Insect Management in Corn and Soybean

Northwest Illinois Agronomy Summit
Freeport, IL Jan. 14, 2020

Dr. Nick Seiter
Department of Crop Sciences
University of Illinois
nseiter@Illinois.edu | (217) 300-7199
Twitter: @nick_seiter

ILLINOIS
Crop Sciences
COLLEGE OF AGRICULTURAL, CONSUMER & ENVIRONMENTAL SCIENCES

ILLINOIS
Extension
COLLEGE OF AGRICULTURAL, CONSUMER & ENVIRONMENTAL SCIENCES

Western corn rootworm

Photo: John Obermeyer

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

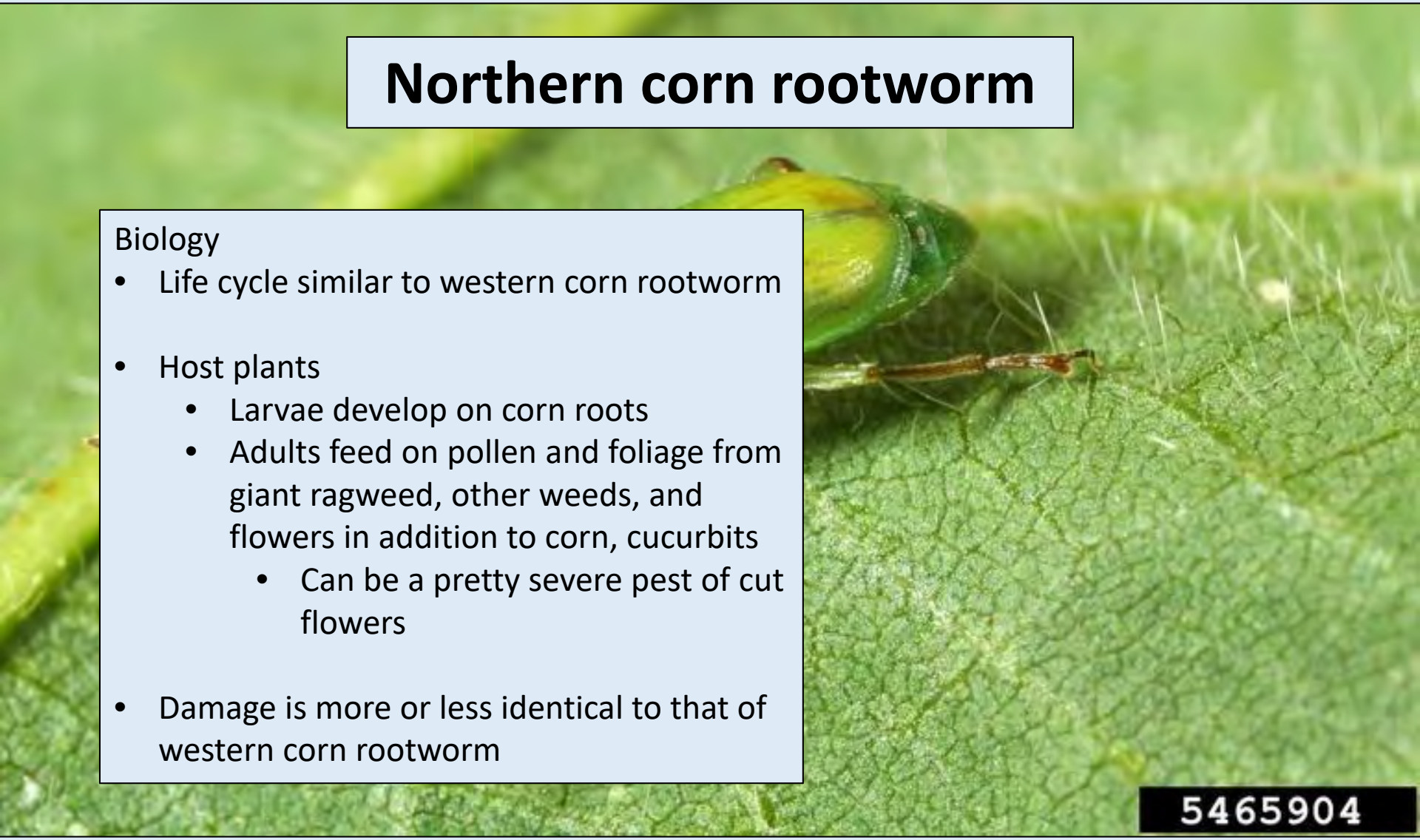
- Damage
  - 1st instar larvae feed on root hairs, burrow inside of roots
  - 2nd and 3rd instar larvae feed on and ultimately prune roots

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

The Handy Bt Trait Table

for U.S. Corn Production

The latest version of the table is always posted at https://www.texasinsects.org/bt-corn-trait-table.html
For questions & corrections: Chris DiFonzo, Michigan State Univ., difonzo@msu.edu
Contributor: Pat Porter, Texas A&M University (web site host)

Updated May 2019

The Handy Bt Trait Table provides a helpful list of trait names (below) and details of trait packages (over) to make it easier to understand company seed guides, sales materials, and bag tags. This latest version incorporates two new findings of resistance, and categorizes western & northern corn rootworm separately.

Breaking News #1: Entomologists at the University of Guelph in Canada confirmed European corn borer (ECB) resistance to Cry1F Bt (the Herculex I trait) in corn. In 2018, ECB populations were collected from multiple locations in the Maritime Provinces of eastern Canada where unexpected damage was reported. Lab bioassays showed a high level of resistance to Cry1F; the registrant of the trait independently confirmed the results. *This is the first case of field-evolved resistance by ECB to Bt corn.*

Use of single-trait hybrids likely contributed to the problem. In eastern Canada, hybrids with only one Bt trait (Cry1F) were still being sold & planted, well after an expected phase out in favor of multi-Bt pyramids to allow for reduced 5% refuge. Although the Maritime provinces are far from the major corn production area in the central U.S., the bioassay results demonstrate that ECB resistance to Bt corn can happen, and that phasing out single-trait hybrids is critical. In short-growing season areas of the U.S. and Canada, seed options tend to be limited, so single-trait hybrids may still be available. Using them risks the development of additional resistant insect populations.

Breaking News #2: Entomologists at North Dakota State University confirmed northern corn rootworm resistance to Cry3Bb1 and Cry34Ab1/Cry35Ab1. Although resistance to multiple traits is well-documented in the Midwest for western corn rootworm, this is the *first confirmation of field-evolved resistance by the northern corn rootworm.*

Field corn 'events' (transformations of one or more genes) and their Trade Names

Trade name for trait	Event	Protein(s) expressed	Primary Insect Targets + *Herbicide tolerance*
Agrisure CB/LL	Bt11	Cry1Ab + *PAT*	corn borer + *glufosinate*
Agrisure Duracade	5307	eCry3.1Ab	rootworm
Agrisure GT	GA21	*EPSPS*	*glyphosate*
Agrisure RW	MIR604	mCry3A	rootworm
Agrisure Viptera	MIR162	Vip3Aa20	broad caterpillar control, except for corn borer
Enlist	DAS40278	*aad-1*	*2,4-D herbicide detoxification*
Herculex I (HXI) or CB	TC1507	Cry1Fa2 + *PAT*	corn borer + *glufosinate*
Herculex CRW	DAS-59122-7	Cry34Ab1/Cry35Ab1 + *PAT*	rootworm + *glufosinate*
(None – part of Qrome)	DP-4114	Cry1F + Cry34Ab1/Cry35Ab1 + *PAT*	corn borer + rootworm + *glufosinate*
Roundup Ready 2	NK603	*EPSPS*	*glyphosate*
Yieldgard Corn Borer	MON810	Cry1Ab	corn borer
Yieldgard Rootworm	MON863	Cry3Bb1	rootworm
Yieldgard VT Pro	MON89034	Cry1A.105 + Cry2Ab2	corn borer & several caterpillar species
Yieldgard VT Rootworm	MON88017	Cry3Bb1 + *EPSPS*	rootworm + *glyphosate*

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/ps5510
  - Gassman et al. 2016 Journal of Economic Entomology DOI: 10.1093/jee/tow110

- 2019: first confirmed reports of field-evolved resistance in northern corn rootworm to Cry3Bb1 and Cry34/35Ab1 in North Dakota

JOURNAL OF ECONOMIC ENTOMOLOGY

Volume 112, Issue 4
August 2019

Article Contents

< Previous Next >

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

Journal of Economic Entomology, Volume 112, Issue 4, August 2019, Pages 1875–1886,
https://doi.org/10.1093/jee/toz111
Published: 22 May 2019 **Article history** ▾

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.*

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


Plant
4

Large Plot Rootworm Trial at Monmouth, IL

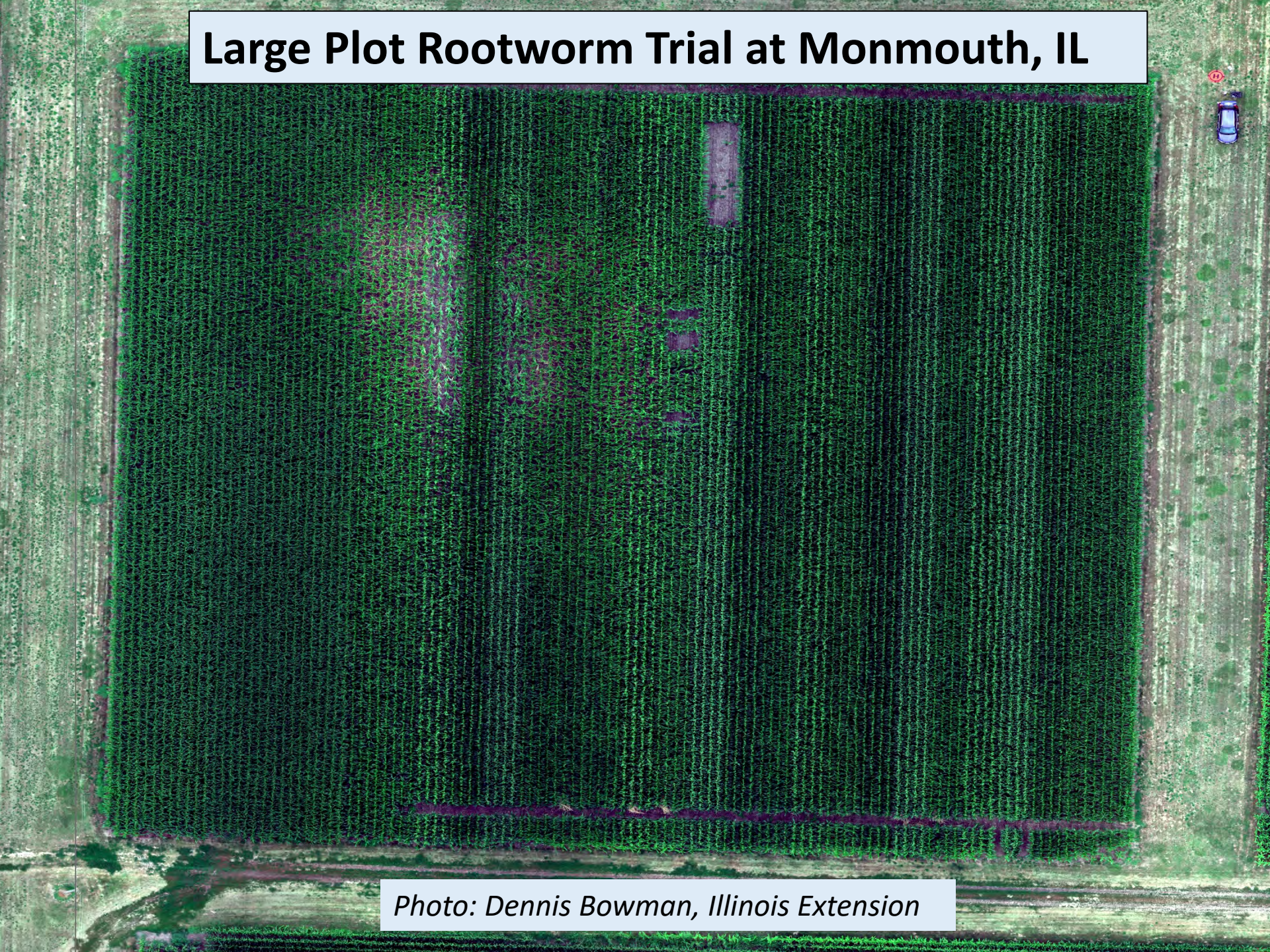
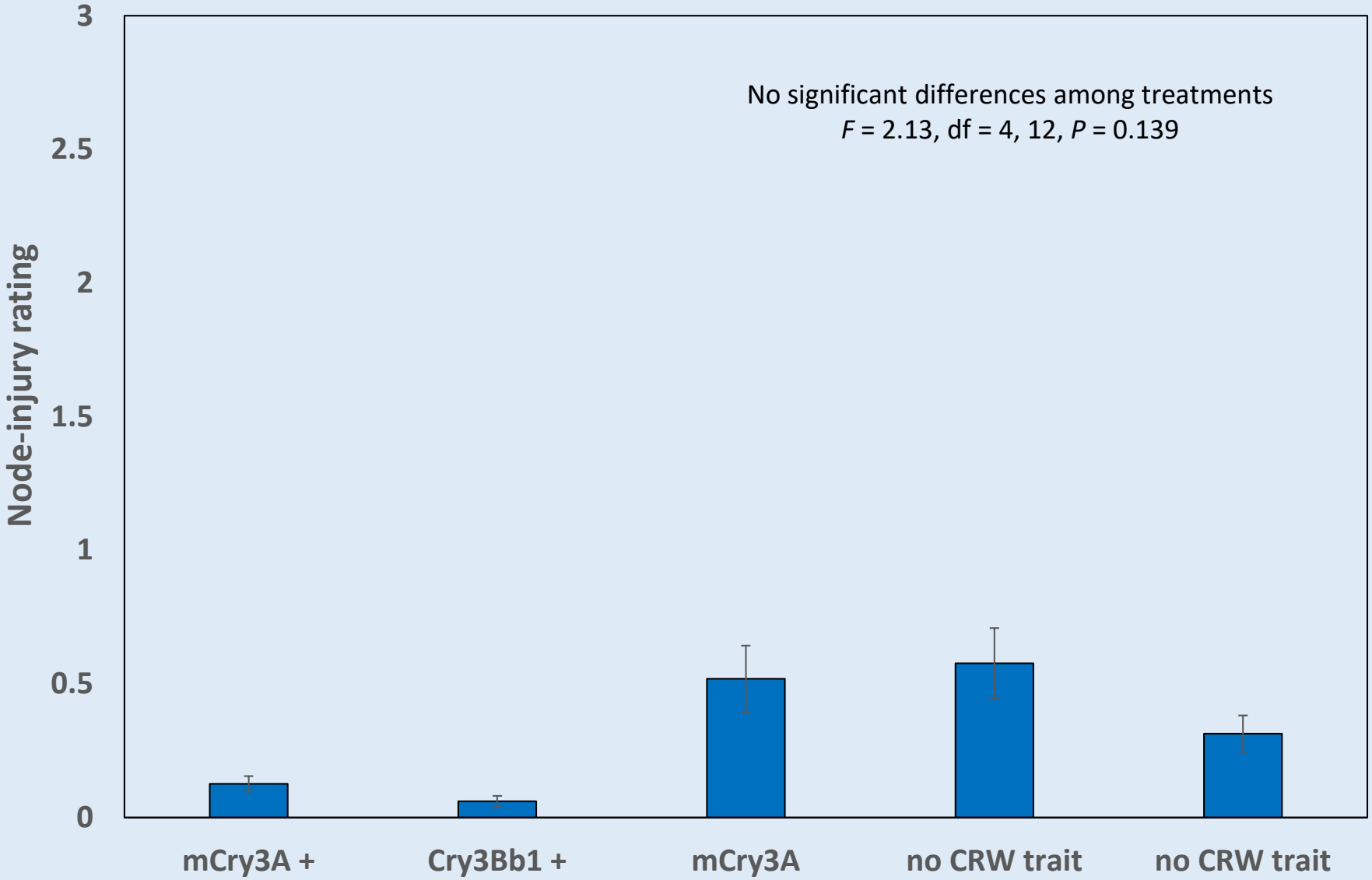


Photo: Dennis Bowman, Illinois Extension

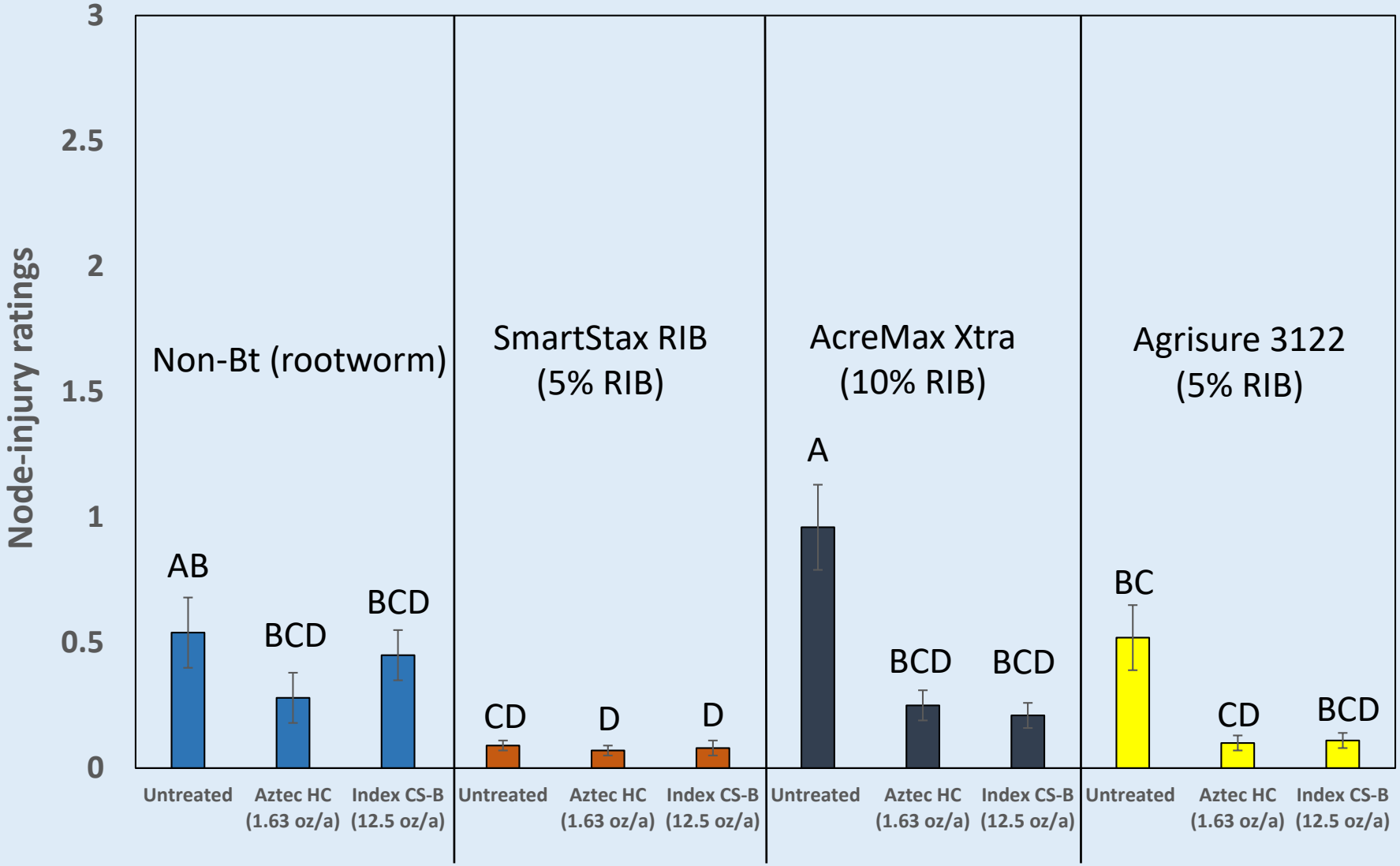
Large-plot CRW trial at Monmouth, IL



More results from 2019 available for download at:
https://uofi.box.com/v/2019PestPathogenARB

Evaluation of Traits in Combination with Insecticides

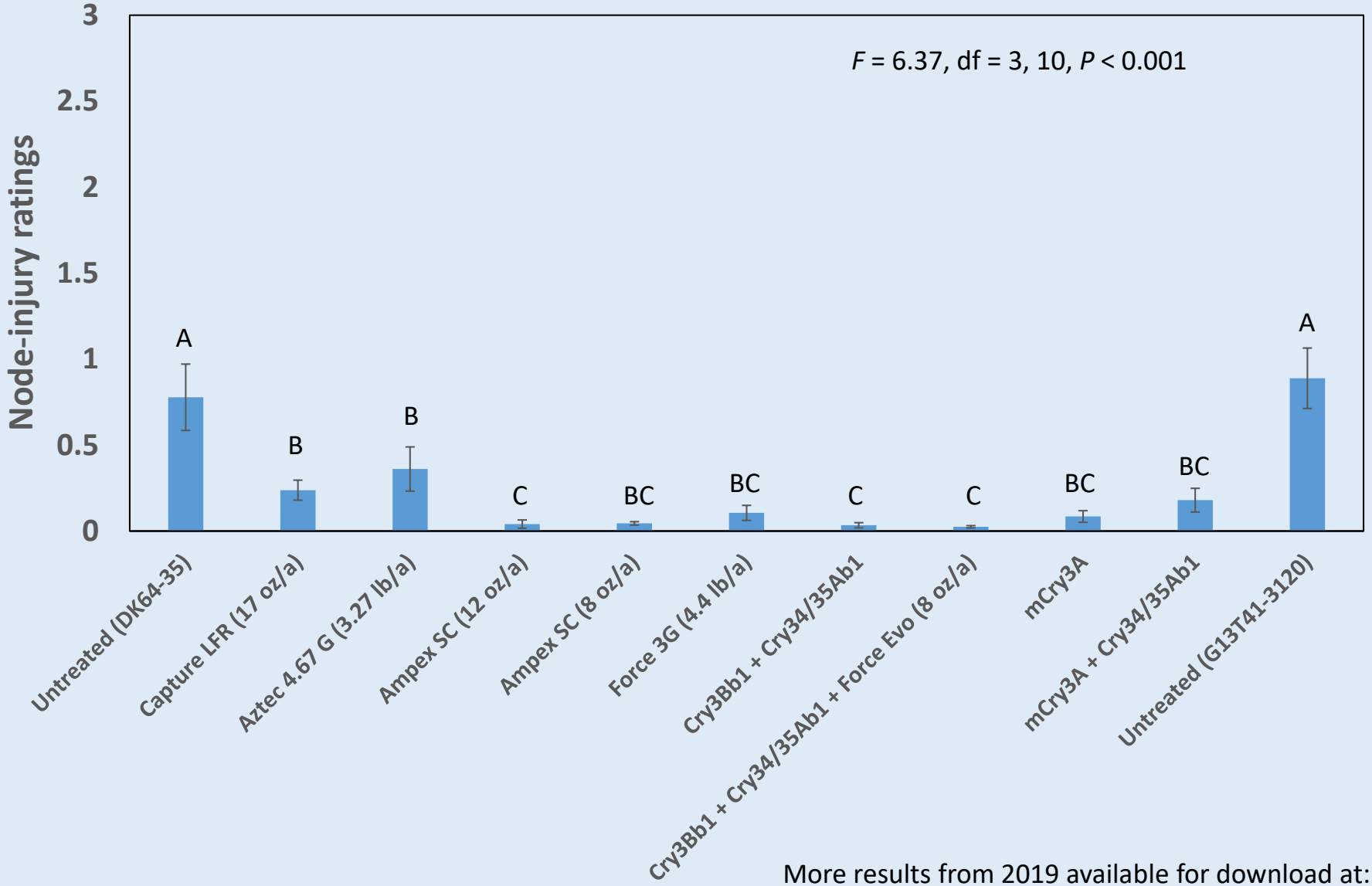
Urbana, IL 2019



More results from 2019 available for download at:
https://uofi.box.com/v/2019PestPathogenARB

Standard Corn Rootworm Evaluation

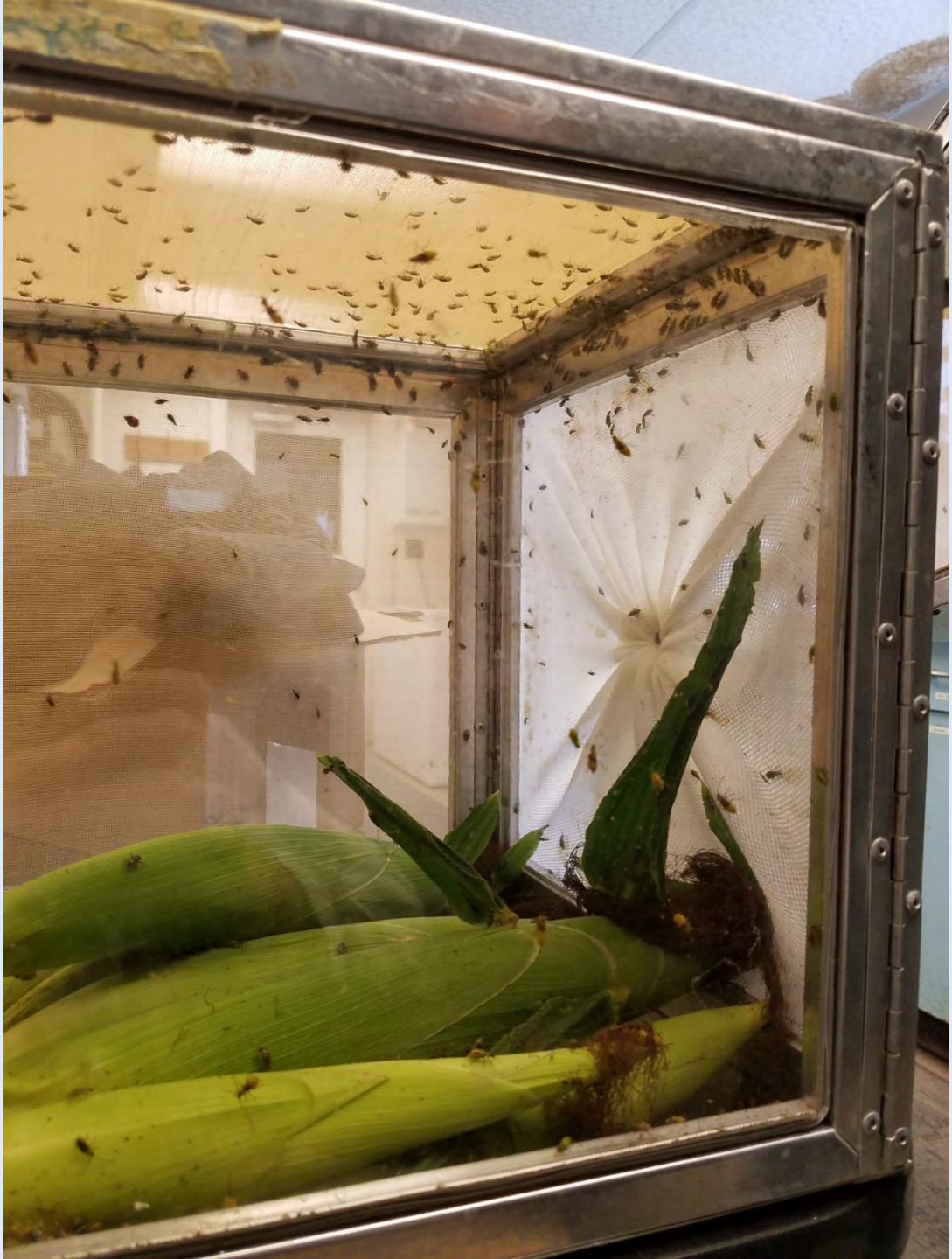
Urbana, IL 2019



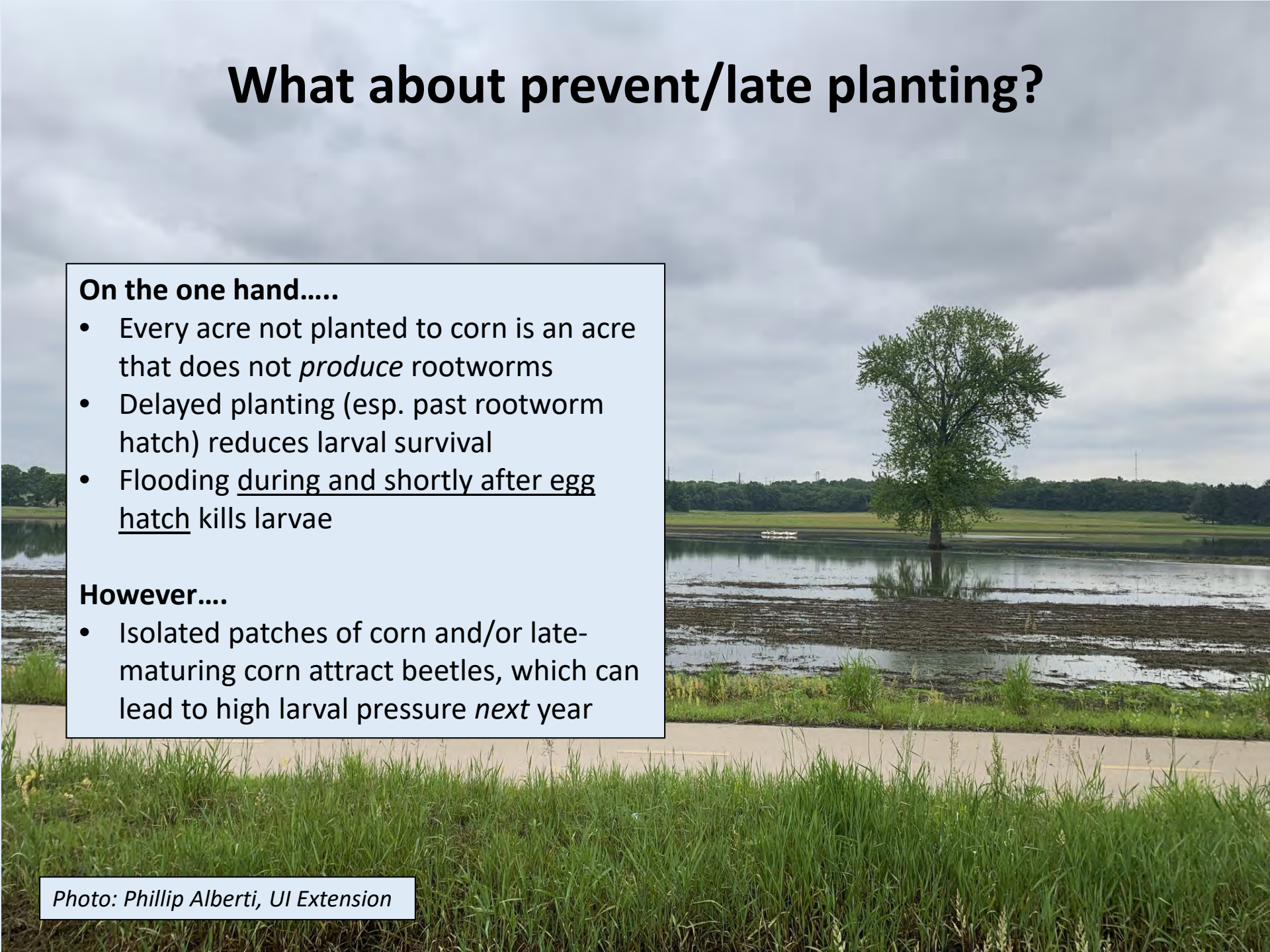
More results from 2019 available for download at:
https://uofi.box.com/v/2019PestPathogenARB

What about prevent/late planting?

Photo: Phillip Alberti, UI Extension



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

Photo: Phillip Alberti, UI Extension

Ear feeding caterpillars

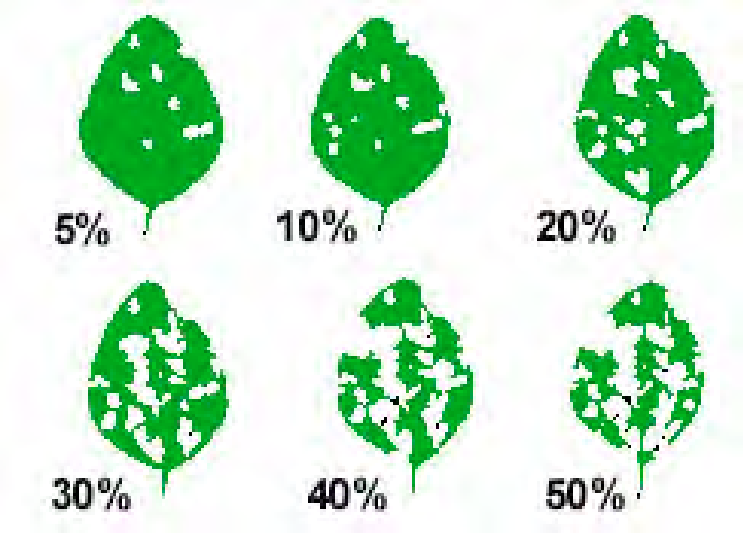
- Direct yield loss, site for ear rot pathogens
- Historically, minor issue in IL:
  - Corn earworm:
    - Feeding mostly at tip of ear
    - Cannibalistic = 1 per ear (usually)
  - Fall armyworm
    - Rarely at damaging levels in IL
- Western bean cutworm
  - Feed at sides of ears
  - Not cannibalistic (>1 per ear)

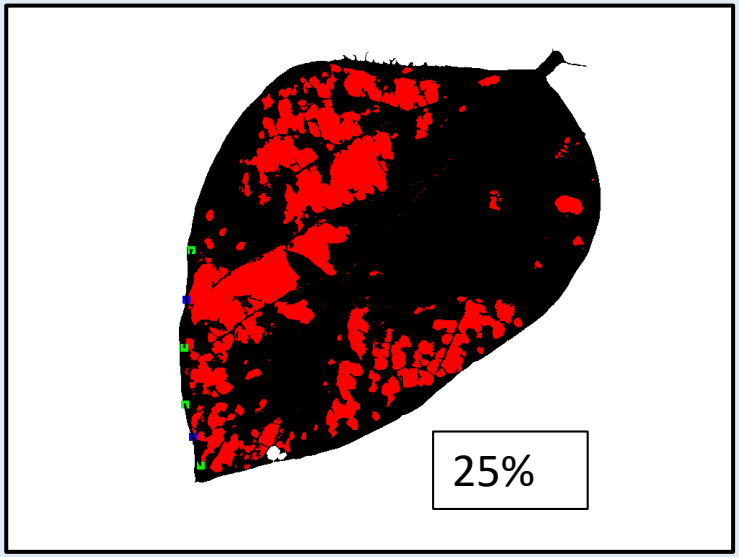
Corn earworm

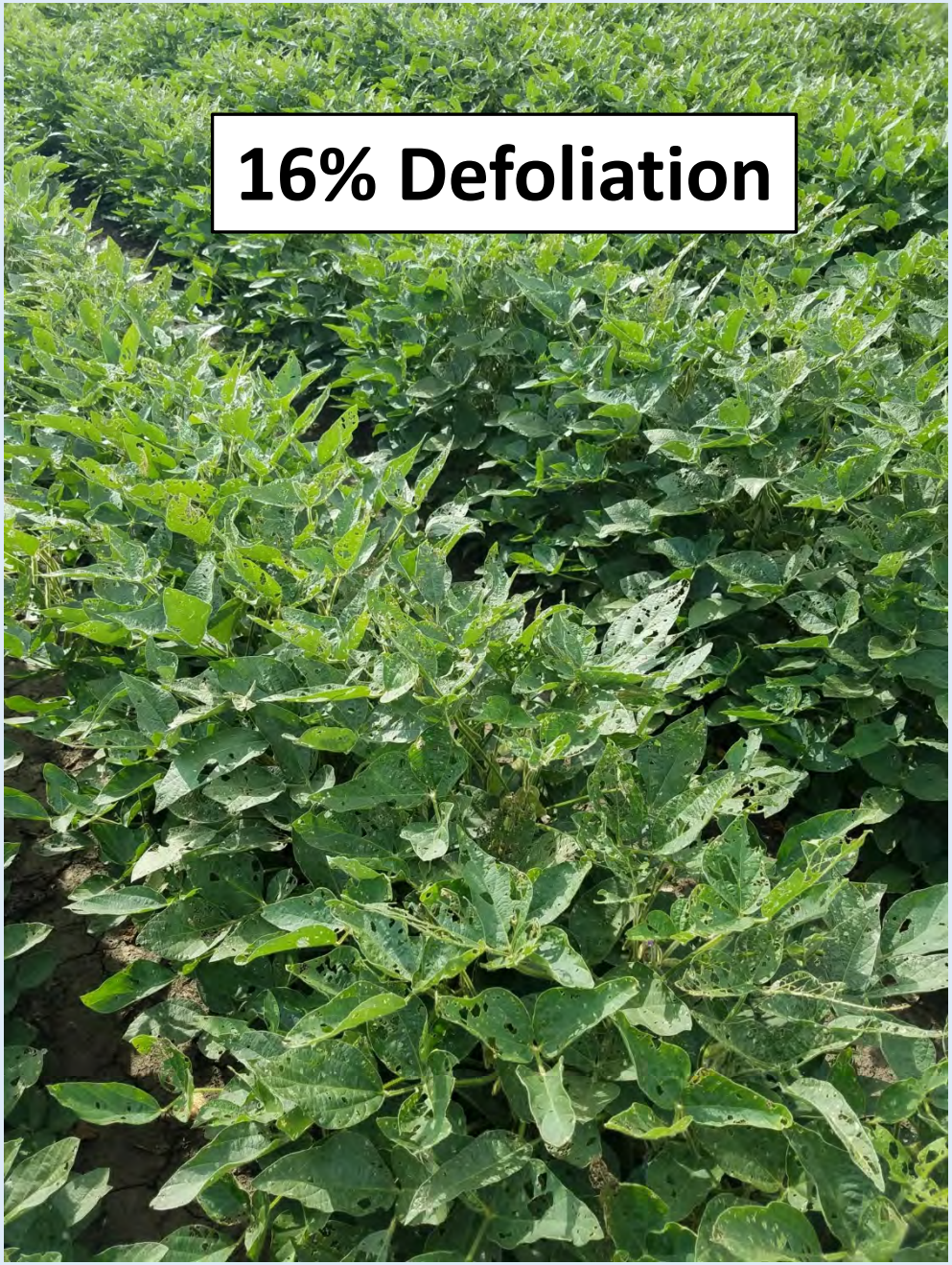
- Migrates into IL from south annually, more of a problem when planting is delayed
  - Sound familiar?
  - Abnormally high pressure throughout IL in 2019
- Resistance to several above-ground trait packages common in the southern U.S.
- Direct yield loss generally minor, feeding limited to ear tips
- 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%


5%
10%
20%
30%
40%
50%

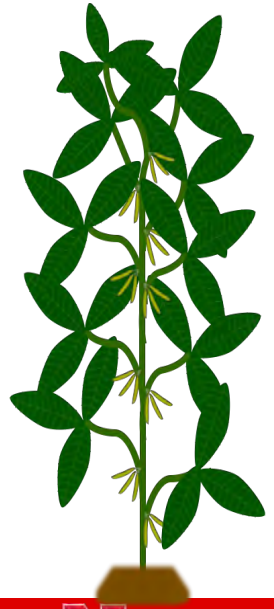

25%


16% Defoliation

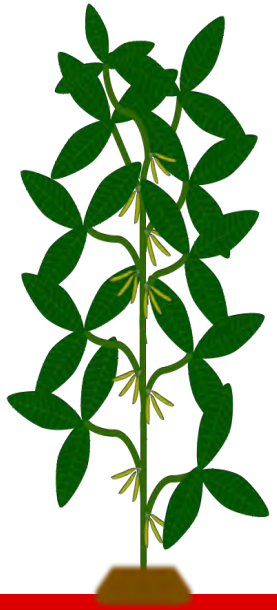
Slides: Dr. Justin McMechan, University of Nebraska, 2018

Soybean Gall Midge

New and Emerging Pest of Soybean



Justin McMechan[1], Tom Hunt[2], and Robert Wright[2]
[1]Crop Protection and Cropping Systems Specialists
[2]Research and Extension Entomologist
Email: justin.mcmechan@unl.edu
Twitter: @justinmcmechan

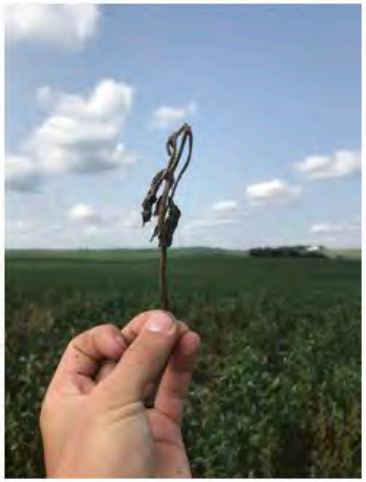


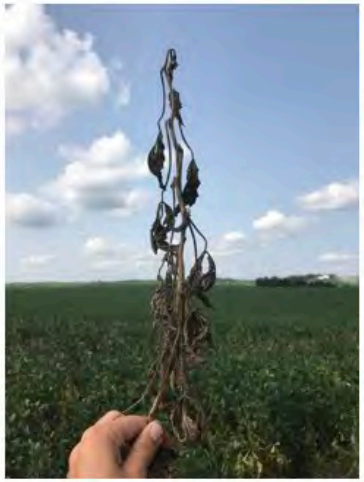
Soybean Gall Midge

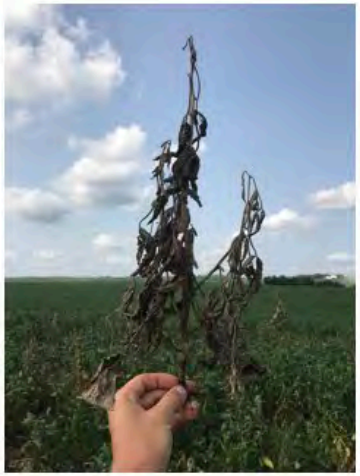
- First Documentation in 2011
  - Isolated to a few fields
  - Secondary pest of plant pathogens or mechanical damage
  - Showed up late in the season
- Observations in 2016 and 2017
- Field Issues in 2018
  - Large number of fields throughout the state
  - Early signs of infestation (Late June)

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)

https://blog-crop-news.extension.umn.edu/2019/06/update-on-soybean-gall-midge-new-pest.html (Soybean gall midge update and description of a similar species in Minnesota)

Questions?

Nick Seiter
Field Crop Entomologist
University of Illinois
nseiter@Illinois.edu
(217) 300-7199 (office)
(812) 593-4317 (cell)
Twitter: @nick_seiter
http://bulletin.ipm.Illinois.edu