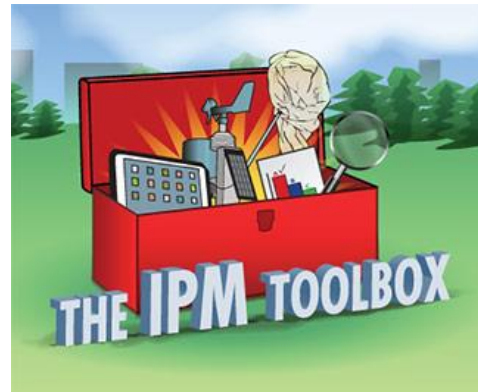




They Came in the Night

April 4, 2022



United States
Department of
Agriculture

National Institute
of Food and
Agriculture

Webinar Details



Welcome



A recording of this webinar will be available within a week at



<http://www.neipmc.org/go/ipmtoolbox>

We Welcome Your Questions

Please submit a question **at any time** using the Q&A feature to your right at any time

If you'd like to ask a question anonymously, please indicate that at the beginning of your query.

Webinar Presenters

- Dr. Sally Taylor
- &
- Dr. David Owens





Some
Questions
for You



They Came At Night!

David Owens and Sally Taylor

owensd@udel.edu

svtaylor@vt.edu



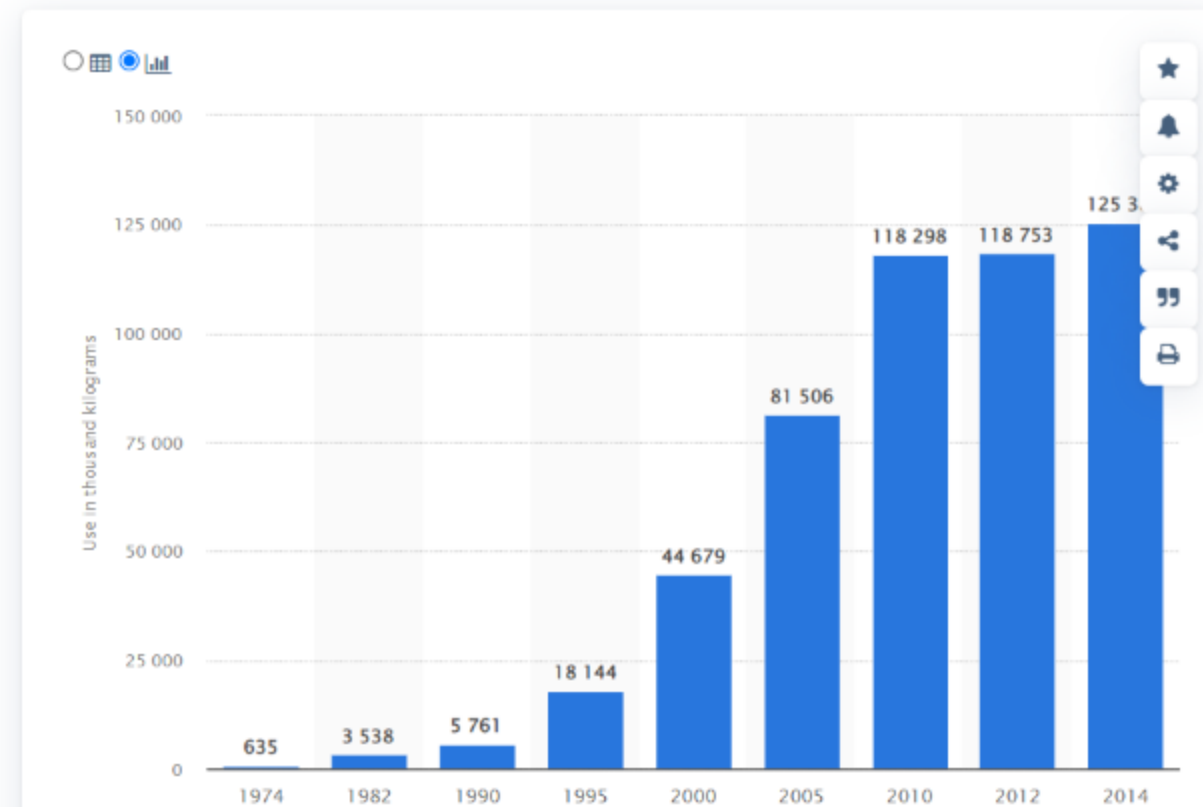
No-Till Agriculture in the Mid-Atlantic

- ❖ Reduced erosion
- ❖ Reduced compaction
- ❖ Increased water infiltration rates/holding capacity
- ❖ Reduced fuel but increased herbicide use
- ❖ NRCS EQIP subsidy ~ \$12-17 for no-till/strip till
- ❖ Increased nitrate leaching and runoff (offset by cover crops and rotations)
- ❖ soil temp moderation - a pro and a con

Glyphosate and glyphosate tolerant crops helps with no-till production, late termination of cover crops, more simplistic less invasive weed management.

*In general, “planting green” is associated with fewer weed problems and more insect problems

Glyphosate use in the United States from 1974 to 2014 (in 1,000 kilograms)*



[Additional information](#)

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[Show source](#)

Herbicide Problems



Cover Crops and No-Till

Cover crops are strongly encouraged in no-till production

Nutrient recapture – reduced runoff and leaching

Break up compaction

Improve soil structure

Dry fields (pro and con)

Other biological benefits

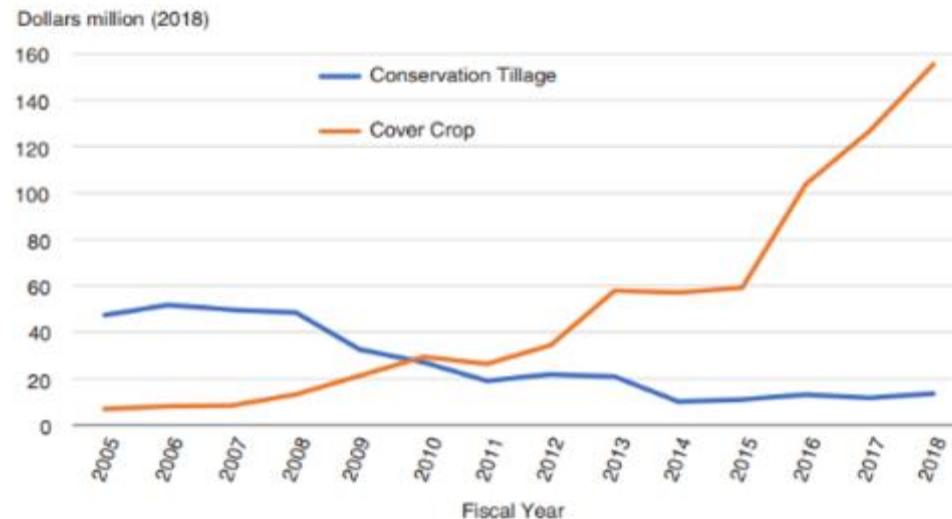


Enter Cover Crops

Not a new concept - cover cropping has been practiced in mid-Atlantic since the 1970's

Production small grain technically doesn't count as a cover crop, but fulfills many of the same principles.

Figure 4
Spending trends on conservation tillage and cover crops in EQIP



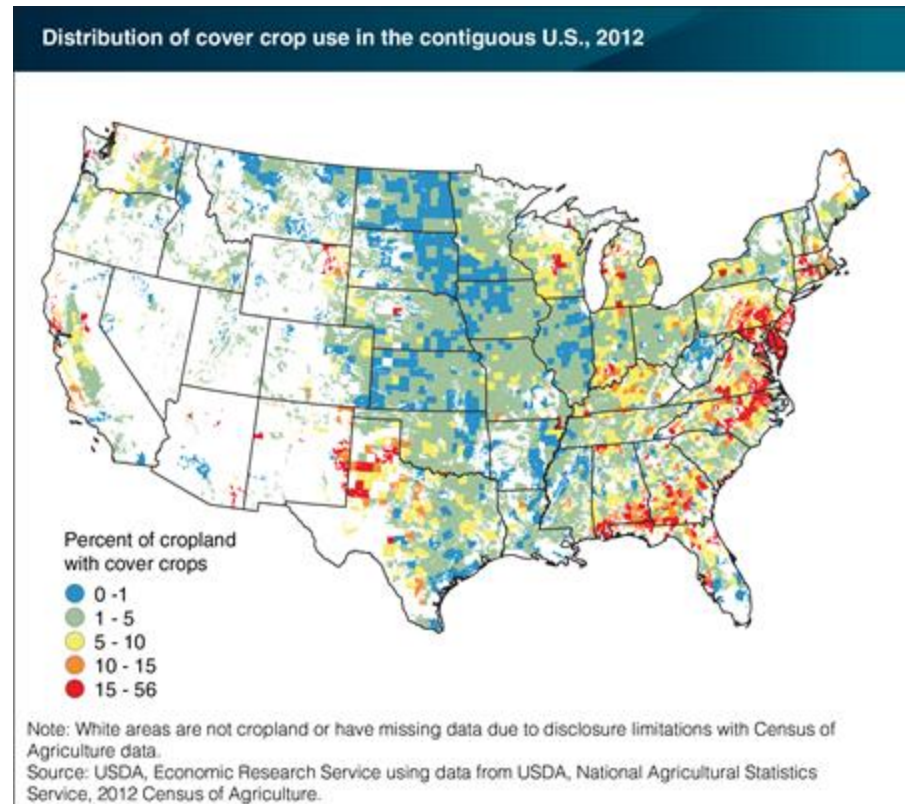
Cover Crop Incentives

NRCS EQIP - subsidy incentives for cover crops up to \$92/acre

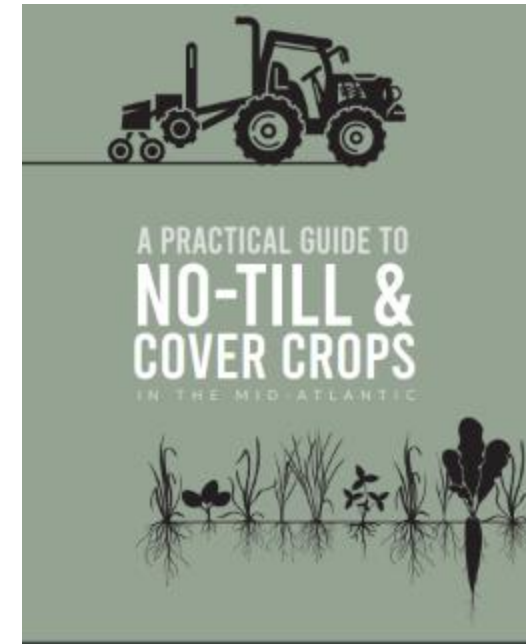
State programs and incentives (tax credits, equipment rental, conservation district equipment and planters, crop insurance)

Delaware - ~22% acreage in cover crop programs

MD - ~ 45%



For More Information...



**A PRACTICAL GUIDE TO
NO-TILL AND COVER CROPS**

**NORTHEAST
SARE**
Sustainable Agriculture
Research & Education

Funded by a Northeast SARE Professional Development Grant

This material is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, through the Northeast Sustainable Agriculture Research and Education program under subaward number 04612-05-7.

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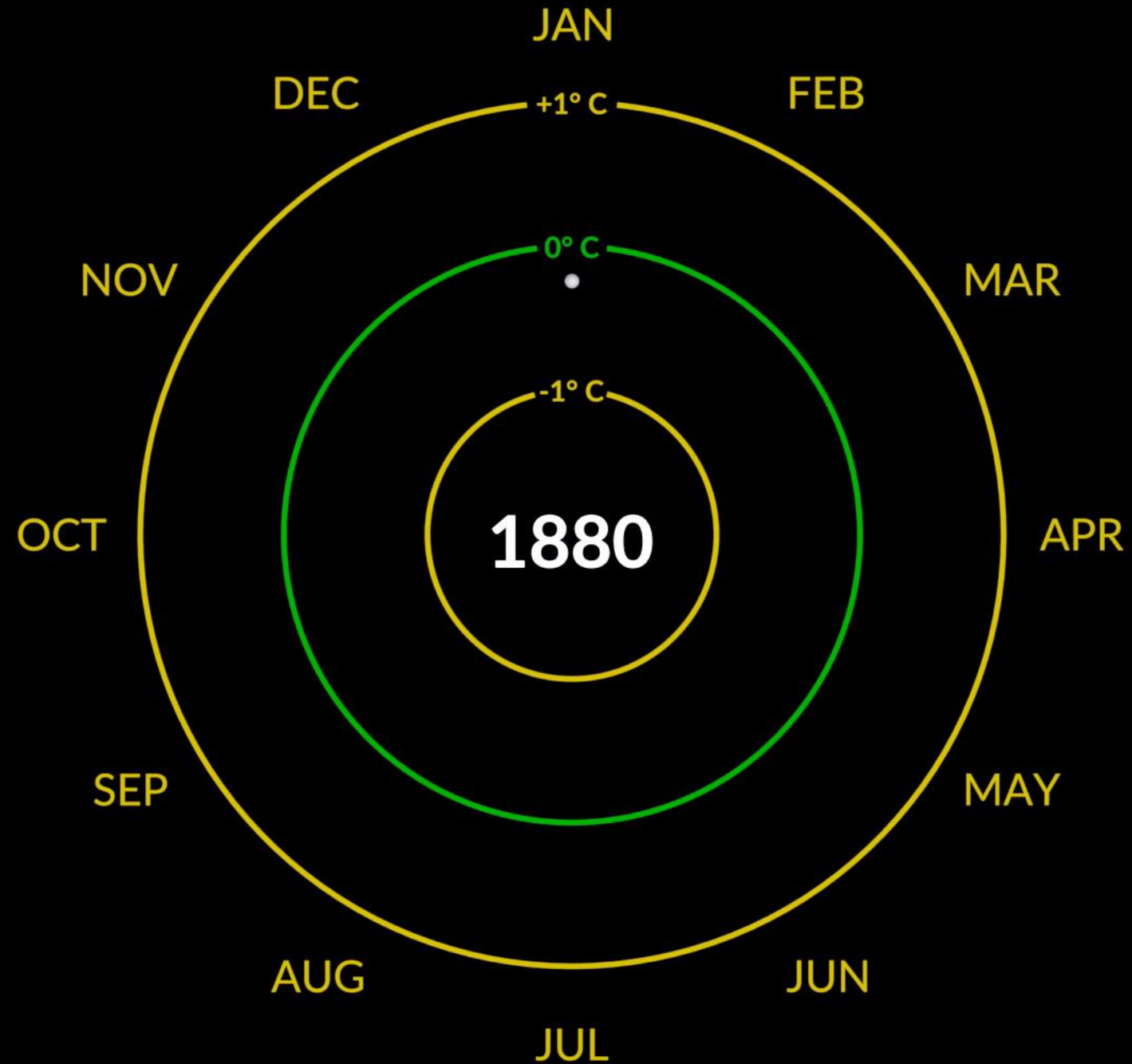
Increased Challenges

Pests adapt to and take advantage of changing climate around them



In general, warmer temperatures are going to favor...

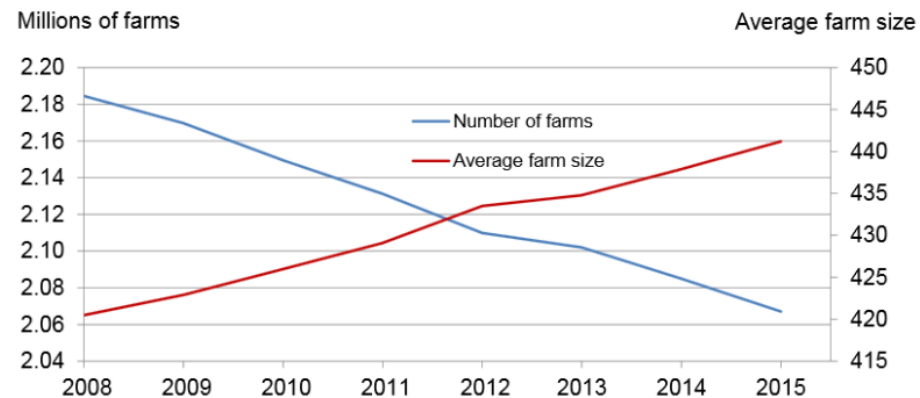
- 1) Increased overwintering survival
- 2) Faster development to reproductive stages
- 3) Faster development of subsequent generations
- 4) Northern expansion of pests



Trends towards increased residue coverage, increased moisture, increasingly milder winters, earlier planting dates as a function of farm size, cultural practices and varietal improvement and seed protection technology



Number of Farms and Average Farm Size – United States: 2008-2015



The number of farms has also declined over the past eight years by an estimated 117,500 farms. The average farm size has increased by 20 acres, which indicates that there is some consolidation, so fewer total farm owners with larger farms. This is a trend that has been ongoing since World War II, but as the average farm size grows, it also becomes that much harder for a young family to get started with a farming operation.







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Questions

 **USDA** United States Department of Agriculture National Institute of Food and Agriculture

Common Slugs



Arion spp. - typically no more than 1-2%.



Gray garden slugs *Deroceras reticulatum* – creamy beige to light gray, sometimes with darker splotches. Milky defensive mucous. Generally associated with more severe damage to corn than marsh slugs

Marsh slugs,
Deroceras laeve - dark gray to black, clear mucous





Late summer/Fall mating



Overwintering eggs under residue and in soil. Some adults will also overwinter



Adults active again in late winter/early spring and continue laying eggs



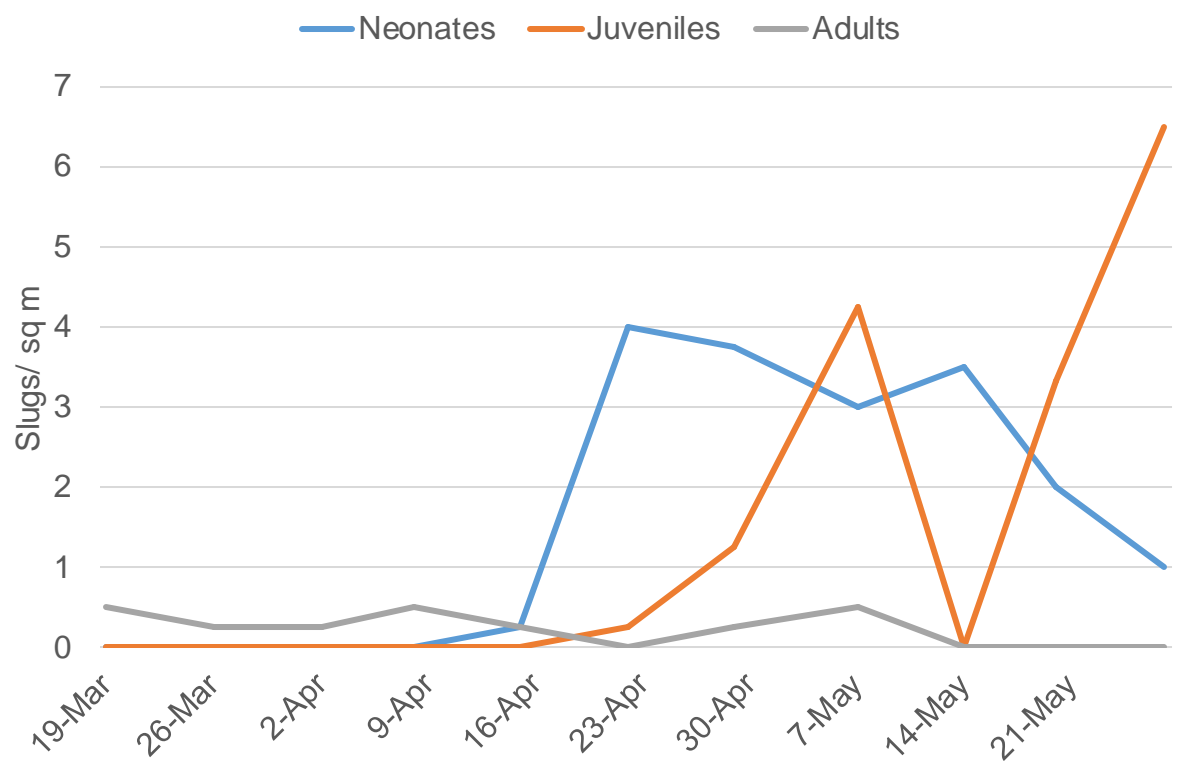
Juveniles associated with greatest amount of crop injury. Feed and gradually grow in size throughout spring and summer



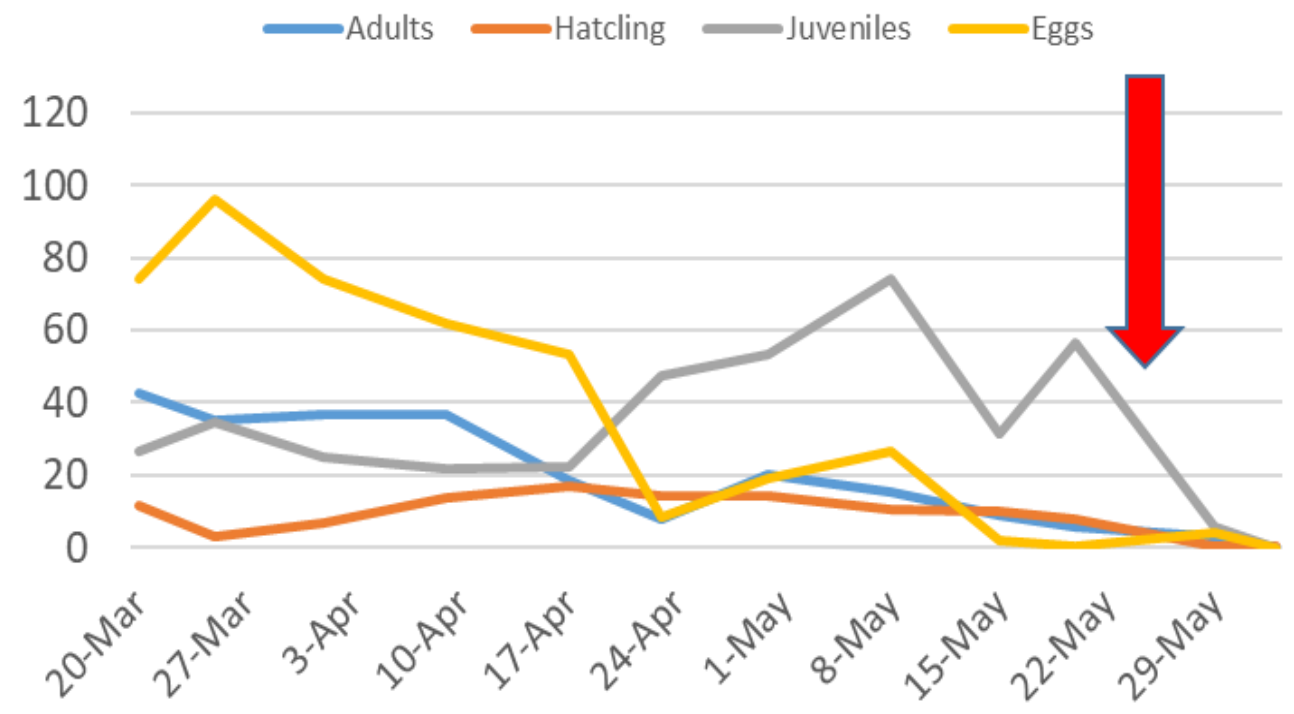
Eggs begin hatching in early spring and continue through May

Most active on relatively warm, humid, still nights
Cloudy, humid weather during the day
Activity and reproduction greatest around 60 F

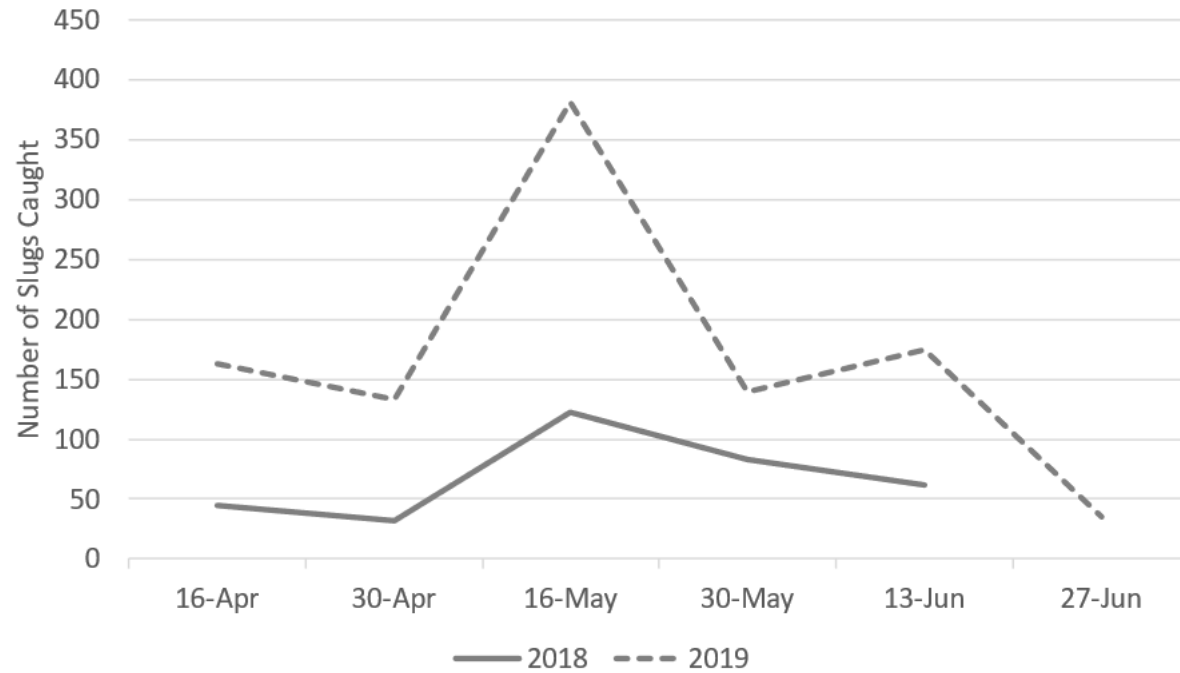
NCC2 Gray Garden



Sussex 3 Marsh Slugs



VA slug seasonality



Biological Control

- Conservation!!!



Slug Natural Enemies: Opiliones

- Daddy long legs: 6,600 species worldwide; ~ 235 species in NA. A few are known to feed on slugs. Most are generalists attacking soft bodied invertebrates. Unknown to what extent they are predators vs scavengers, estimated between 4 and 11% of their diet. Some European species specialize on slugs and snails.



Phalangium opilio – most common species, introduced.

Slug Natural Enemies



Trogulidae, 1 sp introduced from Europe. Snail invaders.



20 species of European 'snail crushers' *Ischyropsalis*

Slug Natural Enemies: Ground Beetles



- Large family of predatory, omnivorous, and granivorous species. ~ 2,500 spp in NA. A few are known to feed on slugs, but their propensity to feed on slugs is not well understood. Prefer juveniles and eggs.



Harpalus

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Pterostichus

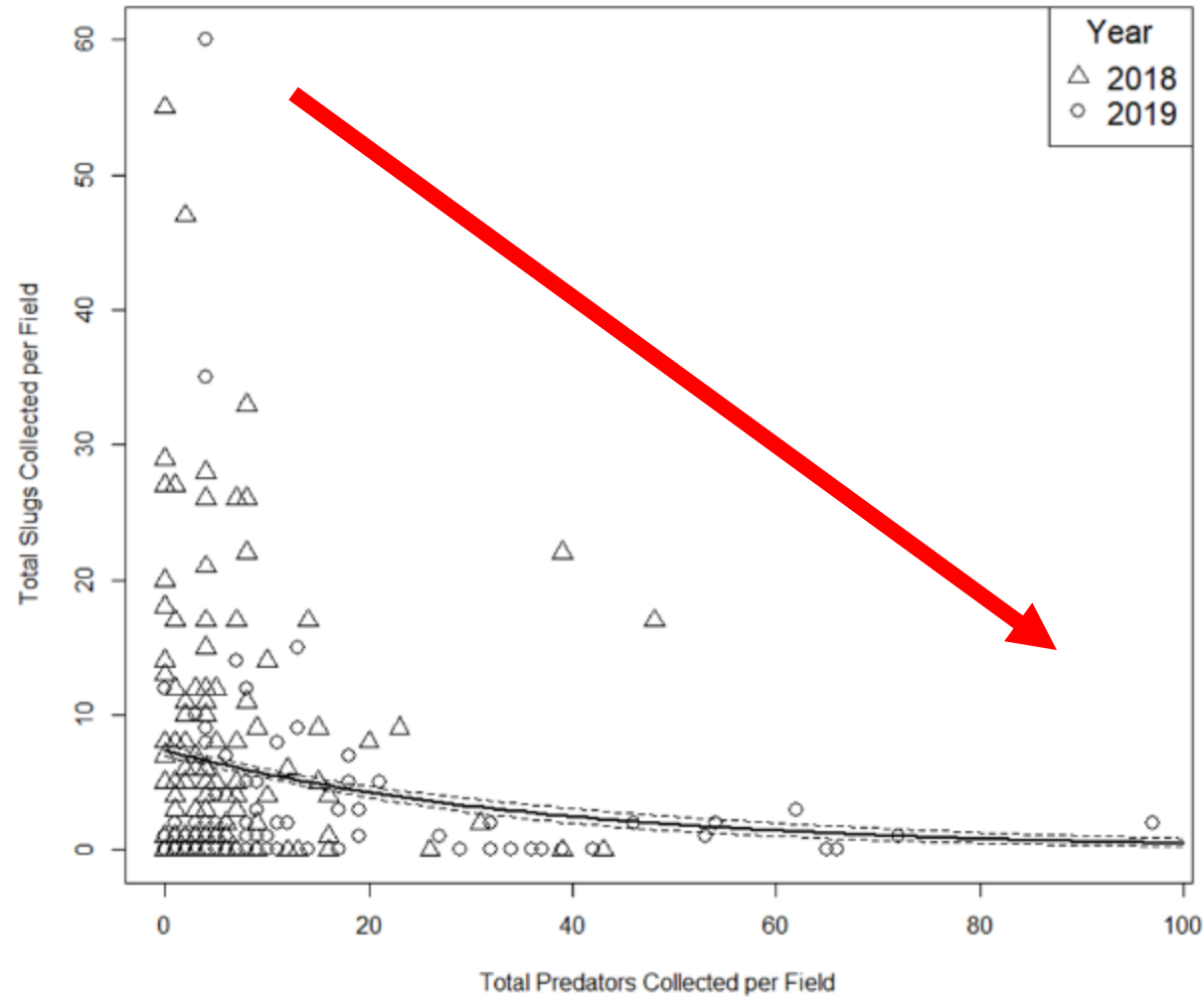
Pterostichus melanostictus? Pterostichus melanostictus

Chlaenius

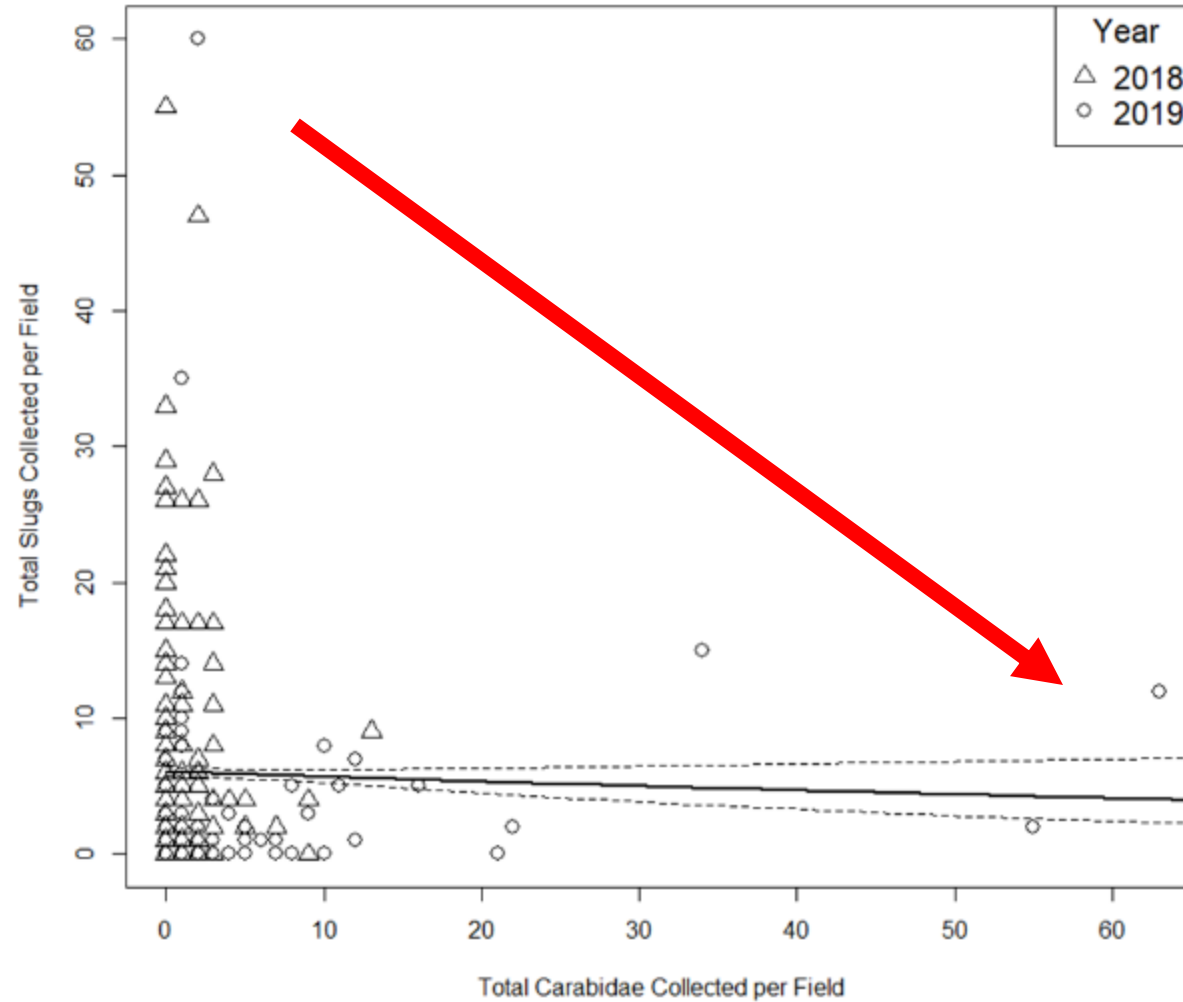


I Gfettenberger, Penn State

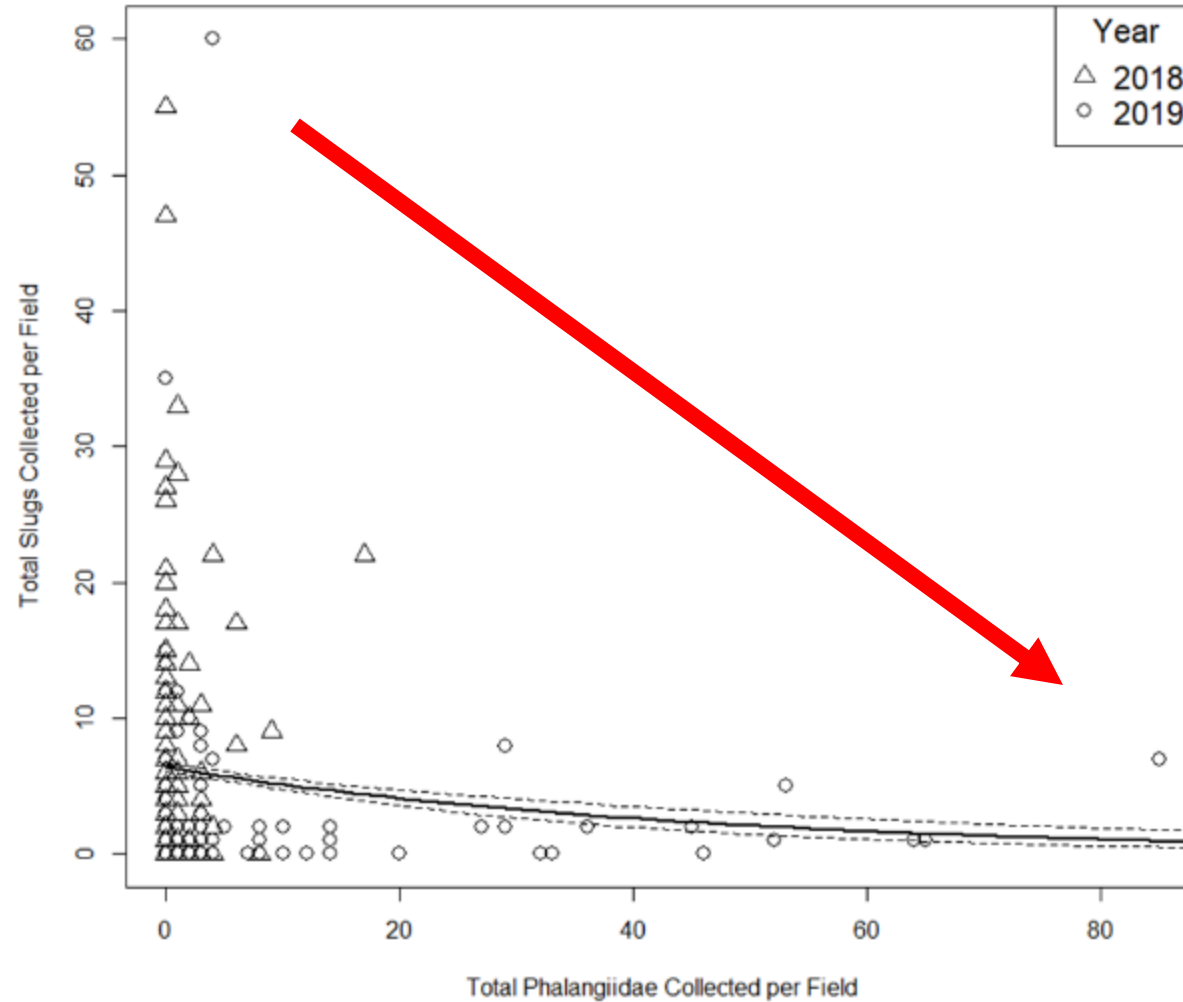
More predators associated with fewer slugs



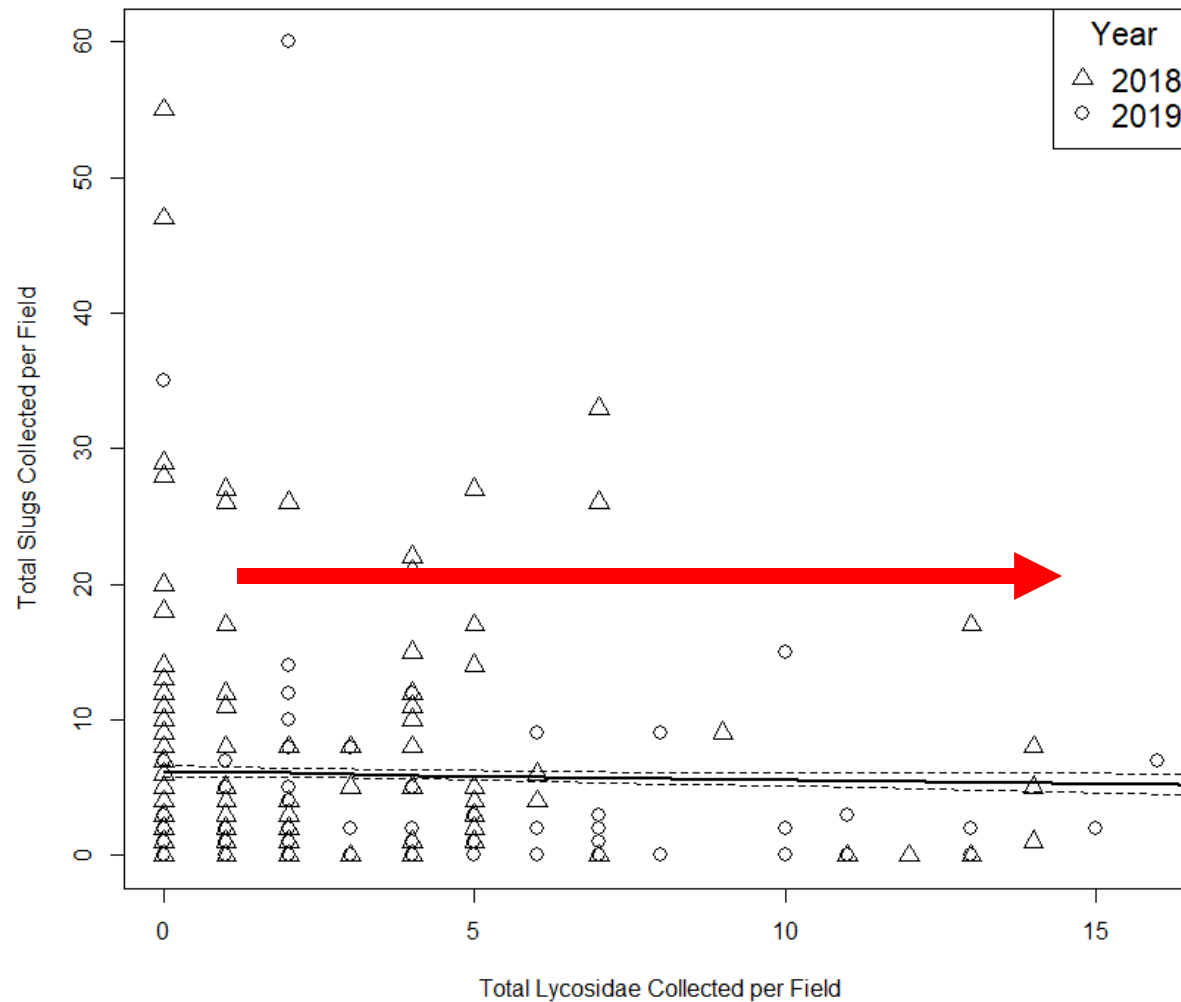
More ground beetles associated with fewer slugs



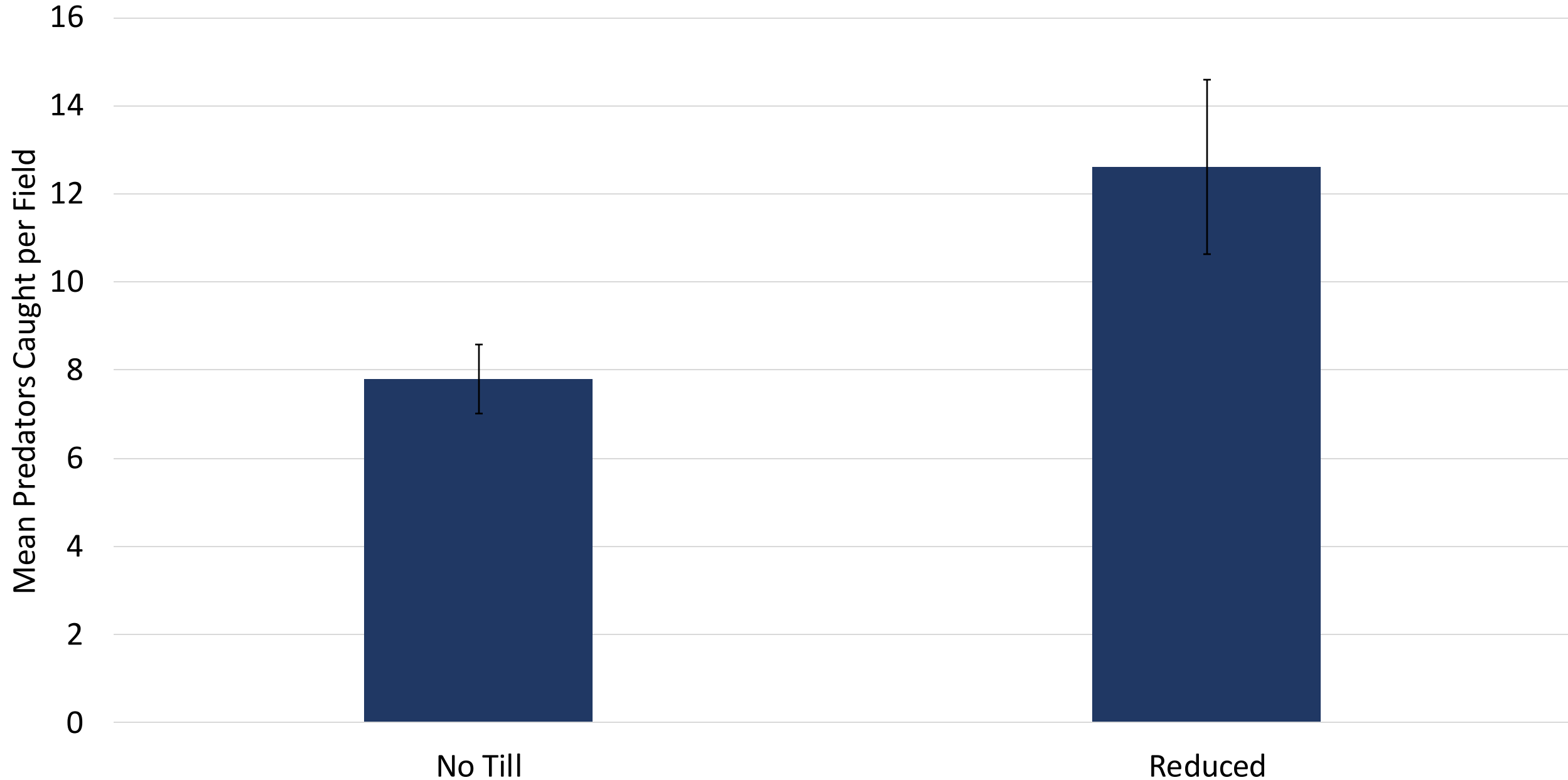
More harvestmen associated with fewer slugs



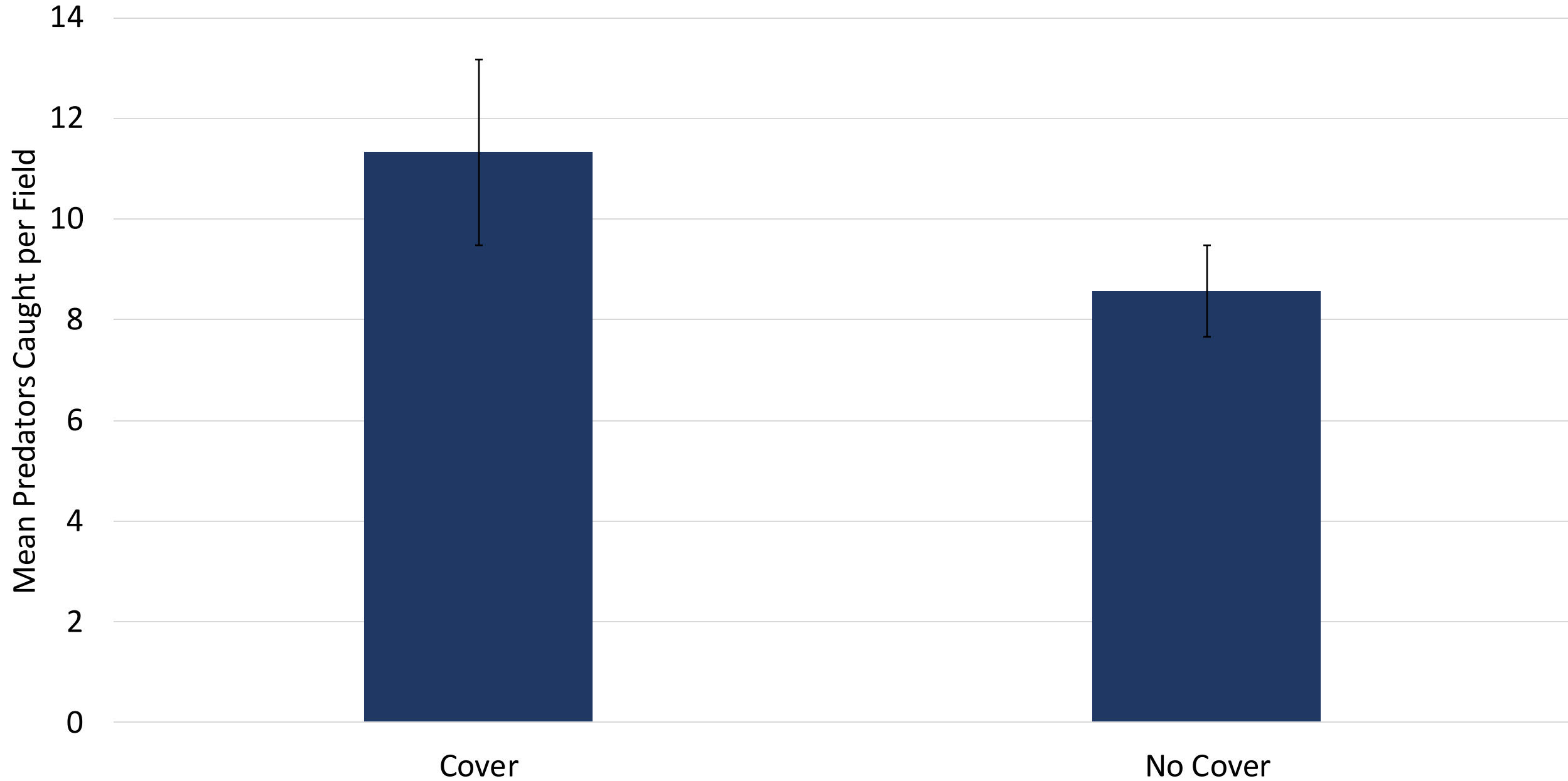
There is no association between wolf spiders and slugs



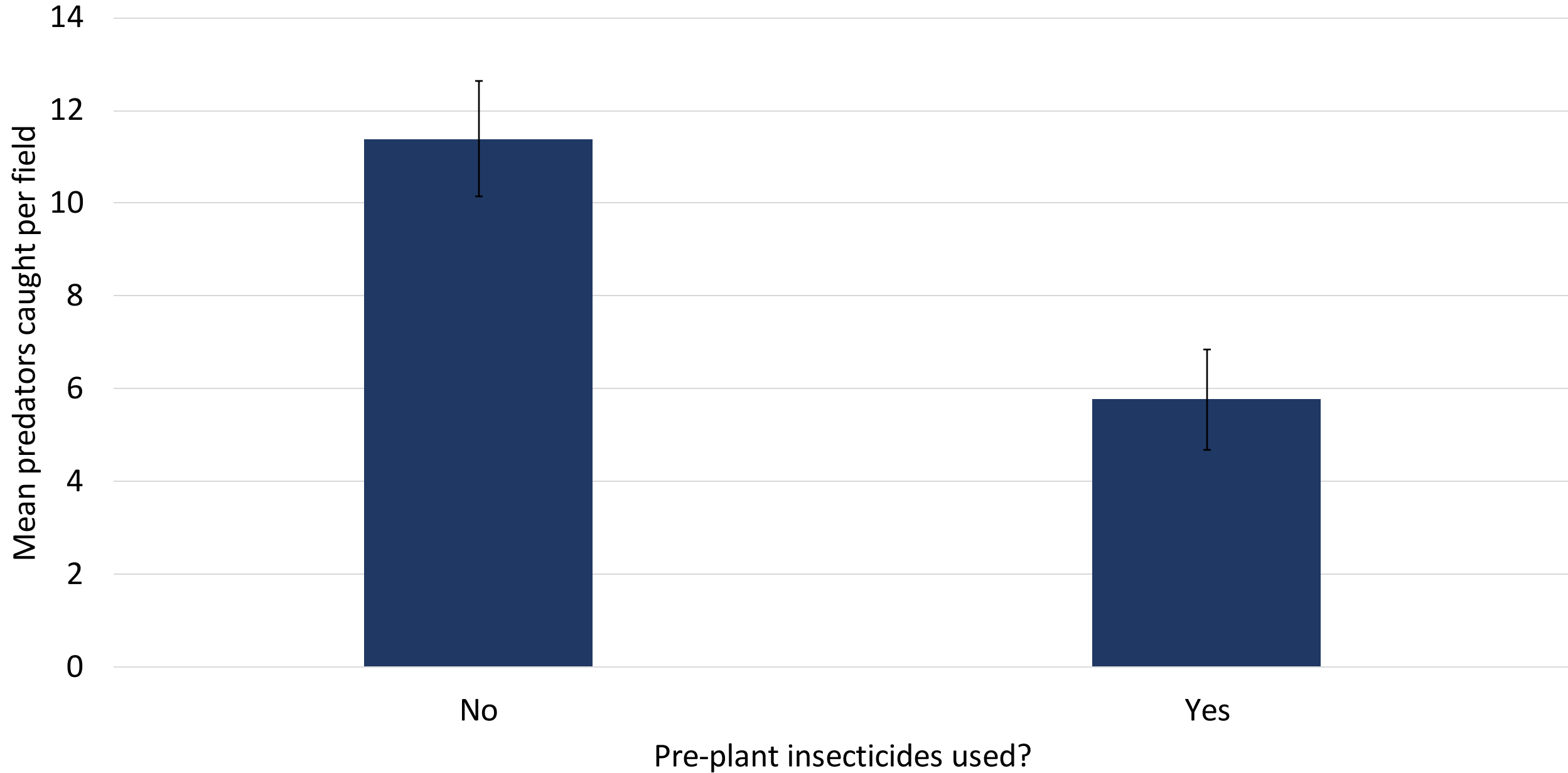
Reduced till fields had more predators



Fields with cover had more predators

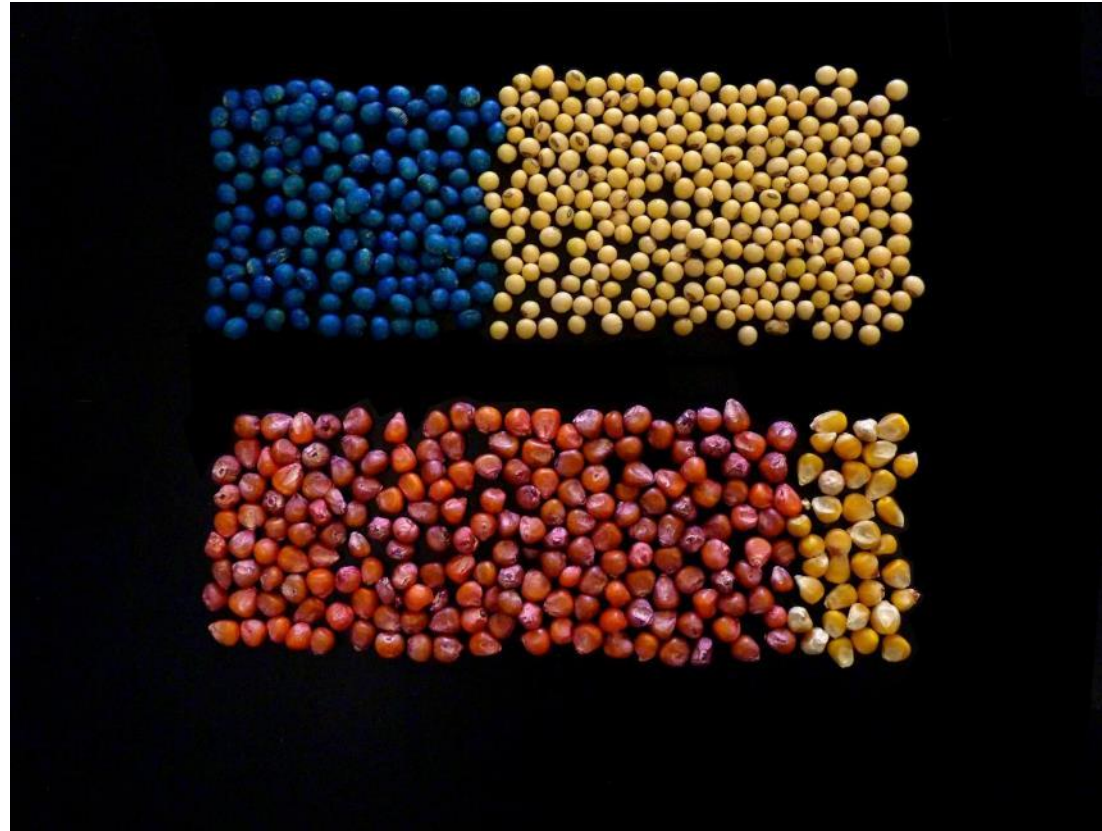


Pre-plant insecticides reduced predator numbers



Chemical Management: What Doesn't Work

- NOT affected by conventional insecticides
 - Lannate, neonicotinoid, diamide products have no direct effect on slugs



Chemical Management: What Doesn't Work

- Slugs are not affected by neonicotinoids, but tissues contain enough to kill ground beetles
- In field experiments, seed treatments resulted in a 33% decrease in predatory insect populations and a 67% increase in slug activity.

50 YEARS WITH IMPACT

Journal of Applied Ecology

1913 2013
British Ecological Society
CELEBRATING 100 YEARS

Journal of Applied Ecology 2015, 52, 250–260

doi: 10.1111/1365-2664.12372

Neonicotinoid insecticide travels through a soil food chain, disrupting biological control of non-target pests and decreasing soya bean yield

Margaret R. Douglas^{1*}, Jason R. Rohr² and John F. Tooker³

¹Department of Entomology, The Pennsylvania State University, 101 Merkle Laboratory, University Park, PA 16802, USA; ²Department of Integrative Biology, University of South Florida, 4202 East Fowler Ave., SCA 110, Tampa, FL 33620, USA; and ³Department of Entomology, The Pennsylvania State University, 113 Merkle Laboratory, University Park, PA 16802, USA

A beetle (*C. tricolor*)
~12 hrs after eating a
slug fed upon **untreated**
soybean seedlings

Video S1. Douglas, Rohr, & Tooker (2014) J. Applied Ecology

Beetles ~12 hrs after
eating a slug fed upon
thiamethoxam-treated
soybean seedlings

Video S2. Douglas, Rohr, & Tooker (2014) J. Applied Ecology

Slug Natural Enemies: Nematodes

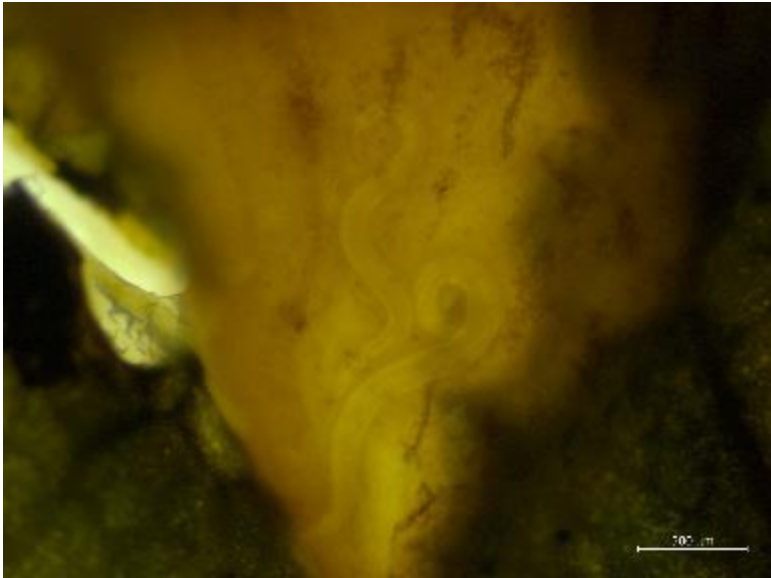
Ivan Hiltbold 2018 nematode survey – 7% slugs collected in Delaware infected with a nematode



Phasmarhabditis hermaphrodita – European species. Recently discovered in California (2014) and Oregon (2017). PNW slug expert Rory McDonnell



Two nematode ‘morphs’ in Delaware 2021 survey – a ‘large’ and a ‘small’. Varying # days until slug death. 15% infection. Only in marsh slugs. 4/9 fields



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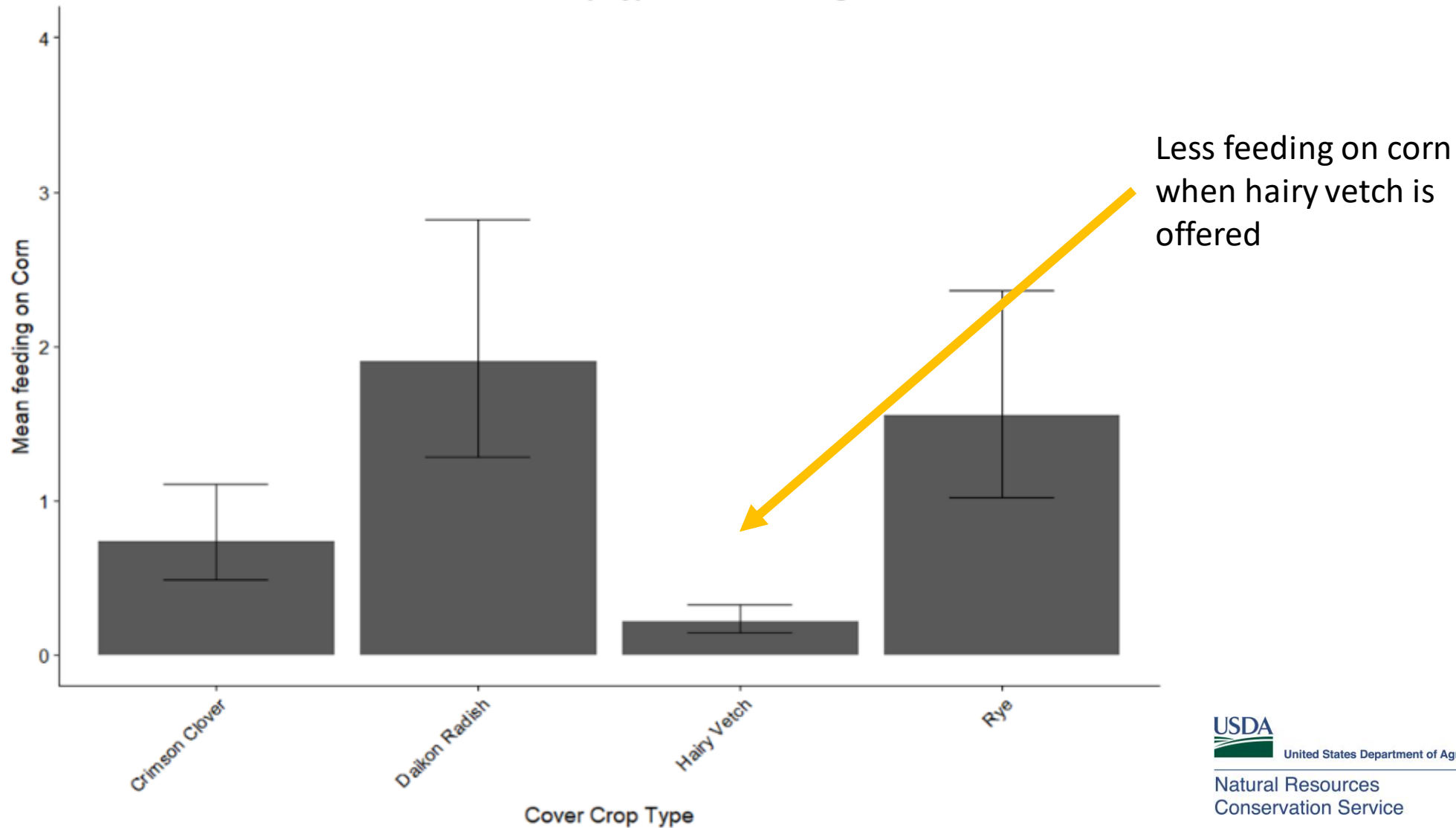
 **USDA** United States Department of Agriculture National Institute of Food and Agriculture

Cultural Control: Diversion and Habitat

- Feed on decaying organic matter and various plant species
- Lab and field studies indicate feeding preferences among cover crops differ; brassicas are favored, some differences among legumes – red clover and vetches attractive, crimson least supportive

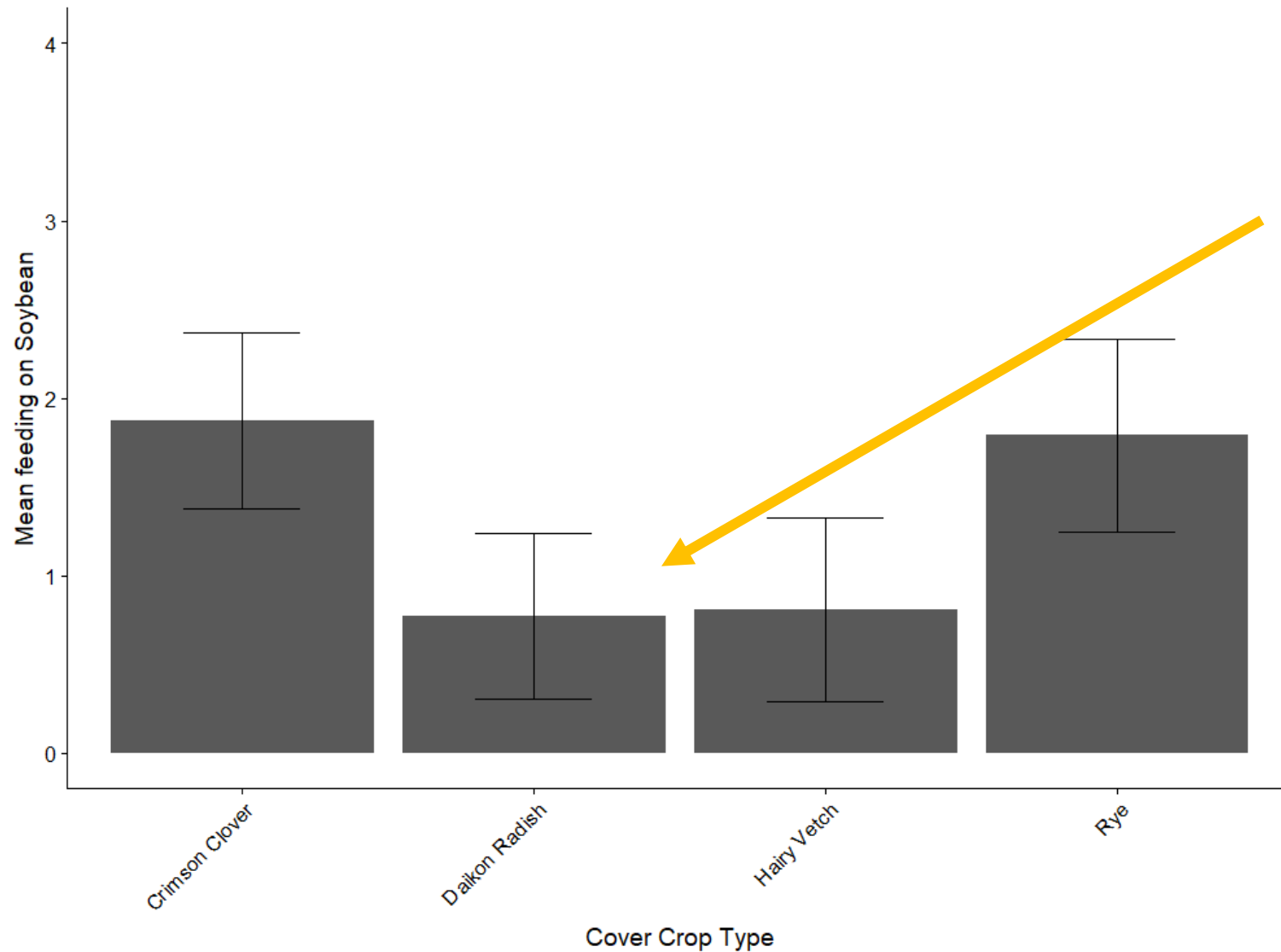


Effects of Cover Crop Type on Corn Feeding



Feeding score on a 1-4 scale [0=no feeding, 1=small signs of feeding (1-9% sample consumed), 2=moderate feeding (10-50% sample consumed), 3=heavy feeding (50-99% sample consumed), 4=food source entirely consumed].

Effects of Cover Crop Type on Soybean Feeding



Less feeding on soybean when hairy vetch or daikon radish are offered

Feeding score on a 1-4 scale [0=no feeding, 1=small signs of feeding (1-9% sample consumed), 2=moderate feeding (10-50% sample consumed), 3=heavy feeding (50-99% sample consumed), 4=food source entirely consumed].



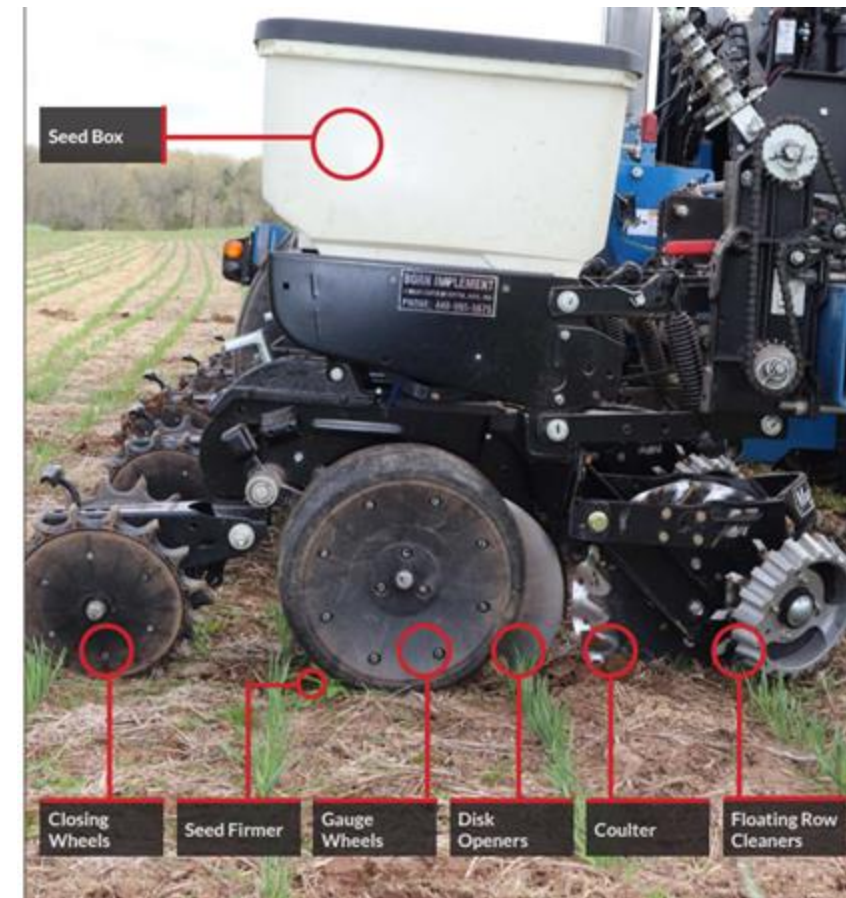
Cultural Controls: Close Seed Slots

- Seed slot is like a slug superhighway
- Seed slot is dark, moist
- Slugs have direct access to germinating seed



Cultural Controls: Take Out The Trash

- Row cleaners pushing residue away from crop – slugs aren't sheltering right at base of seedling; soil warms a little faster = faster germination
- Get that seed into the ground!



Cultural Controls: Waiting

- Warm soil, dryer conditions = faster seedling growth, less slug activity
- OR plant early, but not too early



Cultural Control: Starter Fertilizer

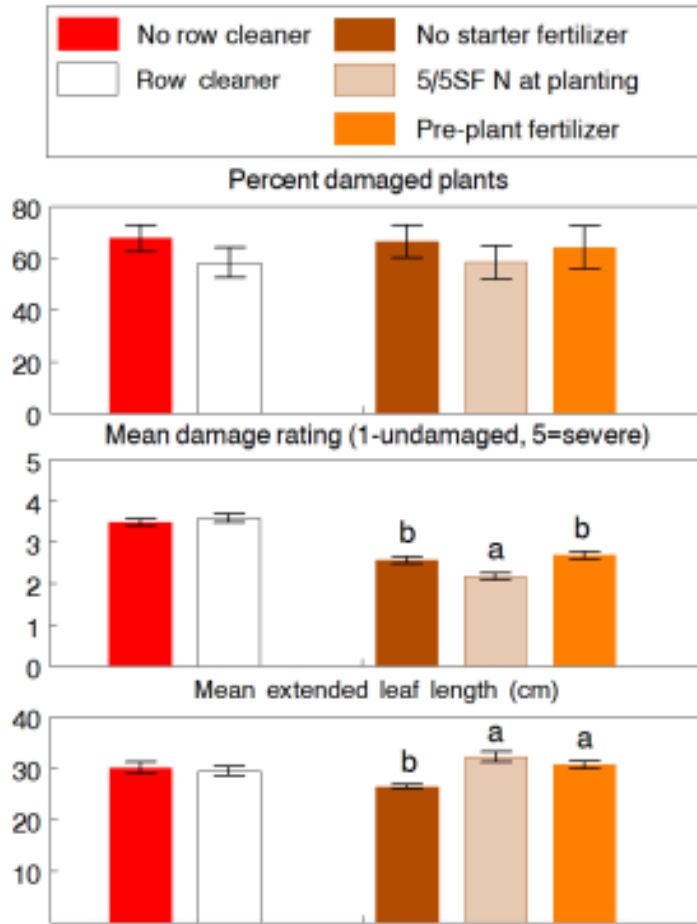


Figure 2. CREC experiment (1993). Effects of using row cleaner

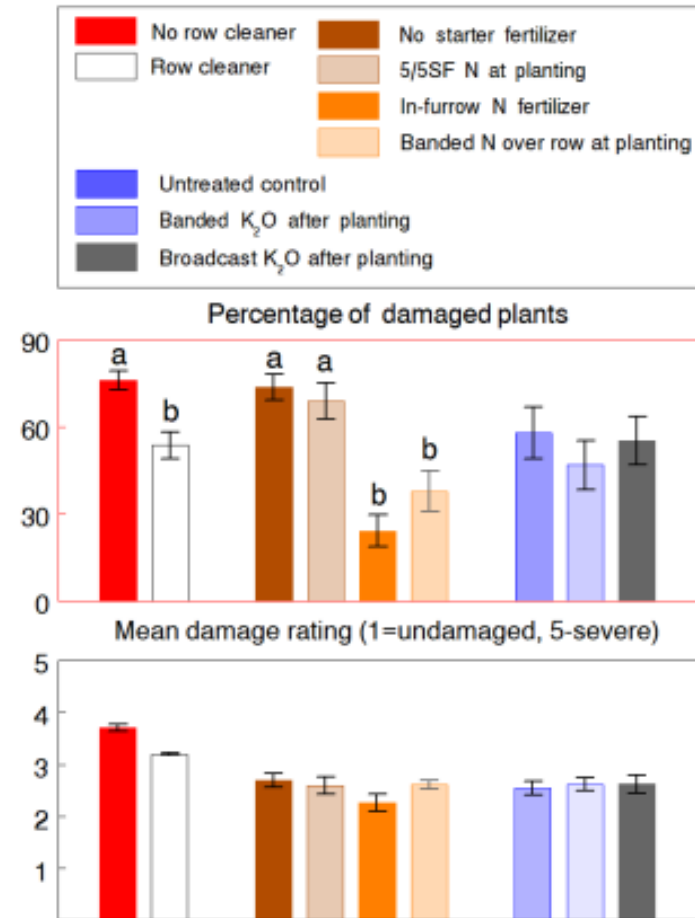


Figure 3. WREC experiment (1993). Effects of using row cleaner, c

An Evaluation of Cultural and Chemical Control Practices to Reduce Slug Damage in No-till Corn

by Galen P. Dively* and Terrence Patton

Department of Entomology, University of Maryland, College Park, MD 20742, USA

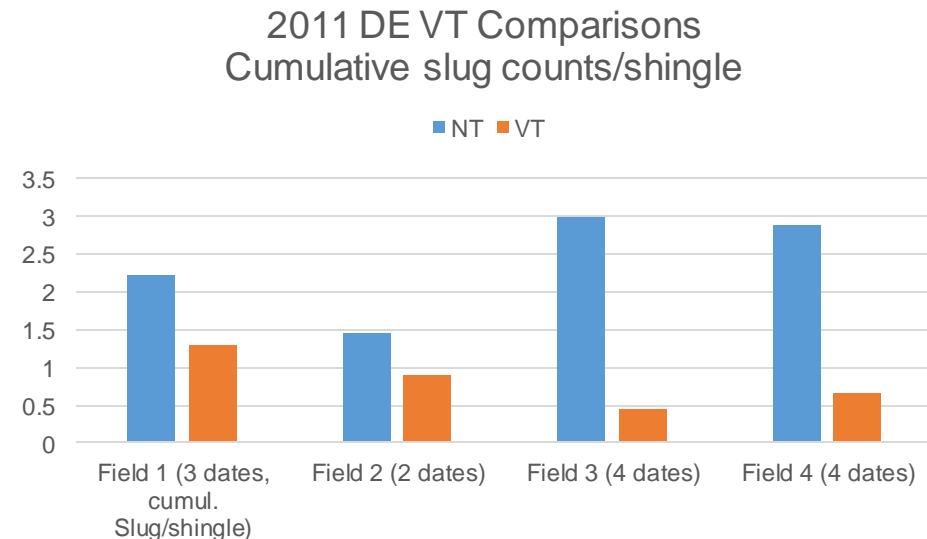
* Author to whom correspondence should be addressed.

Academic Editor: Zhenying Wang

Insects 2022, 13(3), 277; <https://doi.org/10.3390/insects13030277>

Cultural Control: Tillage

- Ground disturbance greatly reduces slug populations and activity
- Vertical/turbo tillage, shallow disking
 - Aid in drying and warming soil, enhancing germination
- How long between tillage events and a slug problem?



Slug Management



Scouting for Slugs

Shelter traps – best examined in early morning hours.

Shingles

Cardboard

Shingle + pitfall trap

Shingle + fermenting bread dough



Why we don't use beer traps...



<https://www.youtube.com/watch?v=cF6FHv5x3sc>

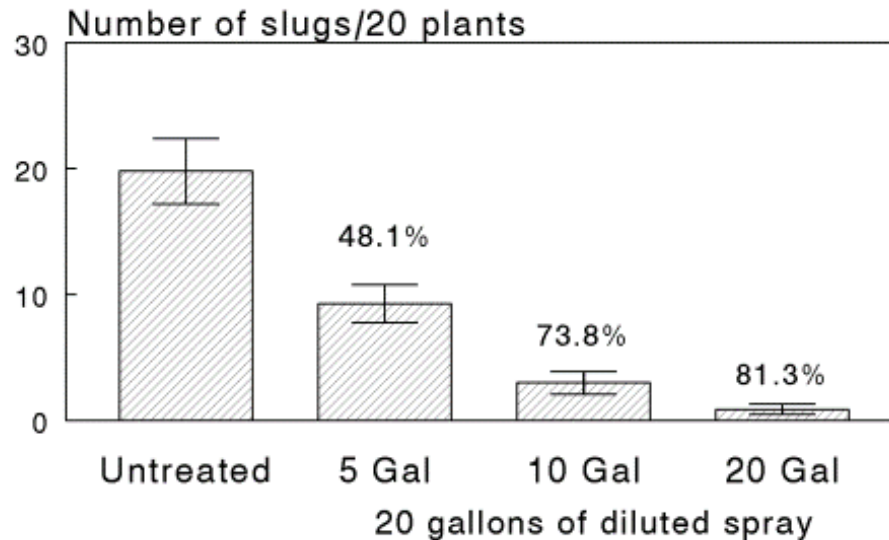
Thresholds

- Varying extension recommendations – 1, 3, 5 / sq ft
- PA suggests 1/ft² corn (Busch et al. 2020)
- Slug feeding on corn peaks 2-3 weeks after planting, leaf damage can be as great as 47% without significant yield loss.
 - Byers and Calvin 1994 EIL range 2-59% defoliation, depending on environmental conditions
- Soybean?
- Cool, wet conditions at planting (with or without lower plant stands) or before unifoliates expand = higher risk

Chemical Management: Urea

- Urea
 - Contact burns
 - Still, Warm, Humid NIGHTS when slugs actively on plants
 - corn

Figure 4. Effect of 30% urea-based nitrogen applied as a broadcast spray at night on slug activity. Means \pm one standard error. Number over bar indicates % control. 1994.



Chemical Management: Baits

- Metaldehyde – Deadline. Mildly toxic, especially by ingestion by pets; Metabolized into acetylde. Slugs excrete mucous and dehydrate
UK looking to ban outdoor use
- Iron Phosphates and Sodium Ferric EDTA – Ferroxx AQ, Ferroxx, Sluggo. Much less toxic by ingestion. Damages slug digestive tract and is Slower acting.

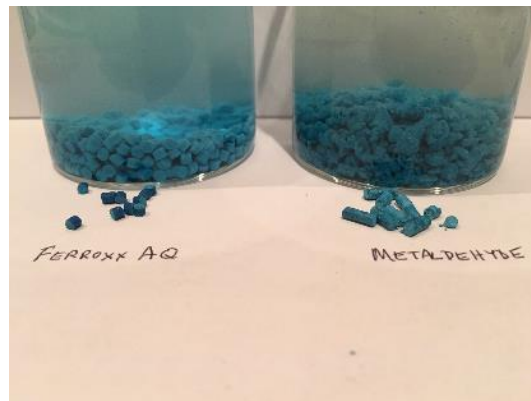


Image from a manufacturer salesman. Not intended as an endorsement

FERROXX
SLUG AND SNAIL BAIT



**NO TILL
SLUG CONTROL**

Chemical Management: Deploying Bait

Deadline:

- Max rate in soybean: 10 pounds/acre, 3 apps/yr
- Max rate in corn: 25 pounds/acre
- Ferroxx AQ: 4-15 pounds/acre
- Bait generally costs ~ 2\$/pound (2022 pricing and availability is a big unknown)
- Always read your labels!!!

Conversion table for application of product to various size areas	
5 – 12 Pellets / sq. ft.	= 3.6 – 7.2 oz. / 1000 sq. ft.
	= ½ - 1 cup / 1000 sq. ft.
	= 1 – 2 lbs. / 4400 sq. ft.
	= 10 – 20 lbs. / acre

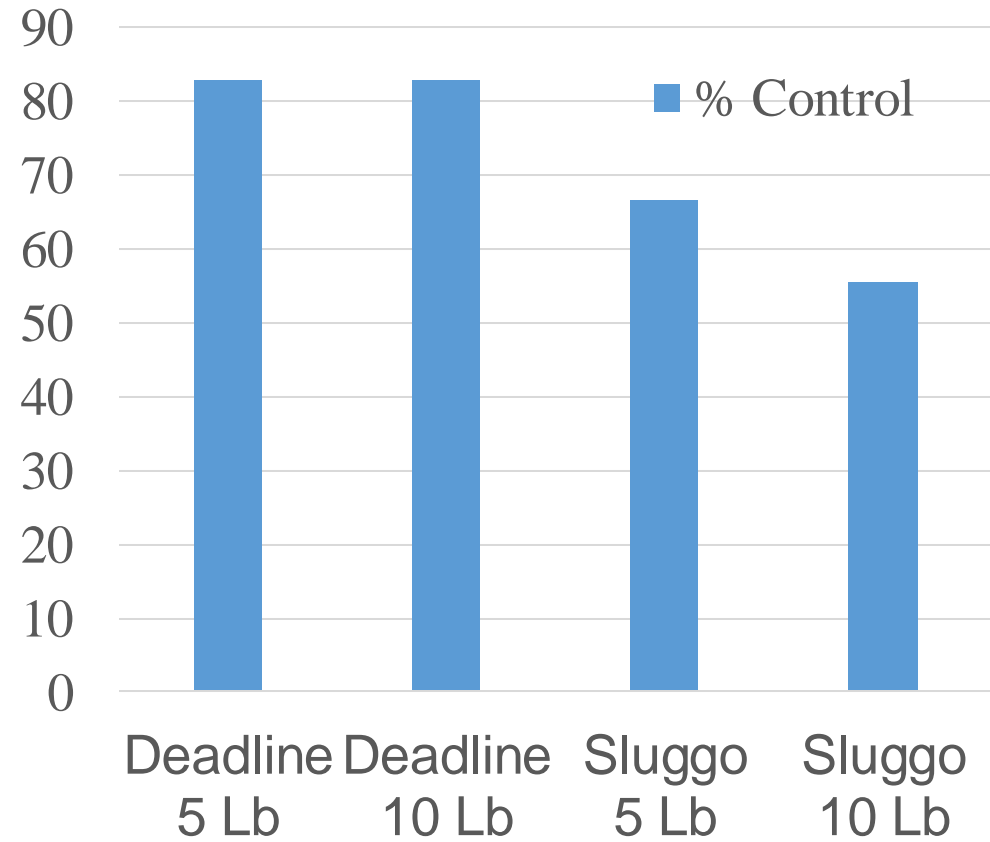


Sampling and Controlling Slugs

Large Plots (2 reps), Tennessee

Slug Baits

Deadline MPs (metaldehyde)
Sluggo (iron phosphate)



Current and Recent Research Efforts and Acknowledgements



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Natural Resources Conservation Service

*Northeastern IPM Center through
Grant #2018-70006-28882 from
USDA NIFA CPPM Regional
Coordination Program*

MyIPM for Row Crops App



MyIPM for
Row Crops

Southern
IPM
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UNIVERSITY OF
DELAWARE
UNIVERSITY OF
FLORIDA

UNIVERSITY OF
MARYLAND
CLEMSON
UNIVERSITY

LSU

VIRGINIA TECH



The MyIPM for Row Crops app is now available on Apple and Android devices! This app was developed at Clemson University with the support of the Southern Region IPM Center and collaborators at Universities across the Mid-Atlantic, Southeastern, and Mid-Southern United States. The app provides pest management information for insects and diseases of corn, cotton, sorghum, soybean, and peanut, including labeled pesticides and rates, photos of pests and diseases, life cycle information, and non-chemical control strategies.

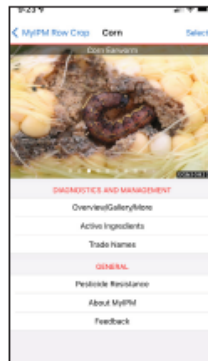
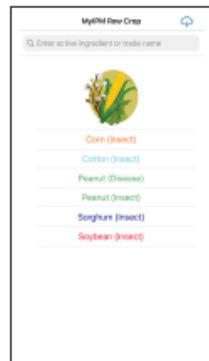
Contact: Tim Bryant, timb@clemson.edu



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Questions

 **USDA** United States
Department of National Institute
Agriculture of Food and
Agriculture Agriculture



Some
Questions
for You

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- Past recordings and today's Webinar will be available to view **on demand** in a few business days.
- <http://www.neipmc.org/go/ipmtoolbox>
- You can watch as often as you like.

Upcoming Toolbox Webinars & Research Update Conference

[Taking a Closer Look: How Strawberry Disease Risk Varies with Microclimates at the Canopy Level](#), May 4, 11am ET

Weather stations in strawberry fields might seem like good sources of highly local environmental data, but this assumes sun, wind, and shade affect an area evenly. There can be microclimate variations at the canopy level, especially when row covers are used for plasticulture strawberry production. Mengjun Hu, assistant professor of plant pathology in the Department of Plant Science and Landscape Architecture at the University of Maryland, Presenter.



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Land Acknowledgment

- The Northeastern IPM Center is based at Cornell University in Ithaca, New York.
- Cornell University is located on the traditional homelands of the Gayogohó:nq' (the Cayuga Nation). The Gayogohó:nq' are members of the Haudenosaunee Confederacy, an alliance of six sovereign Nations with a historic and contemporary presence on this land. The Confederacy precedes the establishment of Cornell University, New York state, and the United States of America. We acknowledge the painful history of Gayogohó:nq' dispossession, and honor the ongoing connection of Gayogohó:nq' people, past and present, to these lands and waters.
- This land acknowledgment has been reviewed and approved by the traditional Gayogohó:nq' leadership.

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Funding Acknowledgment

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