Insecticidal Seed Treatment Efficacy in Canola

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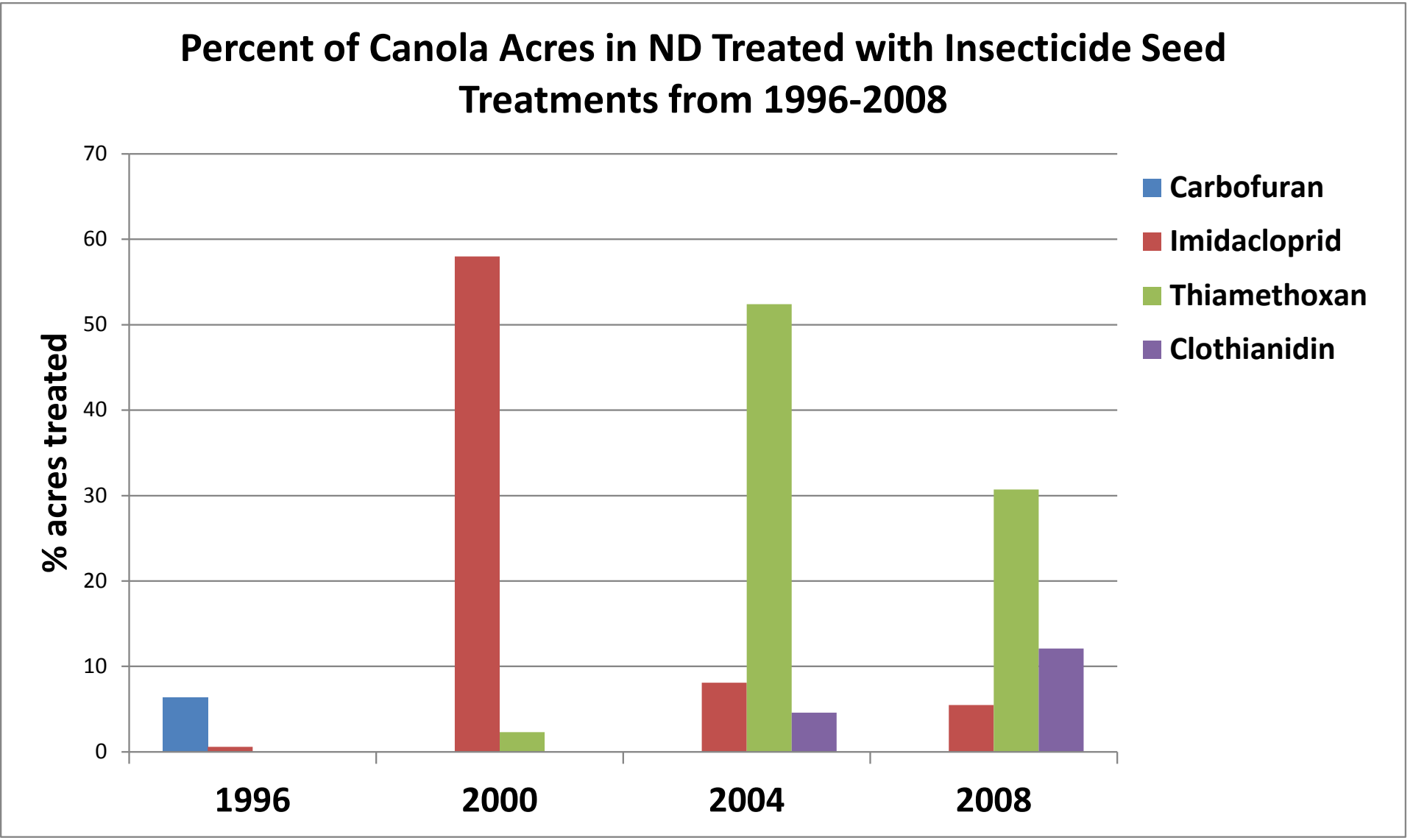
NDSU EXTENSION SERVICE

Flea Beetles of Canola

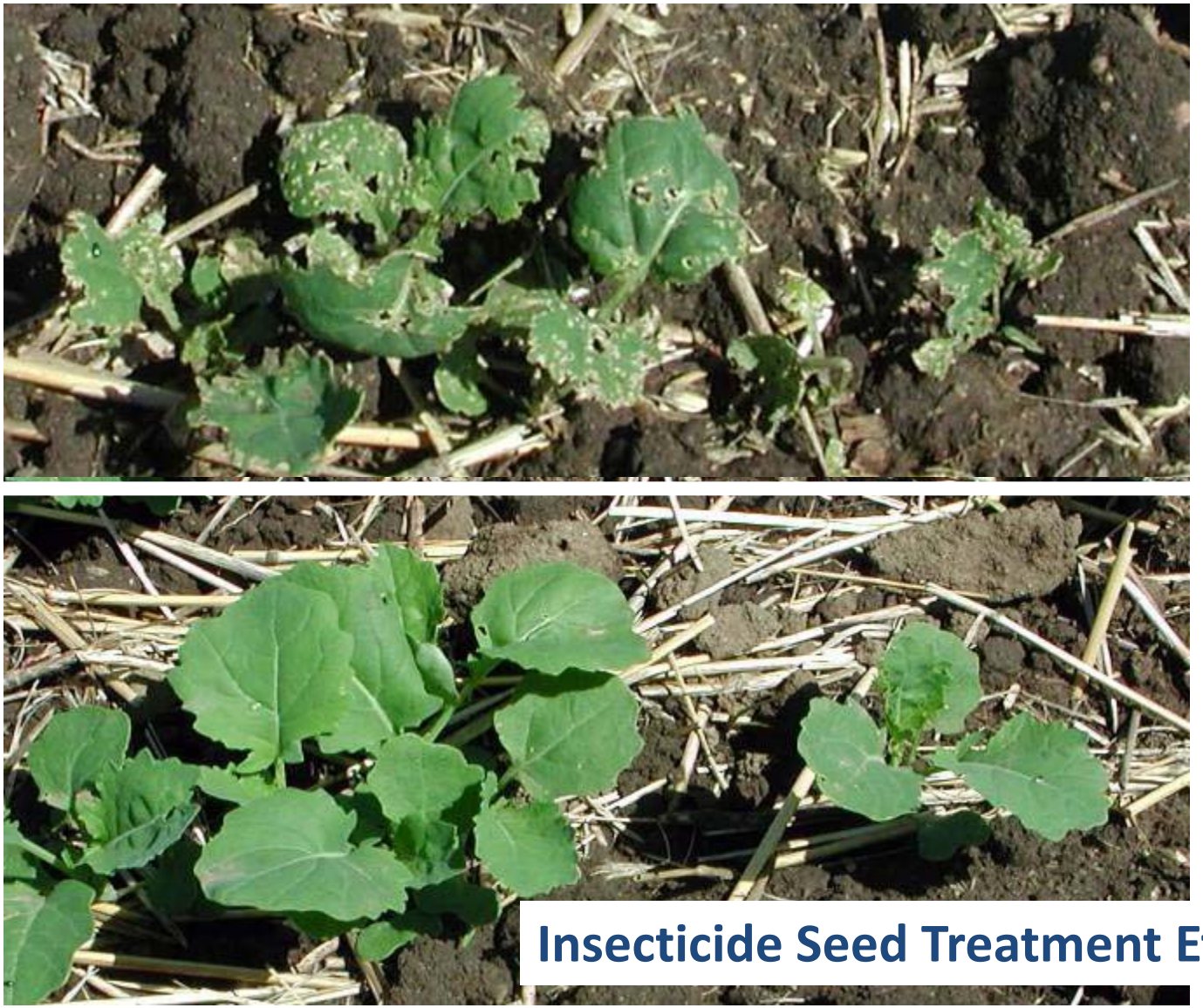
Crucifer Flea Beetle
Phyllotreta cruciferae

Striped Flea Beetle
Phyllotreta striolata



Source: Pesticide Use and Pest Management Practices in North Dakota – 1996, 2000, 2004, 2008

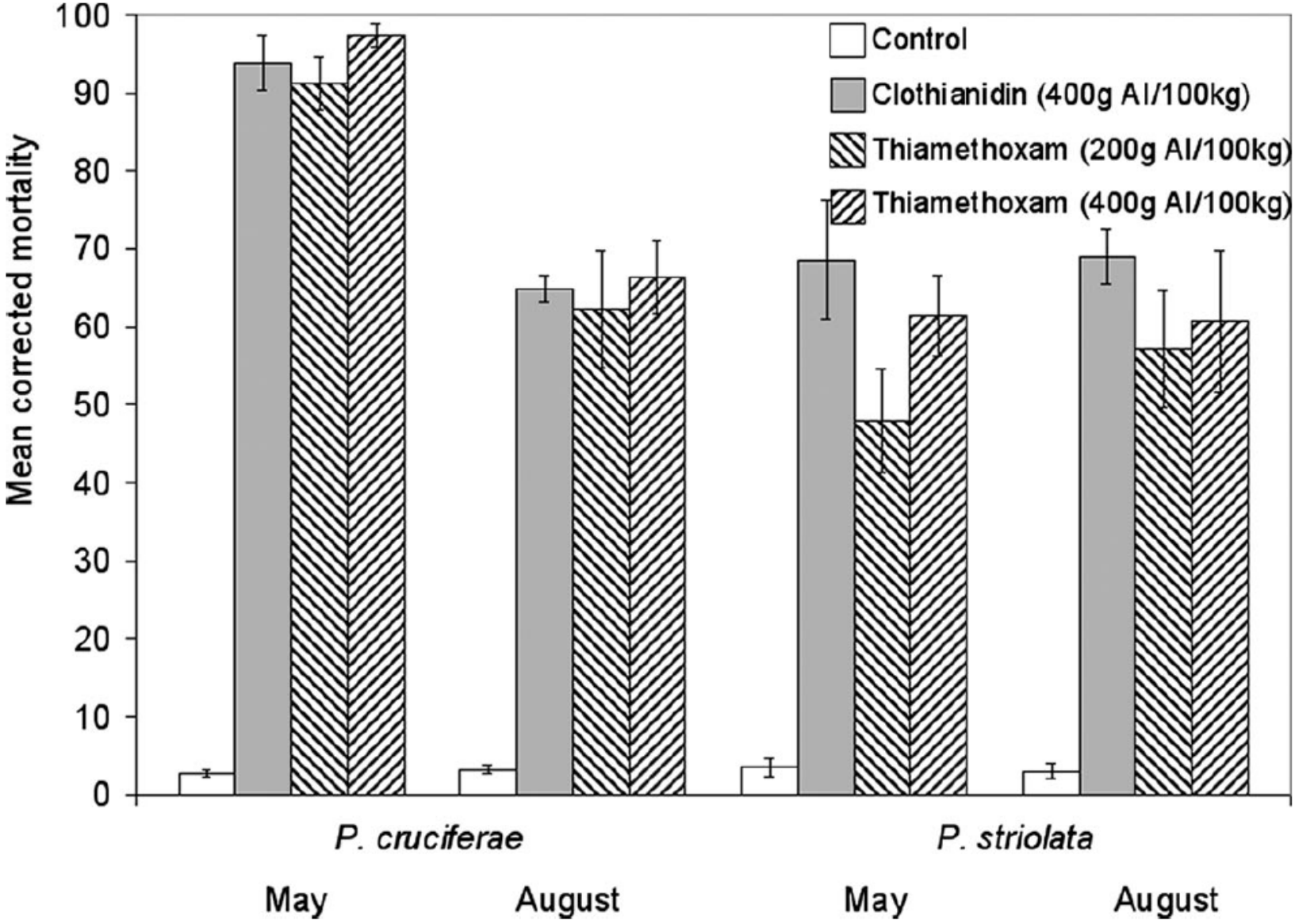
Canola seedling damage, pitting, caused by flea beetle feeding (top) and undamaged seedling (bottom).



Insecticide Seed Treatment Effective

Background

- Neonicotinoid insecticidal seed treatments
  - >10 years
- Insecticide resistance
  - Widespread adoption of one insecticide class used year after year against an abundant pest
- Tansy et al. 2008 J. Econ. Entomol. 101: 159-167.
  - Differences in *Phyllotreta cruciferae* and *Phyllotreta striolata* (Coleoptera: Chrysomellidae) Response to Neonicotinoid Seed Treatments
  - P*. cruciferae* higher mortality than *P. striolata* on neonicotinoid ST (thiamethoxam & clothianidin)
  - Overwintering flea beetles (May) more susceptible than summer flea beetles (August)
  - Species shift from *P. cruciferae* to *P. striolata???*


Mean corrected mortality
100
90
80
70
60
50
40
30
20
10
0
Control
Clothianidin (400g AI/100kg)
Thiamethoxam (200g AI/100kg)
Thiamethoxam (400g AI/100kg)
P. cruciferae
P. striolata
May
August
May
August

Proactive Insecticide Resistance Monitoring and Management for Crucifer Flea Beetle

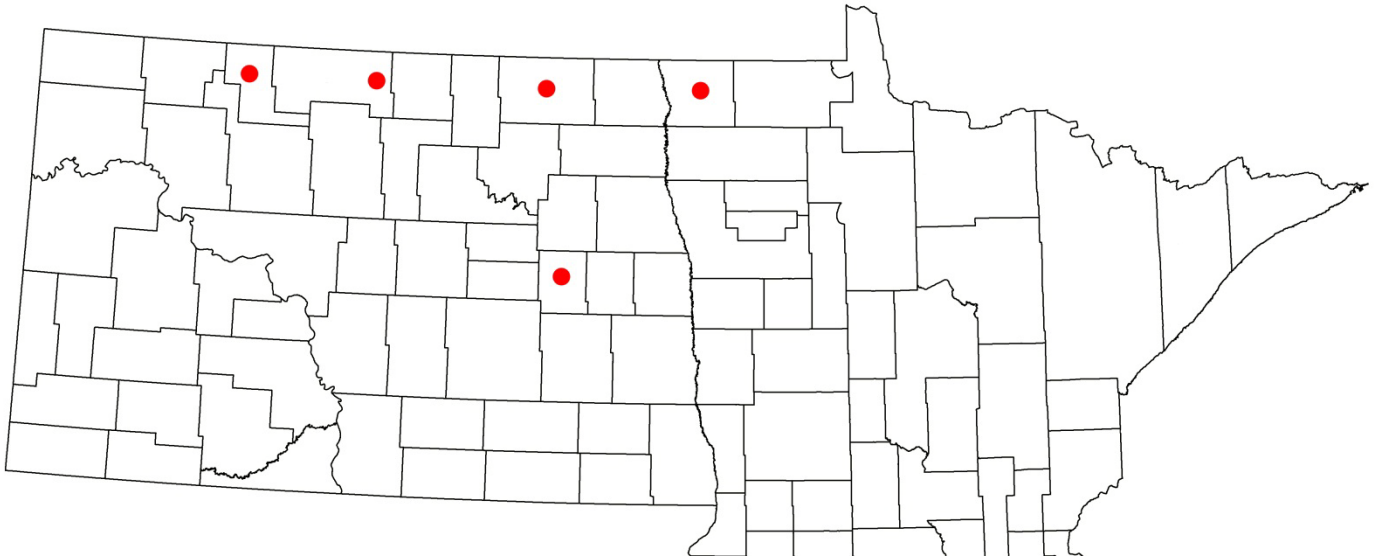
- **Investigators:**
  - **Janet Knodel, NDSU**
  - **Daniel Waldstein, BASF, CA**
  - **Patrick Beauzay, NDSU**

Objectives

- **To determine if clothianidin and thiamethoxam seed treatments at labeled rates are effective for control of crucifer flea beetle (*Phyllotreta cruciferae*) and striped flea beetle (*P. striolata*)**
  - **ND and MN flea beetle populations**
  - **Greenhouse study (2012)**
  - **Spring flea beetles were difficult to collect**
  - **Striped flea beetles were difficult to collect in numbers great enough to test**
  - **Limited to summer generation crucifer flea beetles**

Greenhouse Study
Materials and Methods

- **Live flea beetles collected by sweep net from fields approximately 3 days after swathing**
- **‘Summer’ generation**
- **Renville, Bottineau, Cavalier, Griggs Counties in ND and Kittson County in MN**
- **Approximately 2,500 beetles per location**

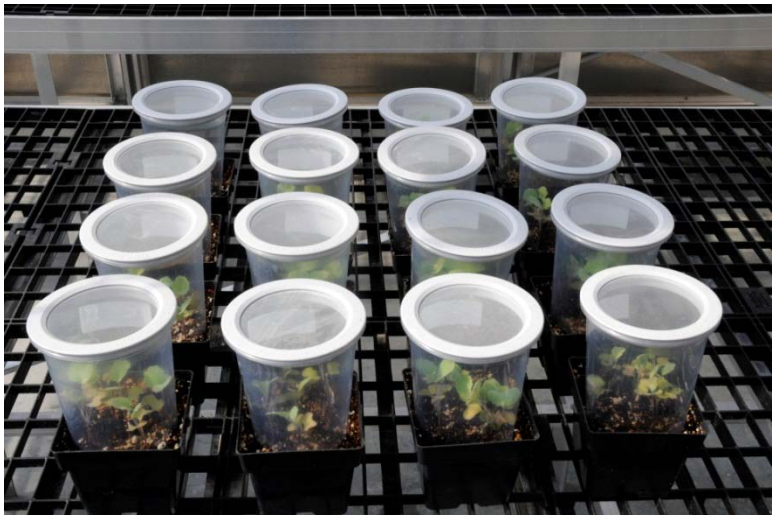


Materials and Methods

- Flea beetles kept in cages
- Flea beetles fed fresh canola and organic kale every three days
- Flea beetles removed from cages using an aspirator and then released in experimental pots

Materials and Methods

- 15 *P. cruciferae* per pot (or 3 flea beetles per seedling)
- 5 canola seedlings per pot
- 5 locations, 4 replications
- 3 treatments
- 2 flea beetle timings (7 and 14 DAP)
- General randomized replicated design



Materials and Methods

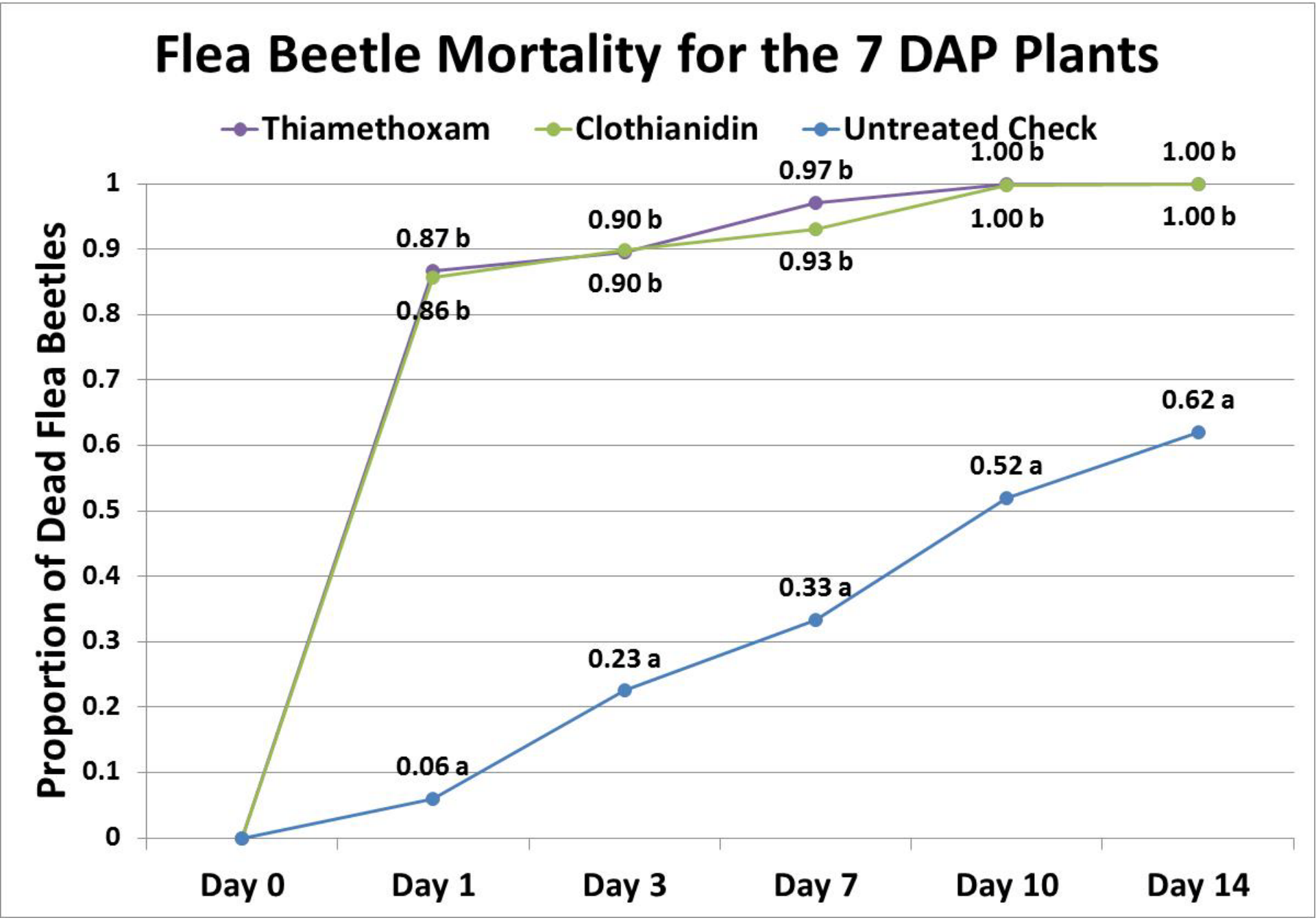
- **Treatments**
  - **Untreated Check**
  - **Thiamethoxam @ 400 gai per 100 kg seed**
  - **Clothianidin @ 400 gai per 100 kg seed**

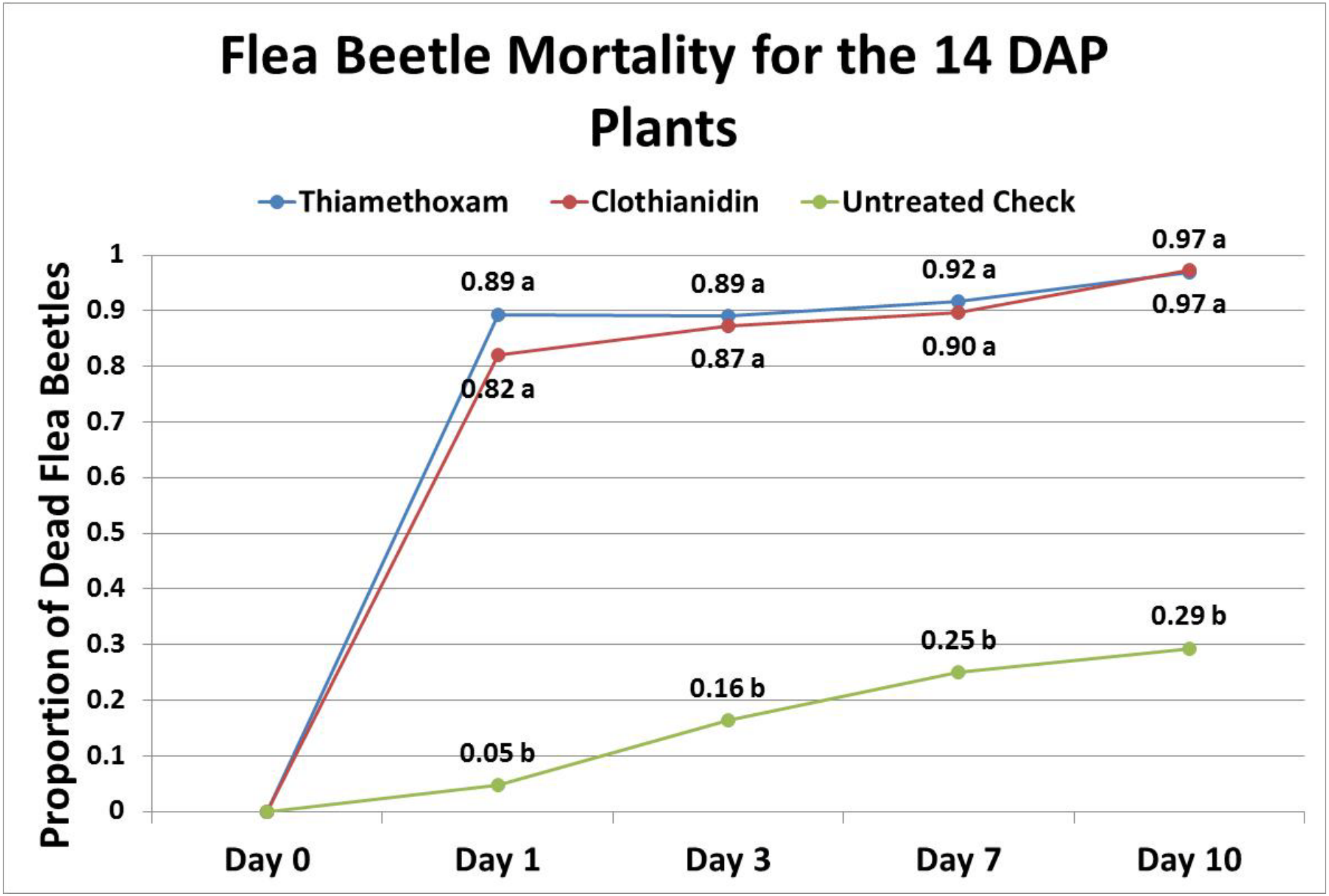
Materials and Methods

- **Live flea beetles counted and recorded for each pot at 1, 3, 7, 10 and 14 days after introduction (up to 10 days for the 14 DAP plants)**
- **Data analyzed using PROC GLIMMIX in SAS statistical software**
- **Treatment means compared using Tukey's HSD at $\alpha = 0.05$**

Results

- **Location effect and location x treatment effect <u>not</u> significant for 7 and 14 DAP**
- **Treatment effect significant**


Flea Beetle Mortality for the 7 DAP Plants
Thiamethoxam
Clothianidin
Untreated Check
Proportion of Dead Flea Beetles
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.87 b
0.86 b
0.90 b
0.90 b
0.97 b
0.93 b
1.00 b
1.00 b
1.00 b
1.00 b
0.06 a
0.23 a
0.33 a
0.52 a
0.62 a
Day 0
Day 1
Day 3
Day 7
Day 10
Day 14


Flea Beetle Mortality for the 14 DAP Plants
Thiamethoxam
Clothianidin
Untreated Check
Proportion of Dead Flea Beetles
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.89 a
0.89 a
0.92 a
0.97 a
0.82 a
0.87 a
0.90 a
0.97 a
0.05 b
0.16 b
0.25 b
0.29 b
Day 0
Day 1
Day 3
Day 7
Day 10

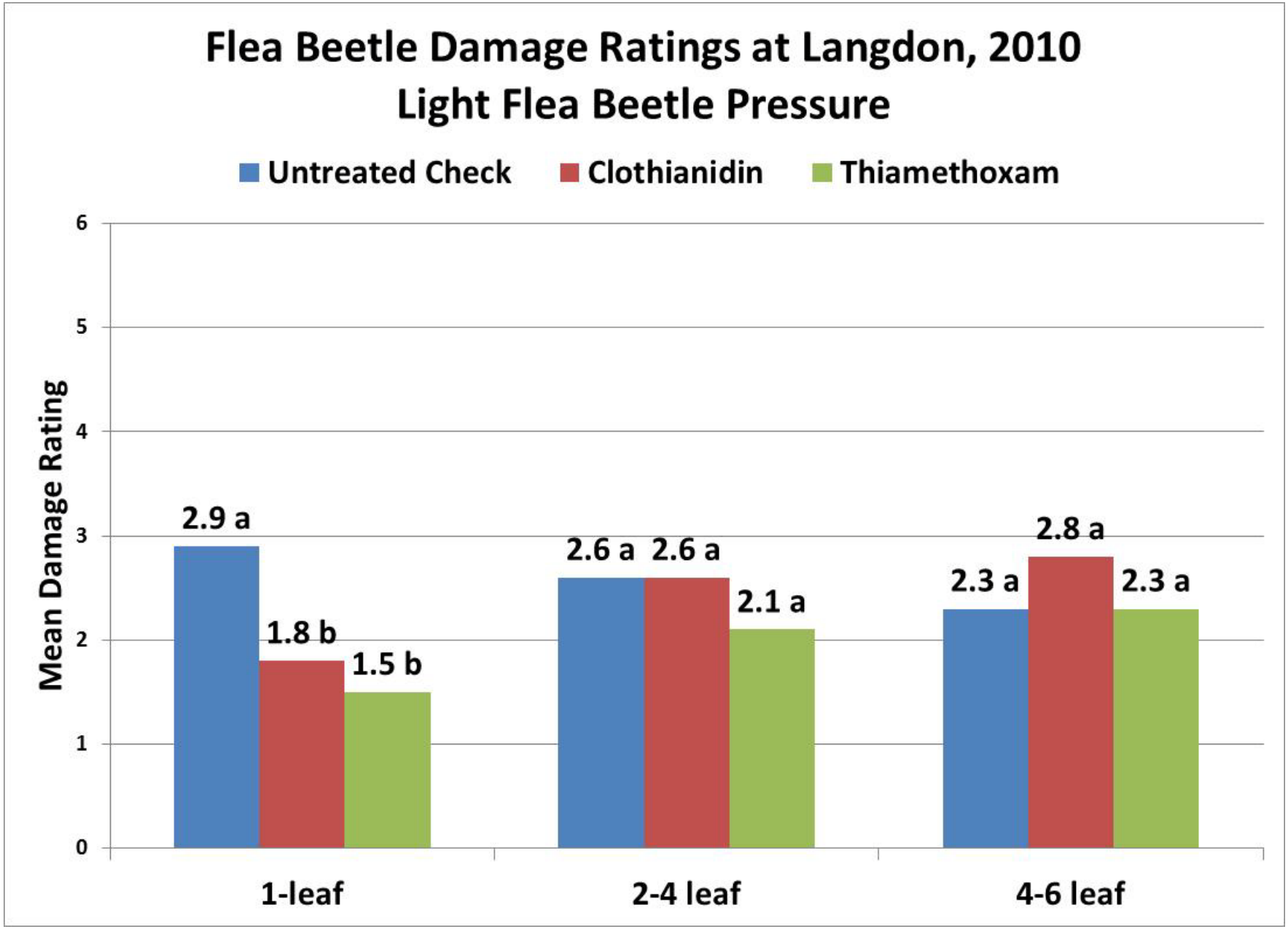
Field Trials

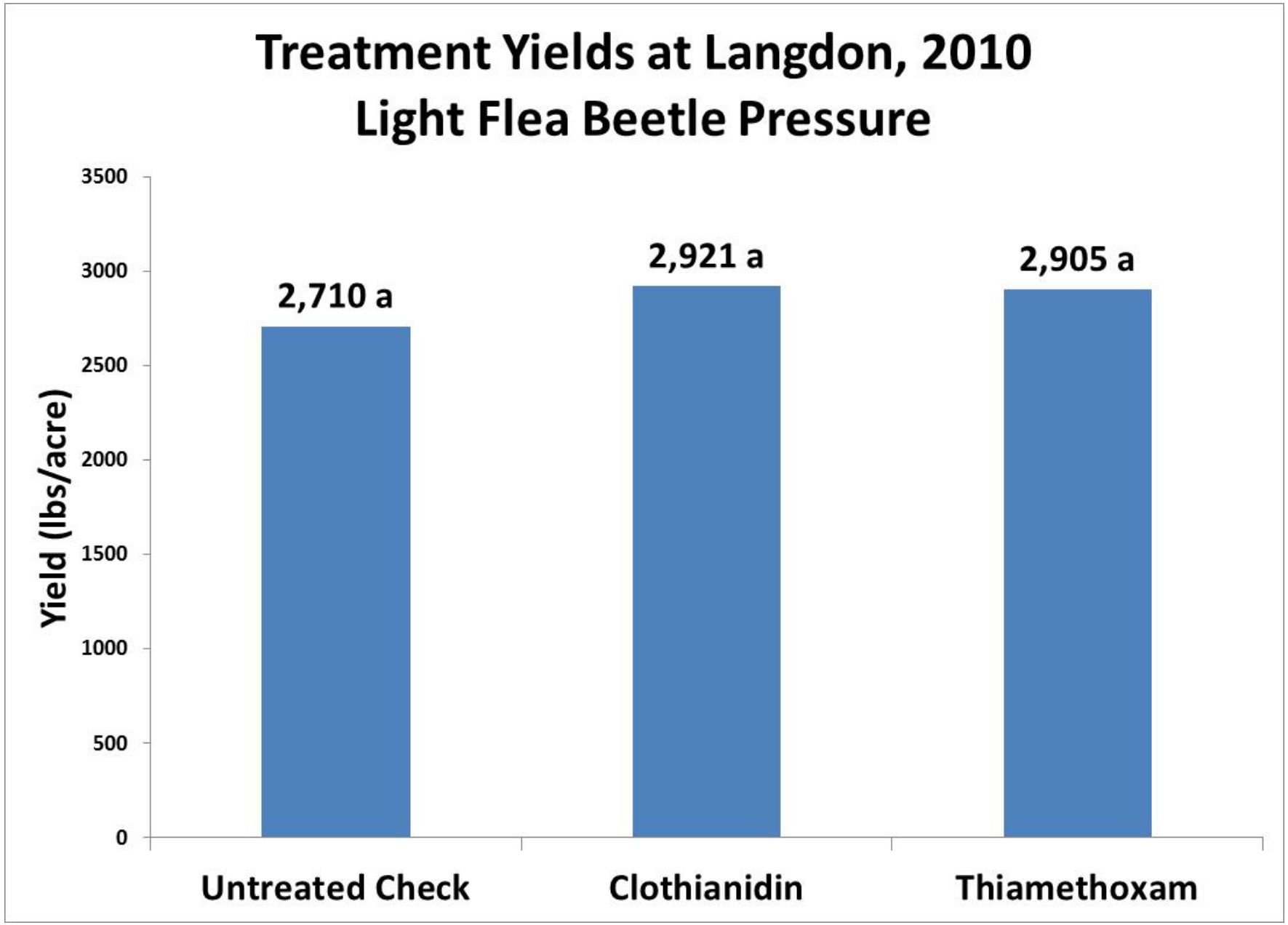
- Conducted 2009-2012 at Langdon REC
- Small plots (4.5’ x 20’)
- RCBD with 4 replications
- Typical agronomic practices
- Treatments
  - Untreated check
  - Thiamethoxam @ 400 gai per 100 kg seed
  - Clothianidin @ 400 gai per 100 kg seed

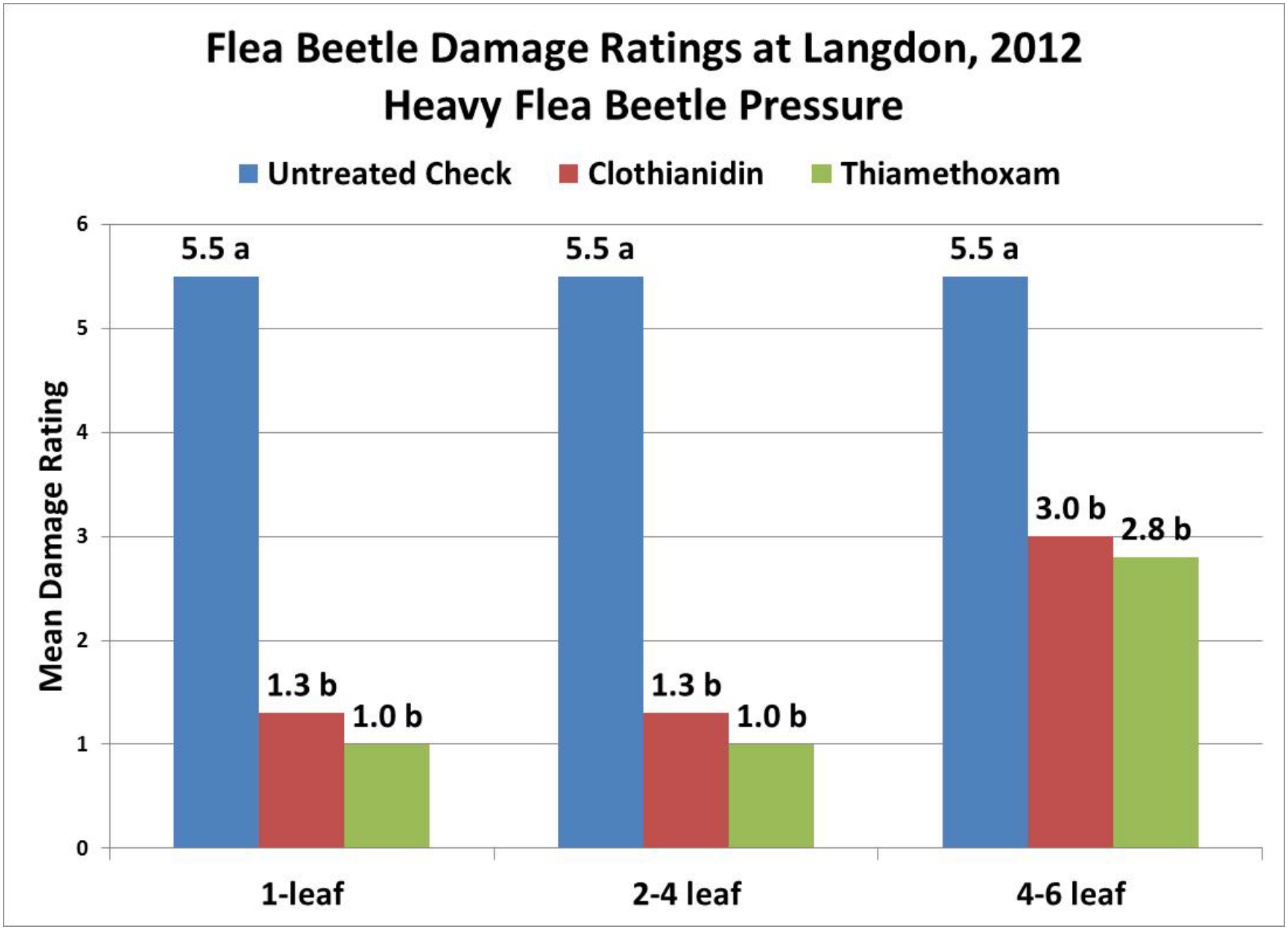
Canola Seedling Flea Beetle Damage Rating Scale

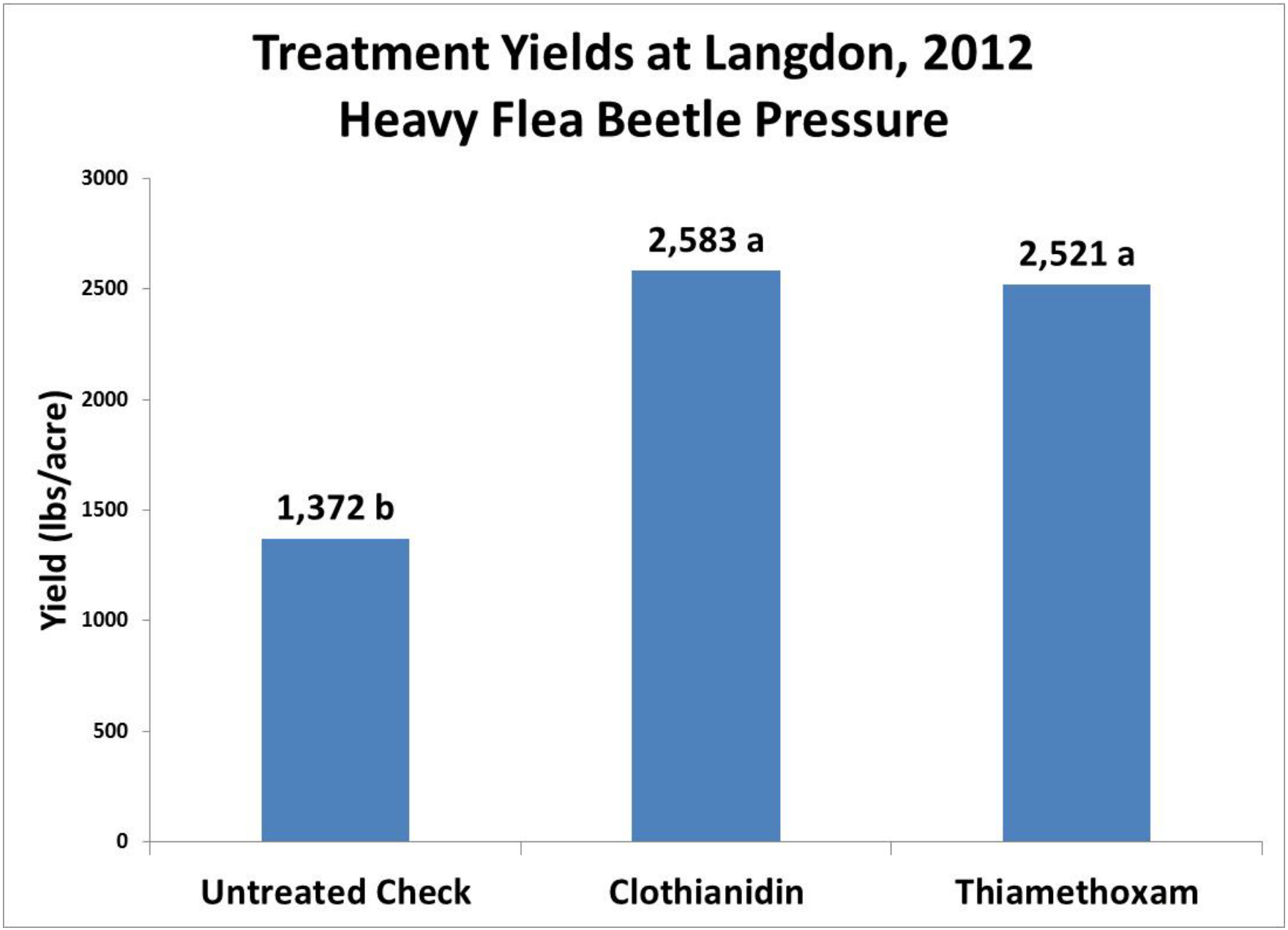
- 1 = 0-3 pits per seedling
- 2 = 4-9 pits per seedling
- 3 = 10-15 pits per seedling
- 4 = 16-25 pits per seedling
- 5 = >25 pits per seedling
- 6 = dead seedling

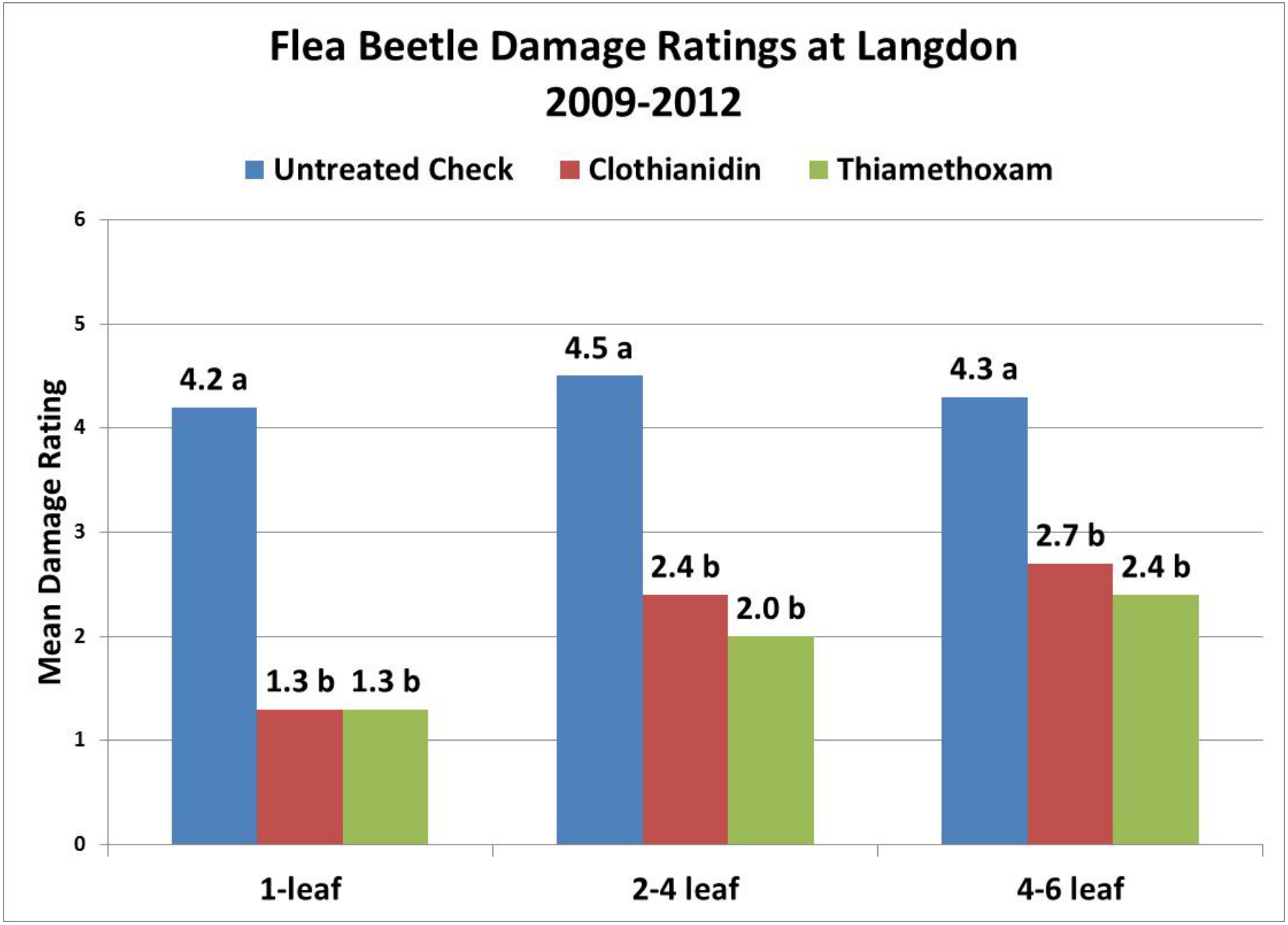
Damage ratings taken at 1-leaf, 2-4 leaf, and 4-6 leaf stages (approximately once per week)

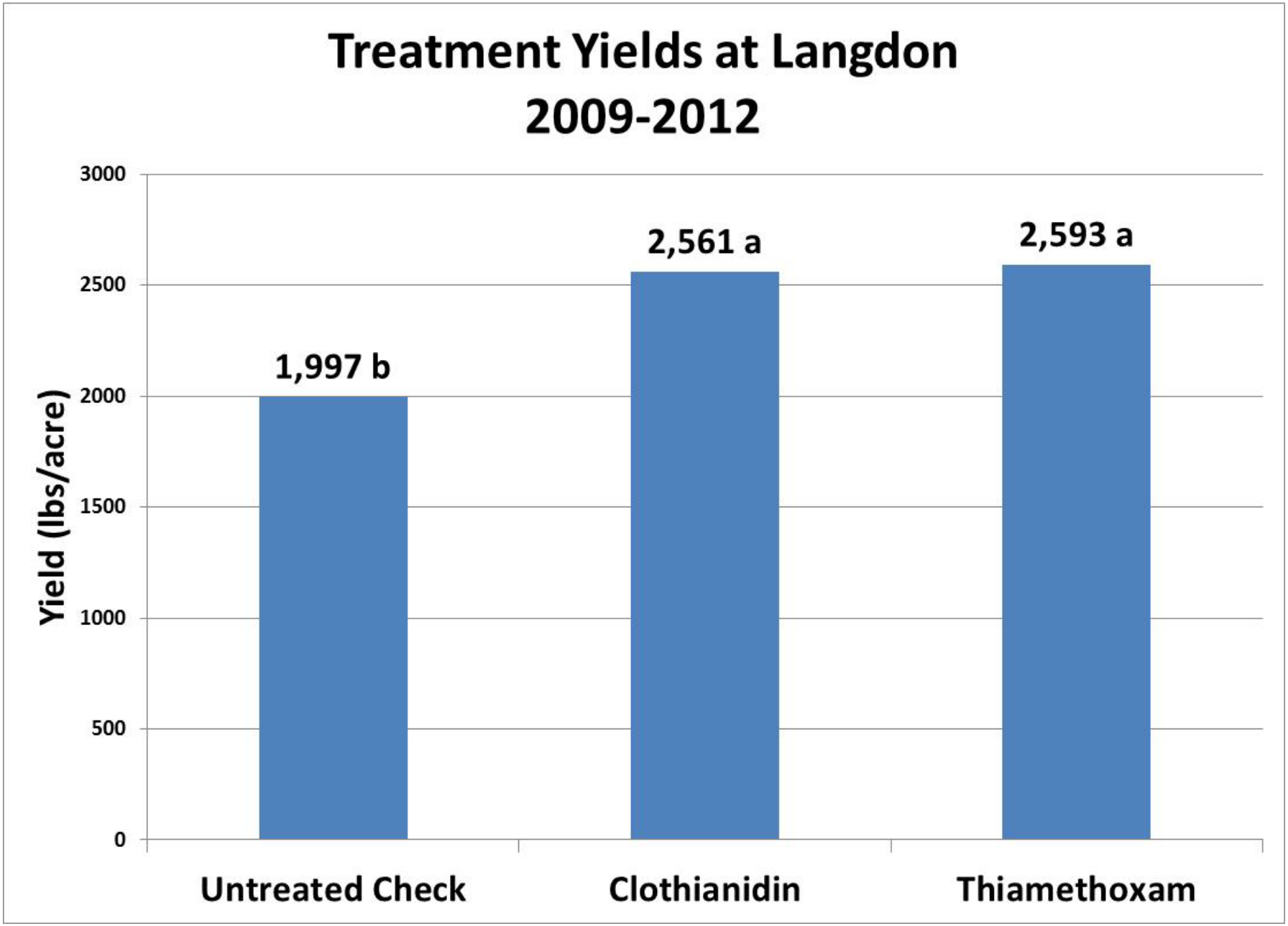

Flea Beetle Damage Ratings at Langdon, 2010
Light Flea Beetle Pressure
Untreated Check
Clothianidin
Thiamethoxam
Mean Damage Rating
0
1
2
3
4
5
6
2.9 a
1.8 b
1.5 b
2.6 a
2.6 a
2.1 a
2.3 a
2.8 a
2.3 a
1-leaf
2-4 leaf
4-6 leaf


Treatment Yields at Langdon, 2010
Light Flea Beetle Pressure
Yield (lbs/acre)
3500
3000
2500
2000
1500
1000
500
0
2,710 a
2,921 a
2,905 a
Untreated Check
Clothianidin
Thiamethoxam


Flea Beetle Damage Ratings at Langdon, 2012
Heavy Flea Beetle Pressure
Untreated Check
Clothianidin
Thiamethoxam
Mean Damage Rating
0
1
2
3
4
5
6
5.5 a
1.3 b
1.0 b
5.5 a
1.3 b
1.0 b
5.5 a
3.0 b
2.8 b
1-leaf
2-4 leaf
4-6 leaf


Treatment Yields at Langdon, 2012
Heavy Flea Beetle Pressure
Yield (lbs/acre)
3000
2500
2000
1500
1000
500
0
1,372 b
2,583 a
2,521 a
Untreated Check
Clothianidin
Thiamethoxam


Flea Beetle Damage Ratings at Langdon
2009-2012
Untreated Check
Clothianidin
Thiamethoxam
Mean Damage Rating
6
5
4
3
2
1
0
4.2 a
1.3 b
1.3 b
4.5 a
2.4 b
2.0 b
4.3 a
2.7 b
2.4 b
1-leaf
2-4 leaf
4-6 leaf


Treatment Yields at Langdon
2009-2012
Yield (lbs/acre)
3000
2500
2000
1500
1000
500
0
1,997 b
2,561 a
2,593 a
Untreated Check
Clothianidin
Thiamethoxam

Conclusion

- Greenhouse study and field trials indicate that thiamethoxam and clothianidin at labeled rates are effective for control of crucifer flea beetles
- Continue to survey flea beetle populations and continue product testing in greenhouse and field

Acknowledgments

- Trapping Cooperators
  - LoAyne Voigt, Renville County Extension Agent
  - Dave Grafstrom, Northland Community and Technical College, Roseau
  - Bryan Hanson, Langdon REC
- Northern Canola Growers Association

Aster Leafhoppers in 2012

Macrosteles quadrilineatus

- **Migrate in ND in early May; may have overwintered in ND**
- **Observed in wheat, barley, canola, potatoes, sunflowers**
- **Vectors aster yellows**
- **Delayed expression of 21-35 days or symptomless**
- **No action threshold or insecticide treatments recommended**
- **ND Aster leafhoppers - 25% infectivity rate (Source - Dr. Olivier, Saskatoon)**

Aster leafhopper adult. (Photo courtesy of W. Cranshaw, CSU, Bugwood.org)

Bladder-like pods of canola infected with aster yellows (H. Kandel, Dept. Plant Sciences, NDSU)

Aster Yellows phytoplasma (16SrI)

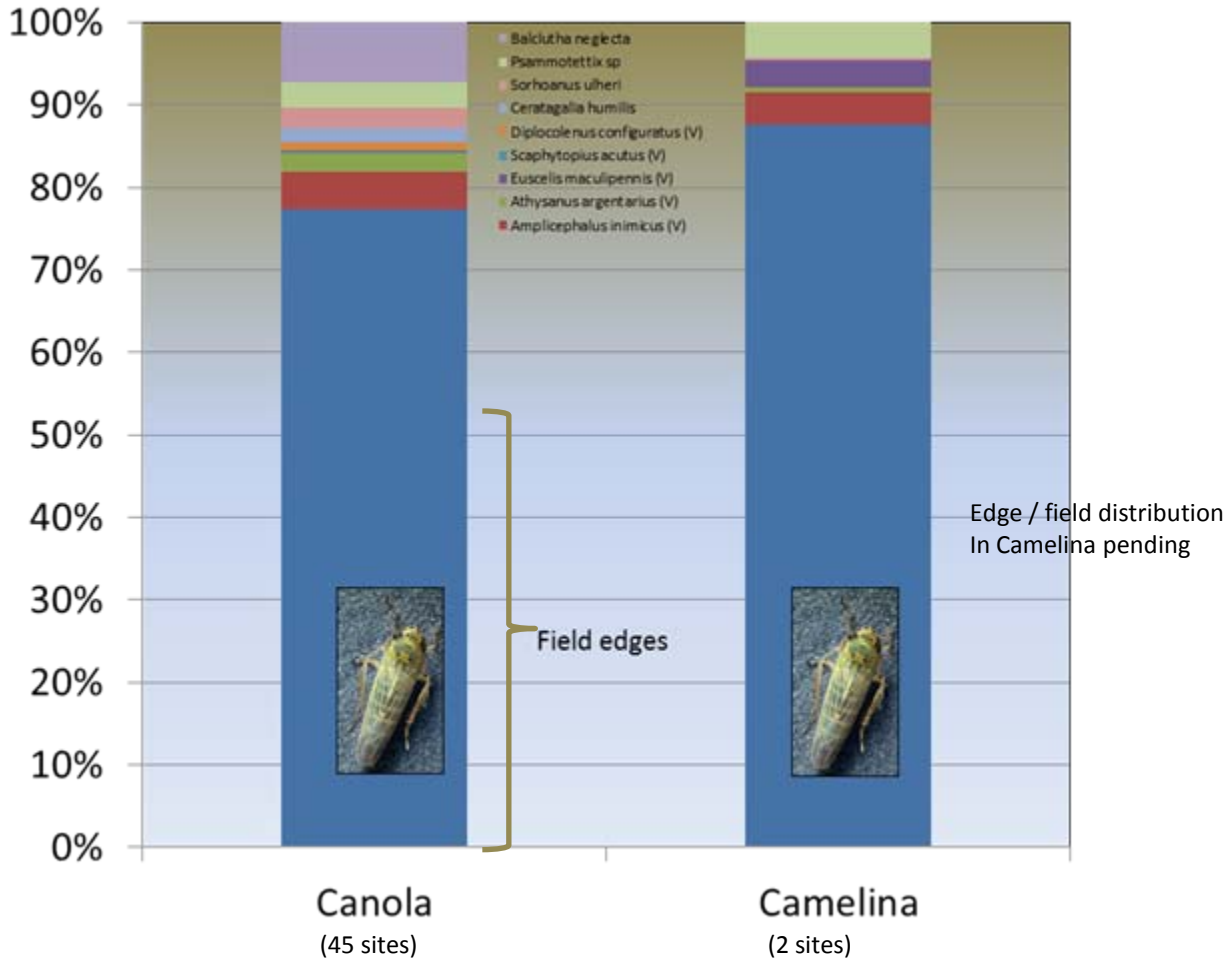
- Worldwide: most diverse and widespread group, with 23 strains, +100 diseases, +150 plant hosts, + 30 vectors (Weintraub and Beanland, 2006)

- In oilseeds in Canada
  - 3 strains (A, B, C).
  - Vectors: *Macrosteles quadrilineatus* and 7 other leafhopper species (maintain reservoir) (Olivier et al., 2004)

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


Macrosteles quadrilineatus

Leafhopper distribution



Edge / field distribution
In Camelina pending

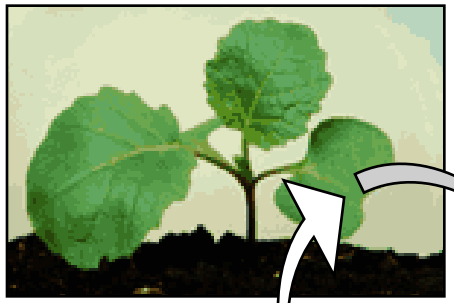
- *M. quadrilineatus* the most abundant leafhopper
- *M. quadrilineatus* in Camelina > *M. quadrilineatus* in canola (?)

AY cycle in oilseeds

Mid-may till July

Migratory and overwintering leafhoppers

Macrosteles quadrilineatus

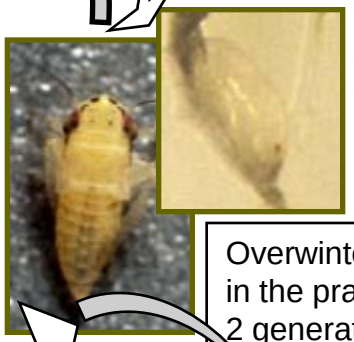


Phytoplasma multiplication

Summer

Symptom expression, 2-6 weeks
-Temperature
-Cultivar (camelina)
-Phytoplasma strain

May-June



Overwintered eggs in the prairies.
2 generations.

Phytoplasma multiplication 2-4 weeks

May-Sept.

May-Sept

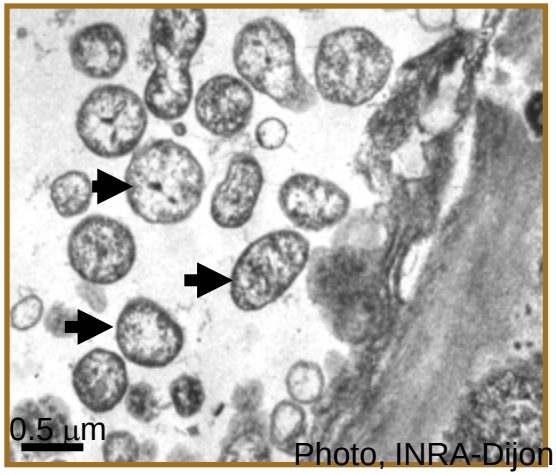
Olivier, 2003 & 2007

AY phytoplasma

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

Characteristics

- Small genome (580-1350 kb).
- Pleomorphic: 200- 800nm.
- Inability to grow *in vitro (Ca*. phytoplasma).
- Classification based on molecular & eco. characteristics. 28 RFLP groups (Wei et al, 2007).



Photo, INRA-Dijon

Transmission (in Canada)

- By insects, mostly leafhoppers
- Overwinter in plant roots and dormant woods.
- By seeds?
  - Detection in flowers, seeds & seedlings of *Brassica napus*, *B. rapa* and *Camelina sativa* (Olivier et al., 2010)

AY symptoms on canola

- Sterile bladder like pods
- Small witches'-broom
- Chlorosis (purple, yellow)
- Other causes for purpling:
  - Cultivar
  - Deficiency in minerals
  - Herbicide injuries

AY symptoms on seeds

- Normal looking pods with germinated seeds.
- Normal looking pods with normal looking & misshapen seeds.

Healthy

AY-infected

Healthy

AY incidence in canola

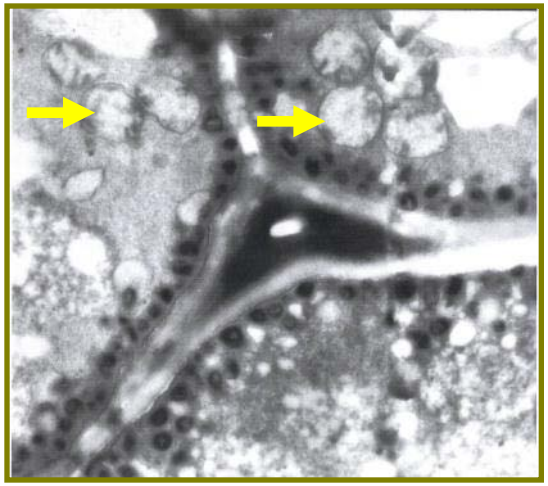
- 30-70% misshapen seeds in AY infected canola.
- Germination: 0% for misshapen seeds; 50-90% for normal looking seeds.

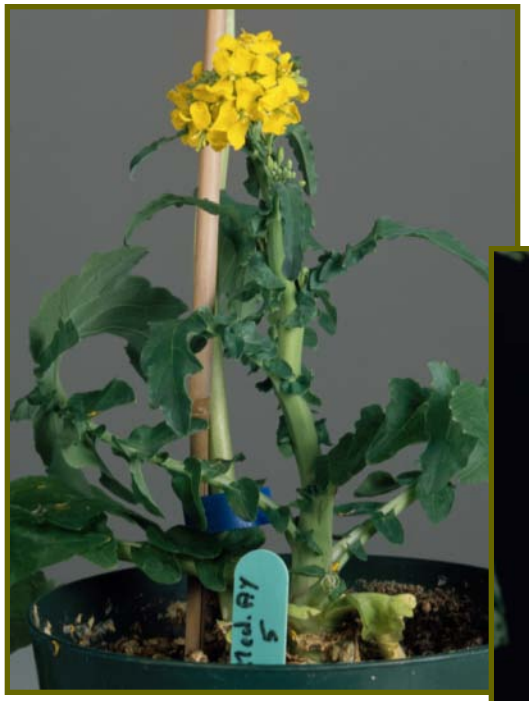
1% infected plants → production loss: 0.03% – 0.07%

5% infected plants → production loss: 1.5% - 3.5%

AY incidence in canola

- About normal-looking seeds in infected plants?
  - Phytoplasma DNA detected in seed coats and embryos.
  - EMs show intact phytoplasma (?) in seed coats. Immunolabeling not successful.
  - 30-45% progeny plants malformed (high number of trichomes, no growing point, condensed flowers, strong growth delay).





AY incidence in canola

Healthy

Progeny of AY-infected plants

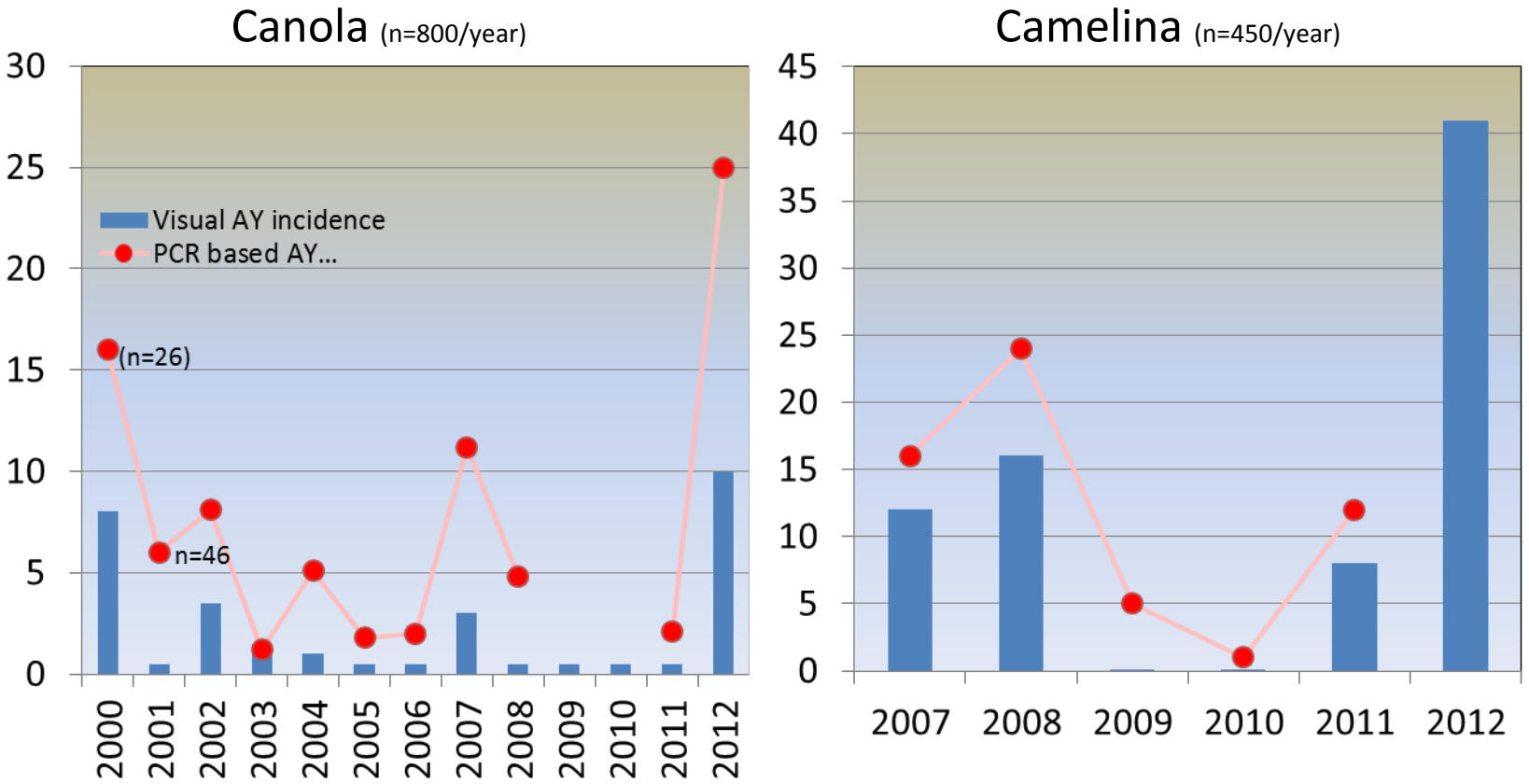
Phytoplasma infection

↓

- Malformed progeny
- Strong growth delay on progeny, meaning no survival of malformed plants.

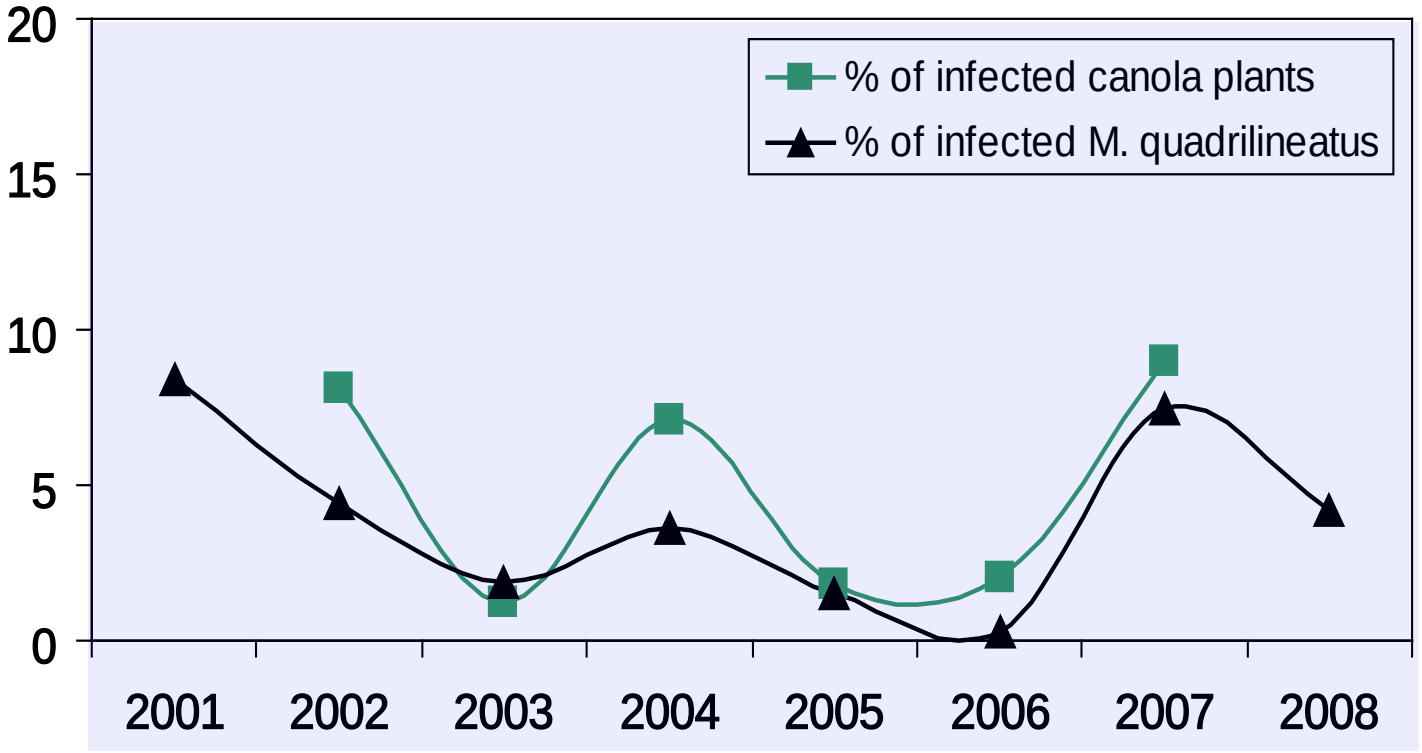
- Plant and insect sampling in Saskatchewan, 2001- 2011.
  - 45-50 Canola / Camelina fields / year.
  - Sweeps every 3-4 weeks & sample100 plants in August per field.
  - PCR tests on plants and insects.
  - Phytoplasma strain identification (DNA sequencing).

AY incidence in canola



- High % of asymptomatic infected plants
- AY in Camelina > AY in canola

% of infected canola and leafhoppers, 2001-2008



% of infected leafhoppers seems to be correlated with the % of infected canola.


Questions?