Are we in for a wireworm plague in Canada?

Starring:

Dr. Bob Vernon,
Dr. Wim van Herk
Pacific Agri-Food Research Centre,
Agriculture and Agri-Food Canada,
Box 1000, Agassiz, B.C. V0M 1A0

Dr. Jeff Tolman,
Dr. Christine Noronha
Southern Crop Protection and Food Centre,
and Charlottetown Research Centre,
Ag. and Agri-Food Canada,
Wireworms in Canada: Challenges, Surveys, Current and Future Control Options.

Bob Vernon¹, Wim van Herk¹, Jeff Tolman², Christine Noronha³

¹Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada, Box 1000, Agassiz, British Columbia, CANADA, V0M 1A0

²Southern Crop Protection & Food Research Centre, AAFC, 1391 Sandford St., London, Ontario, CANADA, V0M 1A0

³Charlottetown Research Station, Agriculture and Agri-Food Canada, Charlottetown, Prince Edward Island, CANADA
Setting the stage:

-Wireworms:
-about 30 economic species in Canada
Examples of common pest species in Canada

- **Ctenicera destructor/aeripennis** (BC, AB, SK, MB)
- **C. lobata, C. morula** (AB, SK, MB)
- **C. pruinina** (OR, ID)
- **Agriotes obscurus, A. lineatus** (BC, NS, PEI)
- **A. sputator** (PEI, NS), **A. mancus** (MB, ONT, NB, NS, PEI)
- **A. sparsus** (BC, OR)
- **Athous spp** (AB, SK, MB)
- **Limonius canus, L. californicus** (BC, AB, SK, MB)
- **Melanotus spp** (ON)
- **Hypnoides spp** (SK, MB)
Identification of economic wireworms in Canada: 2004-2010 Surveys

Wim van Herk
Bob Vernon

AAFC-Pacific Agri-Food Research Centre, Agassiz, BC
2010 Syngenta Crop Protection Canada initiative
Sites sampled in 2010
Many from Alberta!!!
Thanks!!!
Hypnoides prefers non-irrigated fields
Selatosomus prefers non-irrigated fields
Limonius prefers irrigated fields!!
Results: overview (2010)
identifications by Dr. van Herk, Agassiz

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<tr>
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<th># wws</th>
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69.9% 13.4% 4.9% 11.8%
## Results: overview (2010)

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Main species in Alberta:

- *Hypnoides bicolor* (74% of total, 23 sites)
- *Selatosomus destructor* (11% of total, 16 sites)
- *Limonius californicus* (10% of total, 3 sites)

So what?

The two main species are radically different in size and obviously impact crops differently.
Size does matter!!

*Selatosomus destructor*
(up to 2.5 cm)

*Hypnoides bicolor*
(up to 1.0 cm)
Main species in Alberta:
- *Hypnoides bicolor* (74% of total, 23 sites)
- *Selatosomus destructor* (11% of total, 16 sites)
- *Limonius californicus* (10% of total, 3 sites)

So what?
The two main species are radically different in size and obviously impact crops differently

Lots of Unknowns:
- What is their susceptibility to new insecticides? Little info.
- Feeding abilities/amounts, crops damaged? Little info.
- Behaviour, repellency, life history? Little info.
Survey plans for 2011 and beyond:

- Continue with survey as in 2010 with assistance from industry and growers.

- In Spring, need to know sites where wws are present in high #s to collect for Agassiz. *Selastomus destructor, Hypnoides bicolor* and *Limonius californicus*.

- Focus on new field work in prairies will be on these 3 species.

  - Vauxhall/Taber/Saskatoon/Winnipeg (wheat and/or pots.)
  - Hector Carcamo & Ian Wise (AAFC), Doug Waterer (U of S)
Setting the stage:

-Wireworms:
  -about 30 economic species in Can.
  -typically live for 3-5 years in soil
Life Cycle of Click Beetles

- Jan
- Feb
- Mar
- Apr
- May
- Jun
- Jul
- Aug
- Sep
- Oct
- Nov
- Dec

Emerging from the soil

- Adults overwintering in the soil
- Eggs laid
- Eggs hatching
- Transforming to Adults
- Pupae
- Adults overwintering in the soil

- Larvae

3-5 years

neonate

resident
Setting the stage:

-Wireworms:
  -about 30 economic species in Can.
  -typically live for 3-5 years in soil
  -populations may be > 3 million/ha
Click Beetles enter grassy fields, cereal crops, etc. in April, May and June.

Eggs are laid in soil, and hatch within 3 weeks.

Larvae feed on roots of grassy hosts or most other crops for 3-5 years.

The longer a field is in cereals or pasture, the higher the population.
Setting the stage:

-Wireworms:
  - about 30 economic species in Can.
  - typically live for 3-5 years in soil
  - populations may be > 3 million/ha
  - attack most economic crops
    cereals and grasses preferred
Setting the stage:

-Wireworms:
  -about 30 economic species in Can.
  -typically live for 3-5 years in soil
  -populations may be > 3 million/ha
  -attack most economic crops
  -populations & damage growing
Damage in Corn
*Agriotes obscurus*

Feeding Early in Tuber
(Late Summer Feeding)

Damage in wheat:
*Ctenicera destructor*
Setting the stage:

-Wireworms:
  -about 30 economic species in Can.
  -typically live for 3-5 years in soil
  -populations may be > 3 million/ha
  -attack most economic crops
  -populations & damage growing
  -Wireworms attracted by CO₂
Untreated wheat seed

Wireworms are attracted to CO$_2$!!!!!

Resident wireworms ‘large’
*A wireworm can easily consume 2 or more seeds. They also eat roots and other below-ground parts later.
WIREWORM ARSENAL:

CANADA

THIMET: GONE 2012

TEMIK: LONG GONE

MOCAP: NEVER REG.

DYFONATE: GONE

FURADAN: GONE

CHLORPYRIFOS: MU

COUNTER: GONE

LINDANE: GONE

U.S.A.

THIMET: STILL AVAIL.

TEMIK: STILL AVAIL.

MOCAP: STILL AVAIL.

FURADAN: GONE

CHLORPYRIFOS: NOT REG

COUNTER STILL AVAIL.

LINDANE: GONE

All kill wireworms!!!
Canada

- Thimet: Gone 2012
- Temik: Long gone
- Mocap: Never reg.
- Dyfonate: Gone
- Furadan: Gone
- Chlorpyrifos: BC
- Counter: Gone

Won’t kill wireworms!!!

Neonicotinoids: New

U.S.A.

- Thimet: Still avail.
- Temik: Still avail.
- Mocap: Still avail.
- Dyfonate: Gone
- Furadan: Still avail.
- Chlorpyrifos: Not reg.
- Counter still avail.
- Lindane: Gone

Fipronil: Potatoes.
Capture: POTs.

Neonicotinoids: New
Wireworm Insecticide Research

Wheat Trials
- Great study crop
- Easy to work with
- Major crop in Canada

Laboratory Trials

Field Trials

Multi-species Lab Toxicity and Repellency Trials
Laboratory Toxicity Studies

POTTER SPRAY TOWER
AAFC, LONDON, ONT.

Dr. Jeff Tolman

LC$_{50}$s
LT$_{50}$s
Wireworm health examined weekly for up to 300 days
Routine Health Checks:

- Categories of health:
  - **Alive**: can move out of 10cm circle in Petri dish
  - **Writhing**: full body movement, but uncontrolled
  - **Leg & Mandibles**: no visible movement except legs & mandibles
  - **Mandibles**: no visible movement except mandibles
  - **Dead**: decomposing, moldy

- Some "**Mandibles**" wireworms, which appear dead, are capable of full recovery, hence what we term the ‘**Lazarus Syndrome**’.
Laboratory Repellency Studies
- Soil bioassays
  
  ‘Volatile, contact, ingestion’
Inside yellow line = "orient"

Repelled

Intoxicated
Wireworm Management Research

Wheat Trials
- Great study crop
- Easy to work with
- Major crop in Canada

Potato Trials
- 16-20 candidate treatments/year
- Across Canada

Laboratory Trials

Field Trials

Candidate insecticide selections

Multi-species Lab Toxicity and Repellency Trials
What have we discovered?

WHEAT
*Questions:

*Can wireworm DAMAGE be controlled with seed treatments?  
*Can wireworms actually be KILLED with seed treatments?
Cereal Seed Tmts: “PAST”

- Lindane (Vitavax) seed treatment used
- Provided good stand protection AND…
- Killed wireworms quite effectively (3 or 4 years)
- BUT!!!
- Banned in NA in 2004.
Lindane (Organochlorine)  

Resident wireworms ‘large’
Lindane (Organochlorine)

60g AI/100kg seed

Wireworms feed and die within a month or so

-65-70% of residents die during growing season
Lindane 60g AI/100kg seed

*Wireworms are dying or dead while crop establishes*
Around mid summer, click beetles lay eggs in wheat and neonate wireworms are produced.
Lindane also kills neonate wireworms!!!

> 85% reduction in 7 field studies.

Wireworm populations would not recover to damaging levels for 3+ years!!
Why control for 3+ Years?

Year 1: Wheat

Year 2: Potatoes; canola; pulse crops.
- No WWs

Year 3: Wheat; potatoes; canola; pulse crops.
- Few, small WWs.

Year 4: Wheat
Candidate Insecticides for Canada:

Neonicotinoids:
- clothianidin (Poncho, Titan)
- thiamethoxam (Actara, Cruiser Maxx)
- imidacloprid (Gaucho, Raxil ww).

Synthetic pyrethroids:
- tefluthrin (Force)
- bifenthrin (Capture)
- lambda cyhalothrin (Matador).

Phenyl pyrazole:
- fipronil (Regent).
Wheat field trials since 1996

- Agassiz
- Agriotes obscurus
Plot preparation
- Roundup in March
- Field disced, not ploughed
- Clods removed

Preformed furrows

Precision seeding by hand

No CO2!!!!

Does crop protection = Wireworm Mortality?

Weekly counts

Resident wws

1 year later

Bait Traps Installed: 4/plot

Harvest Yield

neonates

Extracts:
-neonates
-resident wws
What have we discovered?

**Neonicotinoids:**
Clothianidin (Poncho)
Thiamethoxam (Cruiser Maxx)
Imidacloprid (Raxil ww)
Neonicotinoid 10-30g AI/100kg seed

Resident wireworms ‘large’
*Wireworms rapidly become intoxicated/moribund
Neonicotinoid 10-30g AI/100kg seed

*Wireworms are intoxicated while crop establishes
*Most wireworms recover fully by mid-summer
Early to mid summer, click beetles lay eggs in wheat and neonate wireworms are produced.

BUT, no kill of neonates occurs with neonicotinoids.
Neonicotinoid 10-30g AI/100kg seed

*The result?

- Great crop establishment and yield, BUT ...........
- Little reduction in resident wws and no reduction of neonates
- Wireworms are there the next year
- True for all neonicotinoids tested
Effectiveness is reduced if germination delayed, since insecticide levels drop over time.

Wireworms most active at near or > 10 C in soil!!!

Resident wireworms ‘large’
Candidate Insecticides for Canada: What have we discovered?

**Synthetic pyrethroids:**
- tefluthrin (FORCE)
- bifenthrin (Capture)
- lambda cyhalothrin (Matador)

All are repulsive, not lethal to wireworms
What have we discovered?

Phenyl pyrazole:
- fipronil (Regent)
Fipronil (phenyl pyrazol) 50 g Al/100kg seed

Rapidly kills resident wireworms!!!
100% reduction in two field studies
Also kills neonate wireworms later on!!!
100% reduction in two field studies
Latently kills resident wireworms!!!
> 90% reduction in two 2008/09 studies
Fipronil 1.0g AI/100kg wheat

Kills neonate wireworms later in summer!!!
> 92% reduction in two 2008/09 studies

Wireworm populations will not recover to damaging levels for 3+ years, just like Vitavax!!!!!
BUT....
Wheat stand not optimal with fipronil at 1.0g Al/100kg wheat!!
Sooooo
How do we accomplish both goals of:

a) Protecting a wheat seed from damage
AND
b) Killing wireworms?
Thiamethoxam + Fipronil BLEND

10g 1g

- Excellent wheat stand (vigour effects).
- Excellent kill of resident and neonate wws.
- WW pops will not recover for 3+ years.
- Proven over 3 years of field trials.
Cereal Seed Tmts: “PRESENT”

Neonicotinoids:
Thiamethoxam (Cruiser Maxx)
Imidacloprid (Raxil ww)
- Provide current season damage protection
- Probably no wireworm population reduction
- Work best in soil temperatures favouring both rapid germination and high wireworm activity.
Cereal Seed Tmts: “FUTURE”

Neonicotinoid + Fipronil Blends (?

- Requires registration of fipronil in Canada
- Will work on all wireworm species
- New methods being developed where fipronil will kill most wireworms with less than 1 gram/ha.

New insecticides are tested every year.
Special thanks to:

-Agriculture and Agri-Food Canada, National Wireworm Project
-Pest Management Centre, AAFC.
-BC Potato Industry Development Committee
-Potato Growers of Alberta
-Syngenta CropProtection Inc.
-Bayer CropScience, Inc.
-FMC and other industry collaborators
-A horde of eager summer students.