March 2018 Webinar

Wireworm Management in Potato

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Growing Forward 2

Canada

• What are the options for managing wireworms in potato?
• What is the effectiveness of non-chemical approaches?

• Overview of webinar
  o Background
  o Insecticide studies conducted with potato, wheat
  o Companion planting in potato
  o Non-chemical approaches
  o Managing click beetles to manage wireworms
  o Summary, further information

Background

• Wireworms
  o Larvae of click beetles (Elateridae)
  o Soil-dwelling stage
  o Long-lived (4-5 years)

Crops affected

Background

• Wireworms
  o Larvae of click beetles (Elateridae)
  o Soil-dwelling stage
  o Long-lived (4-5 years)
  o Seasonal movements in the soil
    • Feeding periods in spring, fall
    • Often not there when you look for them
  o Patchy distributions in the field
  o Larvae attracted to CO2 sources in the soil
  o Feed on many different crops
• Wireworms
  o different pest species (20?)
    • different habitat preferences, life histories
      o Sexual, parthenogenetic
      o Dryland, irrigated land, soil types
    • Different behaviours, susceptibilities to insecticides
    • Size, fecundity, dispersal
  o Need to be understood as a “pest complex”
  o Need to know what species you have in the field
  o You may have more than one economic species in a field
  o Knowing their biology is critical to managing them

Identification + distribution (summary)

• Main pest species today
  - BC
    • Agriotes obscurus
    • Agriotes lineatus
    • Limonius californicus
  - Prairies
    • Hypnoides bicolor
    • Selatosomus destructor
    • Limonius californicus
    • Agriotes mancus
  - Ontario
    • Hypnoides abbreviatus
    • Limonius agonus
    • Melanotus spp.
    • Agriotes mancus

- Quebec
  • Hypnoides abbreviatus
  • Limonius aeger
  • M. communis/fissilis
  • Dalopius vagus
  • Agriotes mancus

- Atlantic Canada (PEI)
  • Agriotes obscurus
  • Agriotes lineatus
  • Agriotes sputator
  • Hypnoidus abbreviatus
  • Limonius aeger
  • Melanotus similis
  • Sylvanelater cylindriformis
  • Agriotes mancus

• 445 fields
• 22% of fields >1 species
• Avg. sample size = 7.6/field

Late instar Selatosomus destructor, Hypnoides bicolor
• 1st instar S. destructor is similar size as 9th instar H. bicolor

Details vary between species!!!!!
**Wireworms**
- Knowing their biology is critical to managing them
  - Activity periods
    - Implications for sampling
    - Predicting fall feeding vs early harvest
  - Susceptibility to insecticides, biologicals
- Life history
  - *S. destructor* (4-9 years)
  - *H. bicolor* (2-3 years)
  - *L. californicus* (4 years)

**Limonius californicus**
- Damage on the increase
- 3rd most numerous species
- Typically prefers irrigated fields.
  - Now also in min-till fields.
  - Main pest ww in Montana, Idaho and Wash.
  - Change in species dominance?
  - Hugely damaging!!
  - Wrecks in fields South of Calgary.

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- Overlapping generations
- Main pest in Montana, Idaho and Wash.
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**• Limonius californicus**
  - Damage on the increase
  - Changes in cropping and tillage practices
    - Continuous cropping = continuous food
    - Direct seeding = less disruption of soil
      - Soil temperatures more moderate
      - Higher moisture
      - Higher survival of eggs, neonates
  - Dissipation of OC residues, lack of effective new chemicals

**Wireworms and potatoes (1)**
- Feeding in spring coincides with mother tuber planting
- 100% of wireworms feed in spring
- Insecticides (e.g. Thimet) applied during this time will be most effective
  - Because wireworms are in the tuber zone
  - Because pesticides are strongest
- Wireworms mostly dormant in summer
- Wireworm feeding in fall (Sept., Oct.) coincides with last daughter tuber growth
  - Fall feeding occurs over a prolonged period
  - The longer potatoes are in the soil at that time, the higher the damage

**British Columbia**

**POTATO TRIAL 2005 - WIREWORM DAMAGE ON TWO SAMPLING DATES**

- September 19th
- October 11th

**Insecticide efficacy studies with potato**
- Since 2000
- In Agassiz, BC (Agriotes obscurus); PEI (A. sputator); ON (Limonius agonus, Melanotus spp.)
- Meticulous, labour intense methodology
  - To reduce variability, error in results
  - Patchy distribution, competing CO2 sources

**• Wireworms and potatoes (2)**
- Some crops (grass, cereals) are preferred for egg laying
- Problems occur when these are in rotation with high value crops susceptible to wireworms, such as potatoes

**Plot preparation**
- Roundup in March
- Field disked, not ploughed
- Grains removed
- Entire period harvested by hand

**Harvests done at 100 and 120 DAP**

**Leona Arnold**
- 15 yrs grading experience
At planting options in potato production in BC.

Insecticide Efficacy Trials at PARC, Agassiz, 2013
Mean wireworm blemishes per market-sized tuber

Insecticide Efficacy Trials at PARC, Agassiz, 2016
Mean wireworm blemishes per market-sized tuber

Tuber blemish protection = Wireworm Mortality?
Insecticide efficacy studies with wheat

Since 1996, field studies in BC, PEI, AB, SK, MB
- Much easier study crop than potatoes
- Can be used to screen for promising products
- Can be used to develop trap crops, intercrops
- Precise, exhaustive methods
- Lab, under controlled conditions
  - Evaluate for repellency, morbidity, mortality
  - Compare with results from field studies
    - patchy distributions, seasonal movements, competing food sources

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Wireworm seedling damage

Does crop protection = Wireworm Mortality?

Seed treatments historically
- Lindane (Vitavax) treated seed
  - Provided good stand protection AND killed wireworms
  - Protection for 3 to 4 years
  - Banned in Canada in 2004
Seed treatments

Products screened

- **Neonicotinoids**: clothianidin (Poncho, Titan); thiamethoxam (Actara, CruiserMaxx); imidacloprid (Gaucho, Stress Shield 600)
- **Synthetic pyrethroids**: tefluthrin (Force); bifenthrin (Capture); lambda cyhalothrin (Matador)
- **Phenyl pyrazoles**: fipronil (Regent)
- **Others**: renaxypyrr, cyazypyr, spinosad, halofenocide, *Metarhizium*, etc.

**Seed treatments**

- **Neonicotinoids**
  - reversible intoxication, no kill
  - usually good wheat stand protection
- **Synthetic pyrethroids**
  - repulsion, no kill
  - usually good wheat stand protection
- **Phenyl pyrazoles: fipronil**
  - kills ALL SPECIES at very low rates
  - good wheat stand protection
  - better than Lindane for damage protection and ww kill!!!!
- **Others**:
  - didn’t work

**Seed treatments**

- **Fipronil**
  - kills ALL SPECIES at very low rates
  - good wheat stand protection
  - better than Lindane for damage protection and ww kill!!!!
- But, we cannot get it registered in Canada
- We have been researching fipronil replacements for past 5 years
  - Some candidates are as effective, but still proprietary
  - If / when they are registered, the problem will be solved.

**Wheat Trial in Alberta**

- Crop Protection
- Neonate + Resident wireworm kill
- New “Silver bullets” are coming

**the search goes on for Lindane replacement(s):**
Soil Bucket studies

Measures:
- Stand protection
- Wireworm distress (surfacing)
- Wireworm mortality

Health of wireworms when removed from pots 17 DAP (2013)

<table>
<thead>
<tr>
<th>Wireworm health categories (van Herk and Vernon, 2013, J Pest Science)</th>
<th>(numerical value shows degree of intoxication)</th>
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Wireworm health categories (van Herk and Vernon, 2013, J Pest Science)

- A: Alive, unaffected
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- WR: Writhing, only upon stimulus

Toxicity and repellency studies

Wireworm soil bioassay

*Agriotes obscurus*

Measures:
- Seed tmt attraction
- Seed tmt repulsion
- Seed tmt toxicity after 24 h exposure

Wireworm movements every 5 minutes;
Done in darkness for 3-5 hours;
Wireworms taken out after 24 h;
Health checks done until wws dead or in perfect health (sometimes > 200 days)

Wireworm mortality over time: Fipronil

- Dividend XL RTA 13 g ai / 100 kg seed
- Fipronil 1 g ai
- Fipronil 5 g ai
- Fipronil 50 g ai

Companion planting

- Can use treated wheat seed to kill wireworms
  - Attract and kill concept, wheat germinates first, draws in wws
  - Avoids putting insecticide directly onto potato seed
- Proof of concept with fipronil/thiamethoxam blend treated seed
  - 3,250g Al/ha Thimet 15G
    - Mammalian tox: 1 ppm; ww mort. <70%
  - 0.095g Al/ha blend treatment
    - Mammalian tox: <100 ppm; ww mort. >95%
- Fipronil not registered, but perhaps new chemistries with same mode of action will work as well.
Attract & Kill Wireworm Management Strategies

A & K strategies on wheat as in-furrow treatments in potato

A & K Wheat 1st to germinate

Spray out wheat after 45 days

British Columbia and Ontario Trials

A & K = T10 + F5
At 170 seeds/m row
T10 + F5 = 1.7g ai Fip/ha
Thimet 15G = 3230g ai/ha

Non-chemical approaches

- Larvae
  - Mechanical
    - cultivation
  - Cultural
    - Field flooding, biofumigant crops, fallowing
- Adults
  - Pheromone
    - Mass trapping, mating disruption
  - Biological
    - Metarhizium, other biopesticides

Targeting the beetle stage

- Why?
  - When chemical control of larvae is not an option
  - Lack of effective chemicals
  - PEI situation, epidemic populations, desperate need
  - If cereals are grown in rotation with potatoes (or other high value crop)
  - Idea: kill beetles before they lay eggs
Managing click beetles
- Requires good understanding of their biology
  - Time of emergence, egg-laying (when and where, how many), how they disperse (walk, fly), nocturnal
  - Distribution in the field (reservoir areas, hotspots, stability) and movement during a season
- Requires an effective way to monitor (effective trap, how many traps/field, where to place, how often to check)
- Requires a way to kill them, and a way to determine if control method worked
- Requires understanding of how beetle numbers correlate with damage

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Vernon Pitfall Trap™
- Cheap, robust
- Easy to install, check
- Rodent proof
- Very efficient
- Can be sealed for winter

Efficient!
- Up to 1000/trap/day
- 900,000 in 3 fields in 2015

Studies in BC and PEI indicate populations stable
- 8 – 10 traps in headland areas enough, check weekly
- But, pheromone-baited traps
- Pheromones for Alberta species to be identified

Grassy headlands are beetle and wireworm reservoirs

So far: only species for which we have sex pheromones...
Dissections of female beetles indicate when eggs are mature, and when egg-laying begins.
• How to control beetles?
  o Field sprays
  o Target hot-spots with sprays, biologicals (Met)
  o Mating disruption
  o Mass trapping (requires pheromone)

Field sprays, e.g. Matador 120EC (83 mL/ha)

• How about management? (for beetles)
  o Nothing registered for beetles
  o Studies in BC, PEI, in lab and field (with AO, AS)
  o Oversprays, various insecticides

Pheromone curtain
  ➢ Alongside permanent grassy headlands
  ➢ Majority of males removed in Spring
  ➢ Untrapped females not mated

• Is my field at risk, and if so, what can I do?

• IPM guide (in dev’p)
• Risk guide (in dev'p)
  o Years in pasture, other preferred crop
  o Nearest reported wireworm damage
  o Wireworm sampling
  o Click beetle sampling

How do you know your field is at risk of wireworm damage?

Wireworm Risk to Fields

Field History

Sampling

Sampling Scores

Wireworm Risk Field History

2. Nearest Wireworm Damage in Past 4 Yrs.
   - Regional WW history
   - Imminent threat
   In Main Field
   5 Pts
   4 Pts
   3 Pts
   1 Pt
   TOTAL POINTS
   Within ½ Km
   1- 2 Km Away
   3-5 Km Away
   /5
   Notes:
   Choose ONLY ONE Box (Max = 5)
   0 if > 5 Km away

Risk Score
0-1 No Risk Damage Unlikely
Wireworm Risk Field History
Baseline Risk
Risk Score
2-3 Low Risk
4-6 Moderate Risk
7-10 High Risk
>10 Extreme Risk
Risk Score
Slight Damage Possible, but Sample for WWs to verify Damage Likely:
Use available WW controls
Damage very likely: Avoid potatoes, or use WW controls
High Damage: Avoid potatoes.

Total Score:
1) Preferred crops: Max 10
2) Damage in area: Max 5
Maximum score: 15

Your Field History Score:

Summary and further reading
• Review of webinar
  o Background
  o Insecticide studies conducted with potato, wheat
  o Companion planting
  o Non-chemical approaches
  o Managing adults to manage larvae
  o More information

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Wireworm
Biology and Nonchemical Management in Potatoes in the Pacific Northwest
Dr. Bob Vernon, Dr. Wim van Herk
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