Insect Management in Corn and Soybean

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Western corn rootworm
Western corn rootworm

Biology
- 1 generation per year
  - Overwinter as eggs
  - Eggs hatch late May/early June
  - Larvae go through 3 “instars” (stages)
  - Adults emerge beginning in July

- Host plants
  - Larvae develop on corn roots
  - Adults feed on corn pollen, silks, foliage, cucurbits

- Damage
  - 1st instar larvae feed on root hairs, burrow inside of roots
  - 2nd and 3rd instar larvae feed on and ultimately prune roots

Photo: John Obermeyer
Northern corn rootworm

Photo: Winston Beck, Bugwood.org
Northern corn rootworm

Biology
• Life cycle similar to western corn rootworm
• Host plants
  • Larvae develop on corn roots
  • Adults feed on pollen and foliage from giant ragweed, other weeds, and flowers in addition to corn, cucurbits
    • Can be a pretty severe pest of cut flowers
• Damage is more or less identical to that of western corn rootworm

Photo: Winston Beck, Bugwood.org
Resistance to Crop Rotation

Western corn rootworm
- Adult female lays eggs in soybean (and corn, alfalfa, etc) and some hatch into corn

Northern corn rootworm
- Some eggs remain dormant in the soil for two or more years, thus avoiding soybean

Photos: Dr. Joe Spencer, Illinois Natural History Survey
Bt traits for corn rootworm control

- Currently four Bt toxins available for corn rootworm control:
  - Cry3Bb1 (Yieldgard Rootworm)
  - Cry34/35Ab1 (Herculex CRW)
  - mCry3A (Agrisure RW)
  - eCry3.1Ab (Agrisure Duracade)

- Combinations of these four toxins are available in 21 different trait packages (note: several of these trait packages include the same combination of proteins; see trait table)

- Most trait packages now include a combination of two of the four toxins (typically Cry34/35Ab1 + one of the other three)

- Single-trait hybrids for CRW are being phased out

https://agrilife.org/lubbock/files/2019/05/BtTraitTable-May-2019.pdf
Rootworm Resistance to Bt Traits

- 2009: first evidence of field-evolved resistance to Cry3Bb1 in western corn rootworm
  - Gassman et al. 2011 PLOS One 6 (7)

- Cross-resistance among Cry3Bb1, mCry3A, and eCry3.1Ab in western corn rootworm

- 2016-2018: confirmed reports of field-evolved resistance in western corn rootworm to Cry34/35Ab1 in Iowa
  - Gassmann et al. 2019 Pest Management Science DOI: 10.1002/ps510

- 2019: first confirmed reports of field-evolved resistance in northern corn rootworm to Cry3Bb1 and Cry34/35Ab1 in North Dakota
Field-Evolved Resistance of Northern and Western Corn Rootworm (Coleoptera: Chrysomelidae) Populations to Corn Hybrids Expressing Single and Pyramided Cry3Bb1 and Cry34/35Ab1 Bt Proteins in North Dakota

Veronica Calles-Torrez, Janet J Knodel, Mark A Boetel, B Wade French, Billy W Fuller, Joel K Ransom

Abstract

Northern, Diabrotica barberi Smith & Lawrence, and western, D. virgifera virgifera LeConte, corn rootworms (Coleoptera: Chrysomelidae) are major economic pests of corn, Zea mays L., in North America. Corn hybrids expressing Bacillus thuringiensis Berliner (Bt) toxins are commonly used by growers to manage these pests. Several cases of field-evolved resistance to insecticidal proteins expressed by Bt corn hybrids have been documented in many corn-producing areas of North America, but only for D. v. virgifera. In 2016, beetles of both species were collected from five eastern North Dakota corn fields and reared in a growth chamber. In 2017, larvae reared from those populations were subjected to single-plant bioassays to screen for potential resistance to Cry3Bb1, Cry34/35Ab1, and pyramided Cry3Bb1 + Cry34/35Ab1 Bt toxins. Our results provide the first documented report of field-evolved resistance in D. barberi and the second report for D. v. virgifera.
Western Corn Rootworm Resistance to Bt Traits: Current Situation

• Resistance or partial resistance to “Cry3” traits (Cry3Bb1, mCry3A, eCry3.1Ab) common in Illinois
  • Yieldgard RW/VT Triple Pro, Agrisure RW, Agrisure Duracade

• Resistance to Cry34/35Ab1 (Herculex CRW) confirmed in NE Iowa – limited area
  • Evidence of reduced susceptibility in IL, not widespread

• Pyramided hybrids overall still performing well in Illinois (SmartStax, Agrisure 3122, etc.)
Current management recommendations

• Implement rootworm control where needed, based on adult numbers the previous year
  • While overall numbers are low, there are “hot spots” out there
  • Make the decision based on local populations, not just overall trends and commodity prices
  • Northern IL: be on the lookout for northern corn rootworm

• Where control is justified, a pyramided Bt trait is still the most effective option
  • Soil insecticides are still viable

• Evaluate trait (and insecticide) performance on your farm
  • Best interpreted if you have an assessment of the previous year’s adult population
  • Look for changes over time
Current management recommendations

• Where unexpected damage is observed and/or resistance is expected:
  • Best option: rotate field to soybean (kills all WCR larvae in the soil at hatch)
  • Next best: rotate to a soil insecticide
  • Unexpected damage (EPA definition):
    • ½ node pruned, pyramided hybrid
    • 1 node pruned, single-trait hybrid

• Local practices have a demonstrated impact on corn rootworm resistance development
Large Plot Rootworm Trial at Monmouth, IL

Photo: Dennis Bowman, Illinois Extension
Large-plot CRW trial at Monmouth, IL

No significant differences among treatments

$F = 2.13$, df = 4, 12, $P = 0.139$

More results from 2019 available for download at: https://uofi.box.com/v/2019PestPathogenARB
### Evaluation of Traits in Combination with Insecticides

**Urbana, IL 2019**

<table>
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<th>Node-injury ratings</th>
<th>Non-Bt (rootworm)</th>
<th>SmartStax RIB (5% RIB)</th>
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<th>Agrisure 3122 (5% RIB)</th>
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Standard Corn Rootworm Evaluation
Urbana, IL 2019

$F = 6.37, \text{ df} = 3, 10, P < 0.001$

More results from 2019 available for download at:
https://uofi.box.com/v/2019PestPathogenARB
What about prevent/late planting?
What about prevent/late planting?

On the one hand.....

- Every acre not planted to corn is an acre that does not produce rootworms
- Delayed planting (esp. past rootworm hatch) reduces larval survival
- Flooding during and shortly after egg hatch kills larvae

However....

- Isolated patches of corn and/or late-maturing corn attract beetles, which can lead to high larval pressure next year
Ear feeding caterpillars

• Direct yield loss, site for ear rot pathogens

• Historically, minor issue in IL:
  • Corn earworm:
    • Feeding mostly at tip of ear
    • Cannibalistic = 1 per ear (usually)
  • Fall armyworm
    • Rarely at damaging levels in IL

• Western bean cutworm
  • Feed at sides of ears
  • Not cannibalistic (>1 per ear)
Corn earworm

- Migrates into IL from south annually, more of a problem when planting is delayed
  - Sound familiar?
  - Abnormally high pressure throughout IL in 2019

- Resistance to several above-ground trait packages common in the southern U.S.

- Direct yield loss generally minor, feeding limited to ear tips

- Route of entry for ear rots, quality issues in seed corn

- Feeds on many plant species
  - Hemp, tomatoes among many others
Defoliators in soybean

• Insect pressure in 2019 in soybean was generally low

• Economic threshold: 20% defoliation after bloom

• Just an example:
  • Sampled the 5 most defoliated fields we could find in Champaign County
    • Highest average defoliation (field level): 2.2%
    • Overall average: 1.7%
Soybean Gall Midge
New and Emerging Pest of Soybean

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2018 Soybean Gall Midge
Soybean Gall Midge

- First Documentation in 2011
  - Isolated to a few fields
  - Secondary pest of plant pathogens or mechanical damage
  - Showed up late in the season

- Observations in 2016 and 2017

- Field Issues in 2018
  - Large number of fields throughout the state
  - Early signs of infestation (Late June)
Field Symptoms

- Damage greatest at the field edge
  - Discoloration at the base of plants
  - Plants easily snapped off
  - Some plants with swollen stems
Soybean Gall Midge Resources

https://cropwatch.unl.edu/tags/soybean-gall-midge
(Articles from University of Nebraska Extension on soybean gall midge)

https://store.extension.iastate.edu/product/Soybean-gall-midge-a-new-field-crop-pest
(Soybean gall midge fact sheet from Iowa State; free download)

(Soybean gall midge update and description of a similar species in Minnesota)
Questions?

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