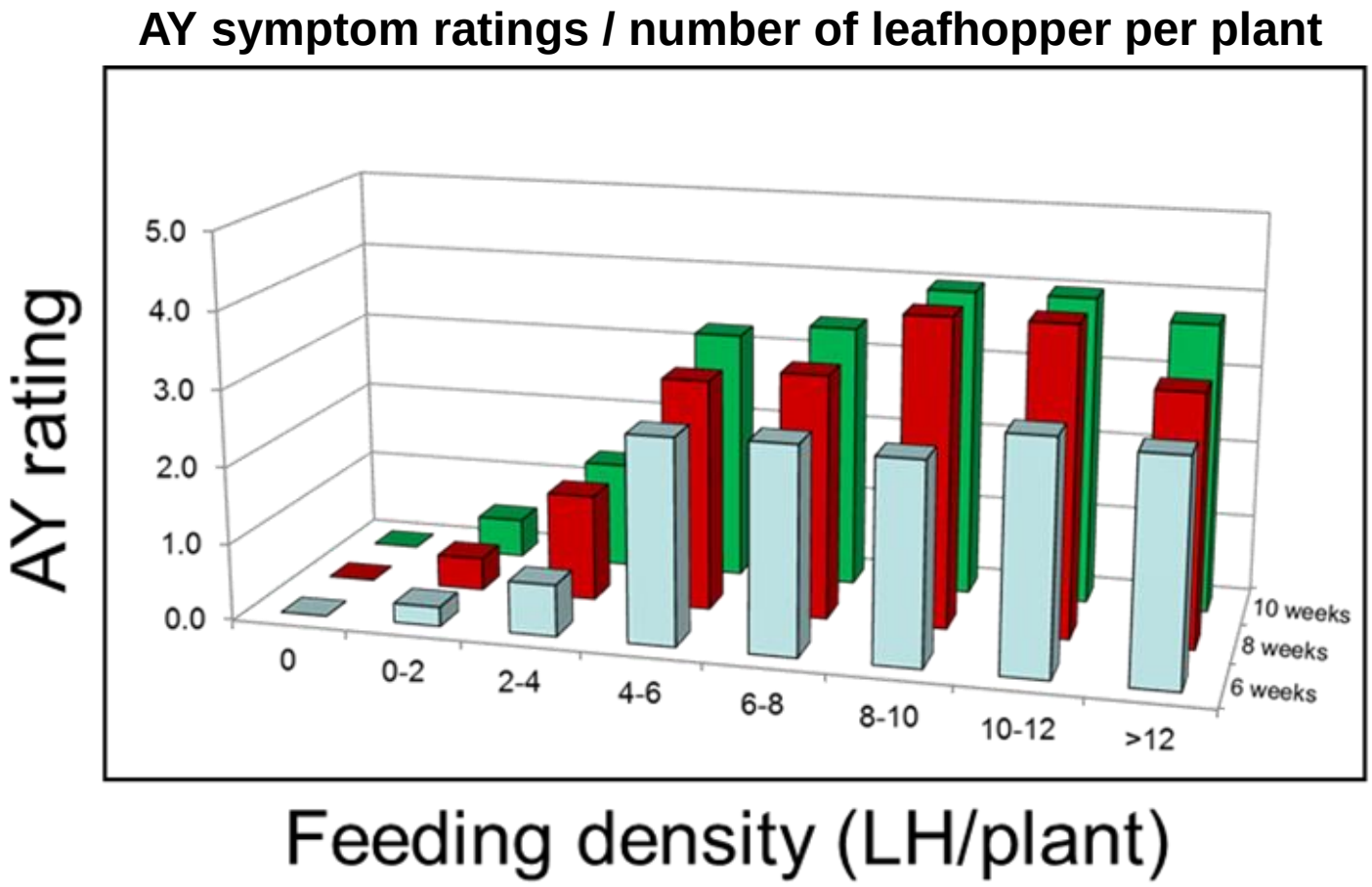
AY symptom ratings / seed yield





- Plants with AY ratings of 1-2 produced malformed seeds
- Plants with AY ratings of 3-5 produced no seed

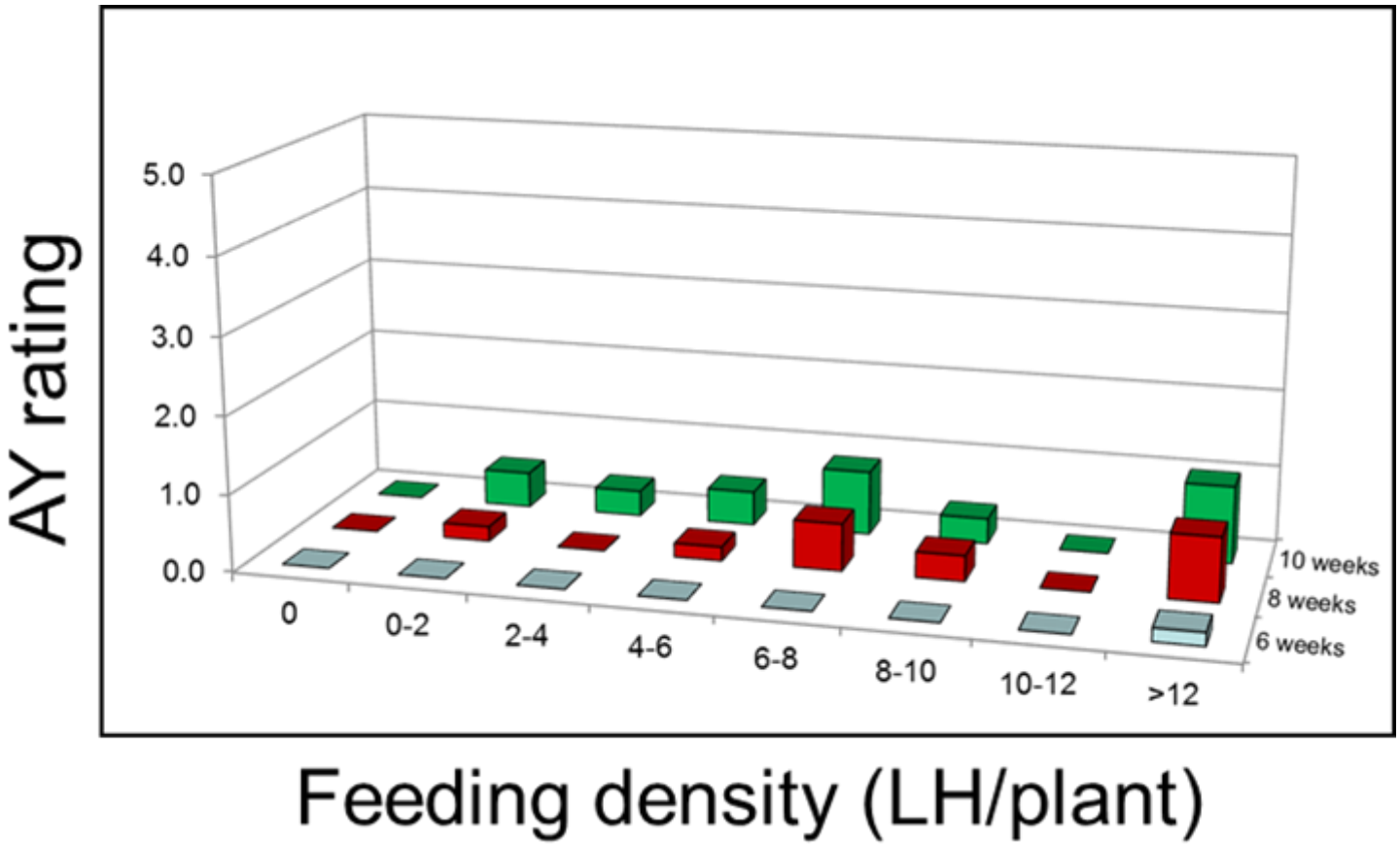
Results; Wet soil, 20C, early infection, 10hrs



Wet soil and number of leafhopper per plant > 2-4: High yield losses

Results; Dry soil, 20C, early infection, 10hrs

AY symptom ratings / number of leafhopper per plant



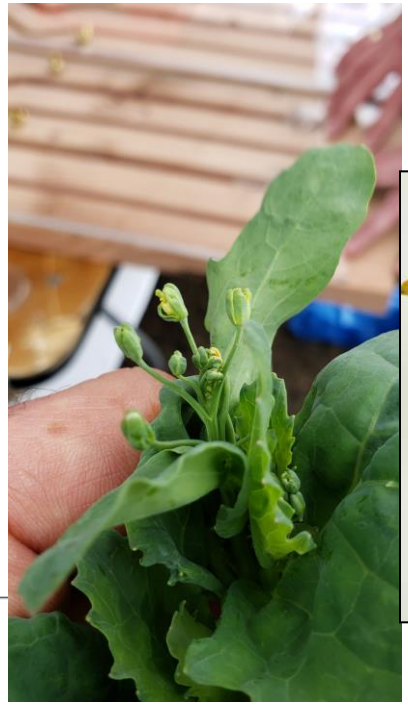
Dry soil and number of leafhopper per plant >12: AY rating below 1

Atypical symptoms of AY : Are they caused by AY phytoplasma ?

Pod abortion
Malformed buds
Chlorosis (yellow, purple)
Empty pods
Germinated seeds in pods
Condensed flowers
Flattened stem
Malformed stem

2019 symptoms reported by Canola Council Agronomists

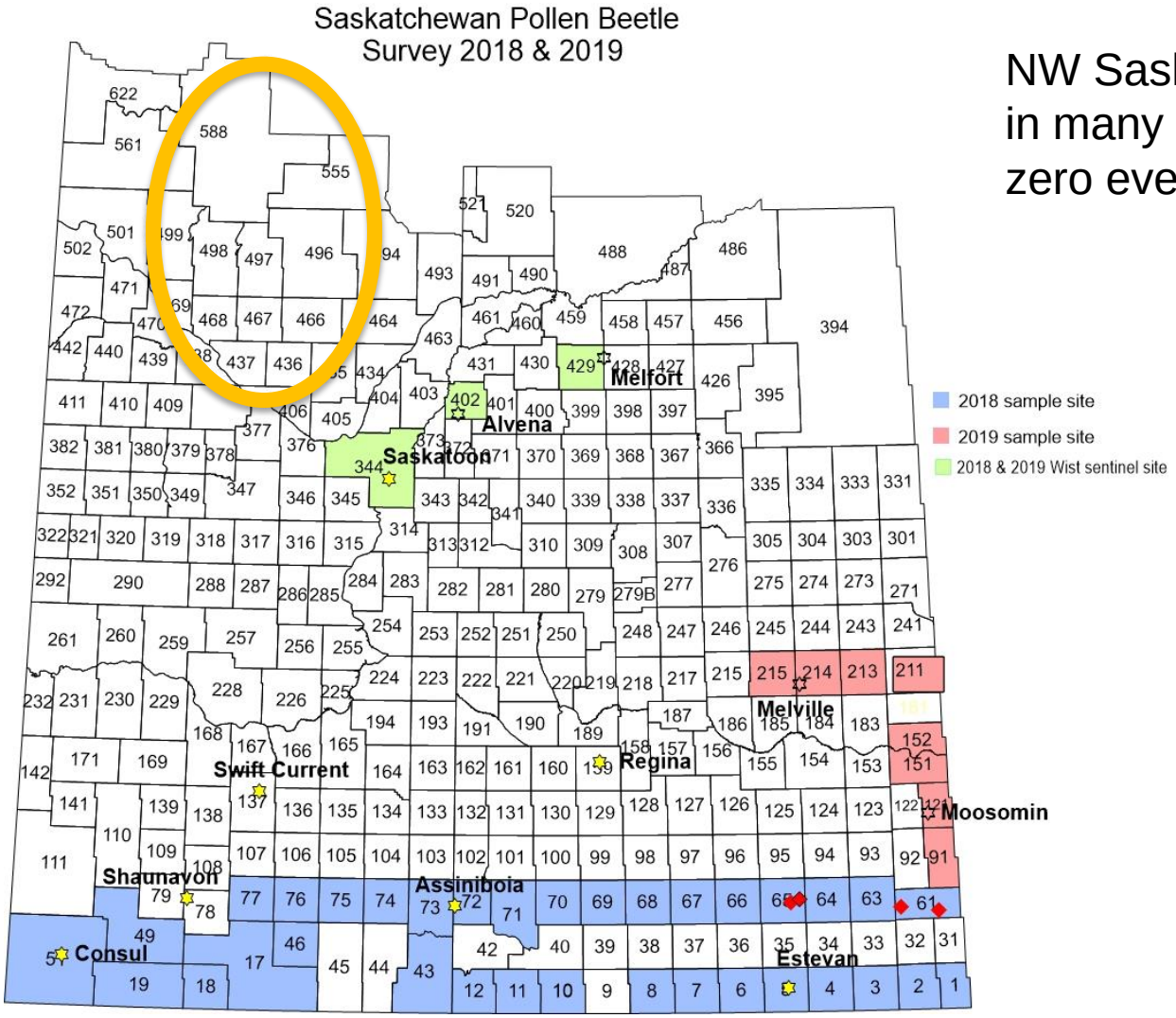
Canola on alfalfa



– Malformed buds

Green malformed buds

- Caused by AY phytoplasma
- Can be the beginning of typical AY symptoms
- Can stay as is (low light intensity and other parameters (to be identified))



NW Sask with higher incidence of AY in many years (4-9%), with nearly zero everywhere else

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Wist Alfalfa	
Sample	Result
AP1 - Root	p
AP1 - Stem	p
AP1 - Leaf	p
AP1 - Flower	
AP2 - Root	p
AP2 - Stem	p
AP2 - Leaf	p
AP2 - Flower	p
AP3 - Root	
AP3 - Stem	p
AP3 - Leaf	p
AP4 - Root	
AP4 - Stem	p
AP4 - Leaf	p
AP4 - Flower	p
AP5 - Root	
AP5 - Stem	
AP5 - Leaf	p
AP5 - Flower	p
AP5 - Flower	p
AP6 - Root	p
AP6 - Stem	p
AP6 - Leaf	
AP - Flower	
AP7 - Root	p
AP7 - Stem	p
AP7 - Leaf	p
AP7 - Flower	
AP8 - Root	p
AP8 - Stem	p
AP8 - Leaf	p
AP8 - Flower	p
AP9 - Root	p
AP9 - Stem	p
AP9 - Leaf	p
AP9 - Flower	p
AP10 - Root	
AP10 - Stem	

AY Reservoir?

Sept 4 2019 AAFC SRDC Alfalfa plots full of aster leafhoppers (>200 in 10 sweeps)

10 plants (100%) of alfalfa plants positive for aster yellows phytoplasma

Alfalfa is perennial = “green bridge” between seasons?

Acknowledgments

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@TylerWist1

- Numerous summer students of the Wist lab: insect collection
- Chrystel Olivier and Bob Elliott
- SK Provincial Agrologists for sticky card trapping
- Nancy Melnychuck, Dana Nordin, Taylor Kaye, Mozghan Mousavi and Jennifer Bogdan for expertise in wing and leg removal from leafhoppers