Production and pest management in high tunnels on urban farms

Samantha Willden and Laura Ingwell

3/1/2024

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Why are urban farms important?

Growing sector, increasingly important contribution to food systems, historically overlooked

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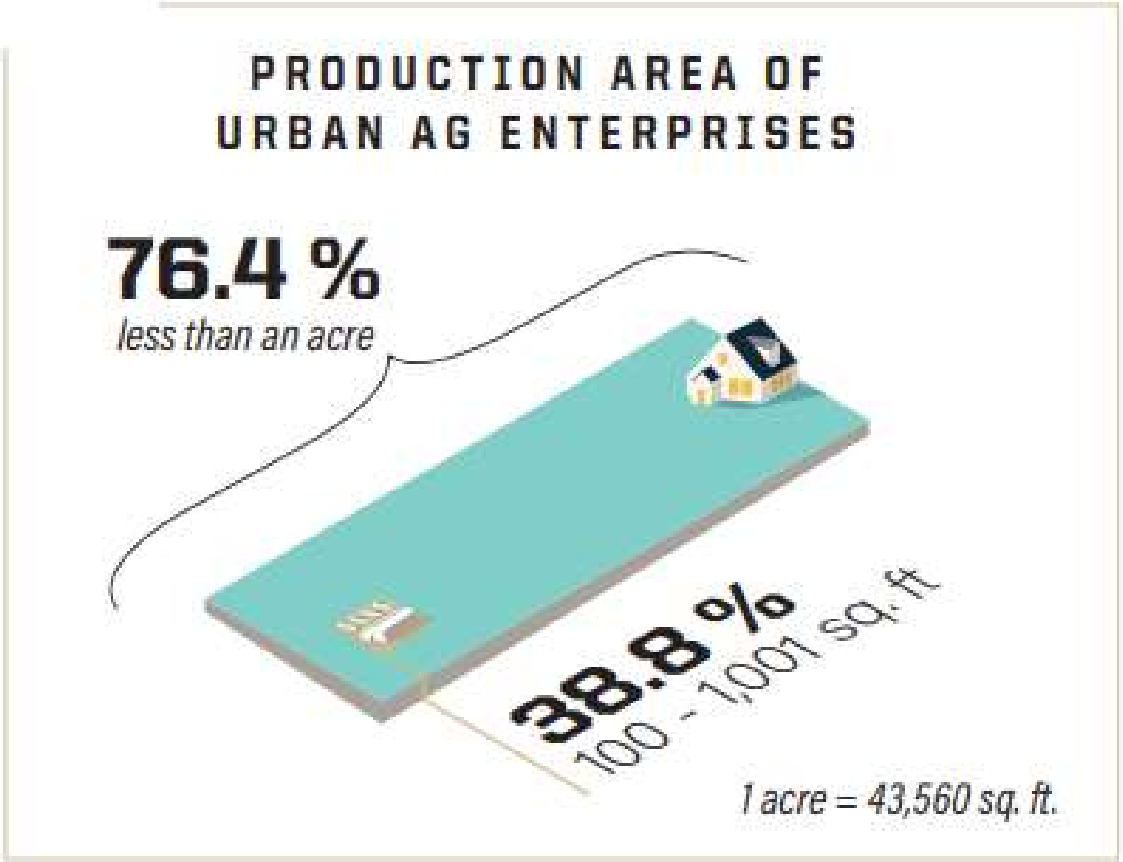
Challenges in urban farming

Land availability:

Urban farms are much smaller than those in rural areas.

More than 76% of urban farmers cultivate on less than one acre.

Shoaff and Ingwell, 2023

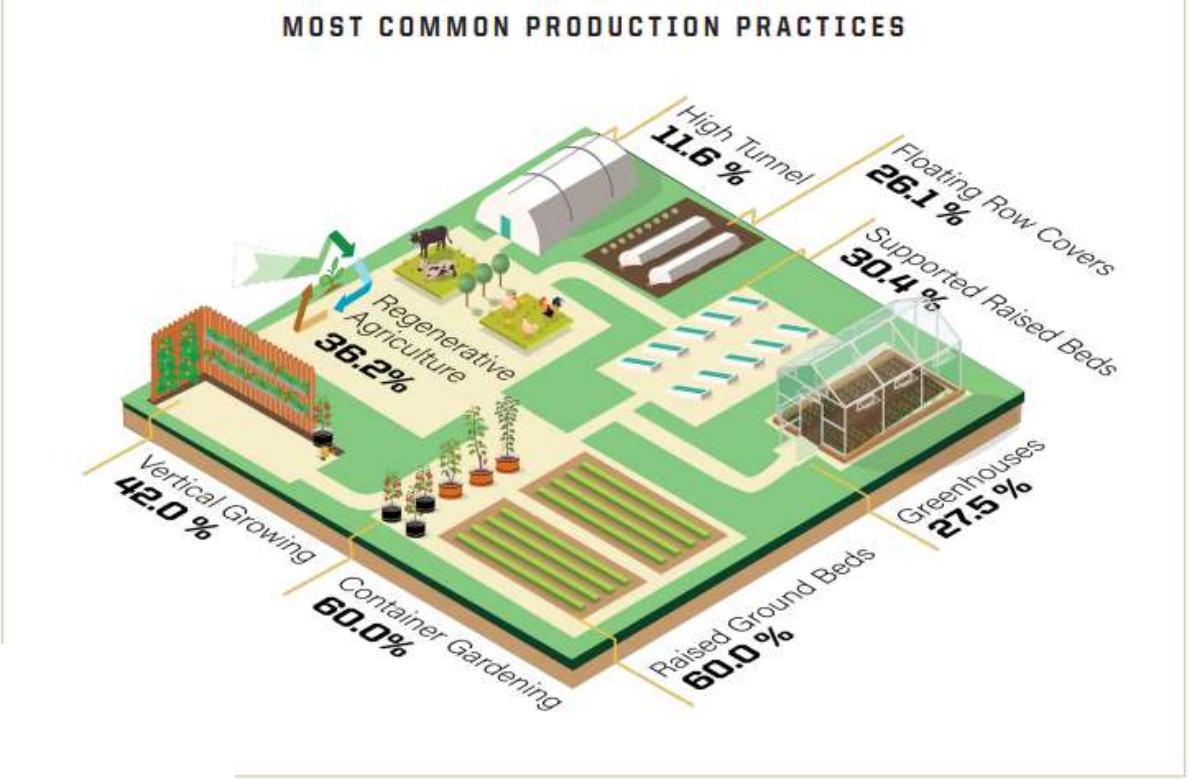


Challenges in urban farming

How is space being used?

Emphasis on maximizing yield on a small area:

- Protected culture (greenhouses, row covers, and high tunnels)
- Vertical cultivation



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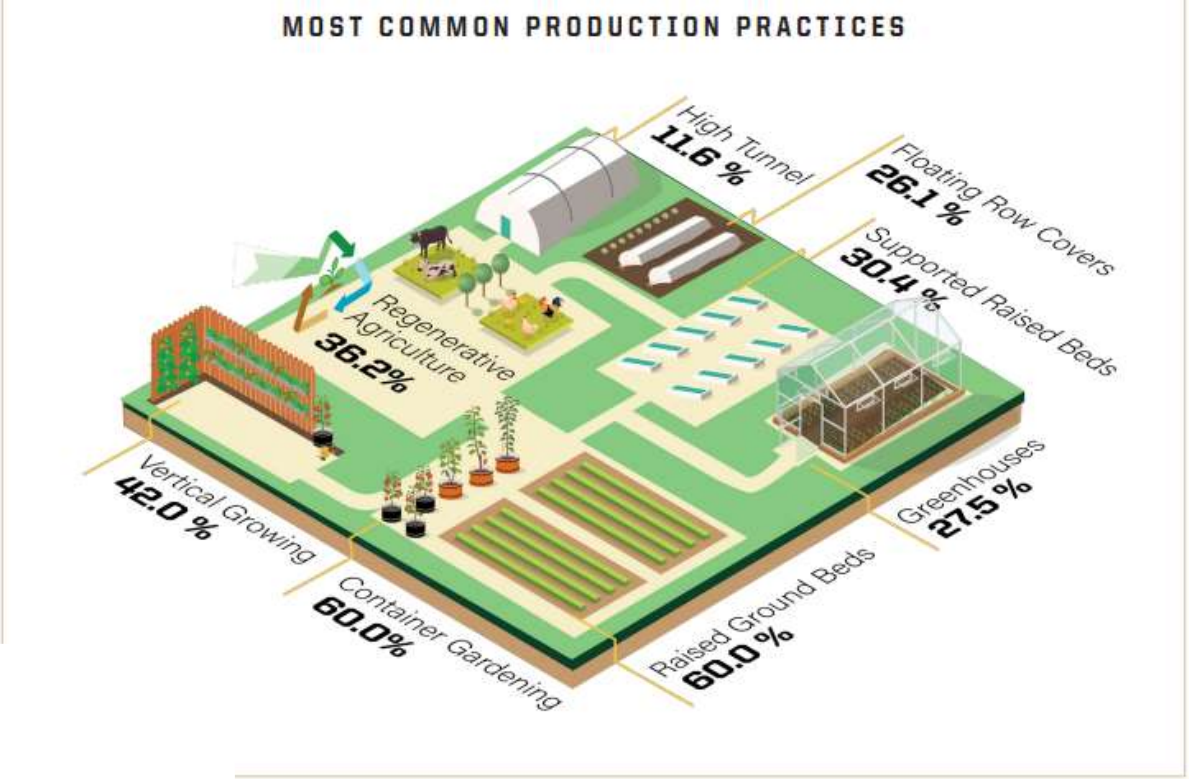

Benefits of high tunnels

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Challenges of high tunnels

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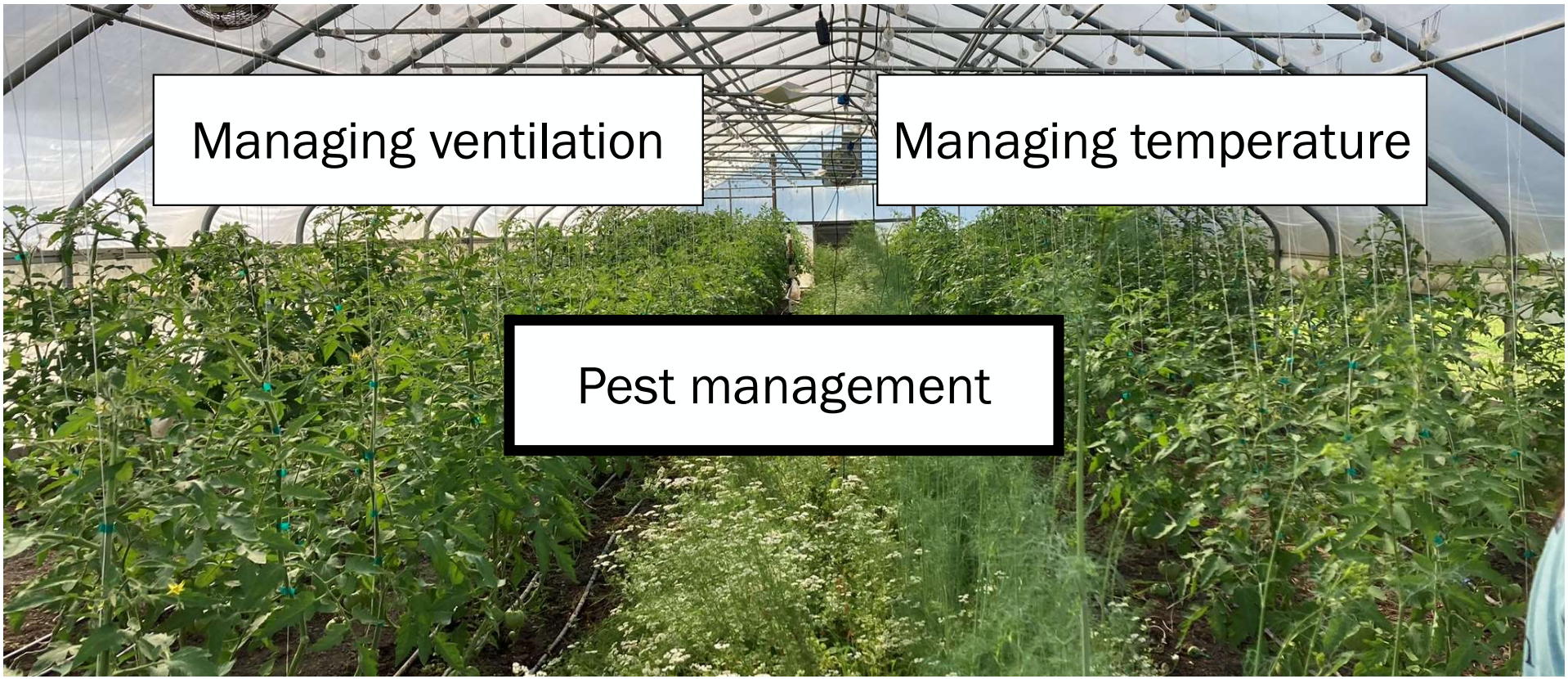
Challenges of high tunnels



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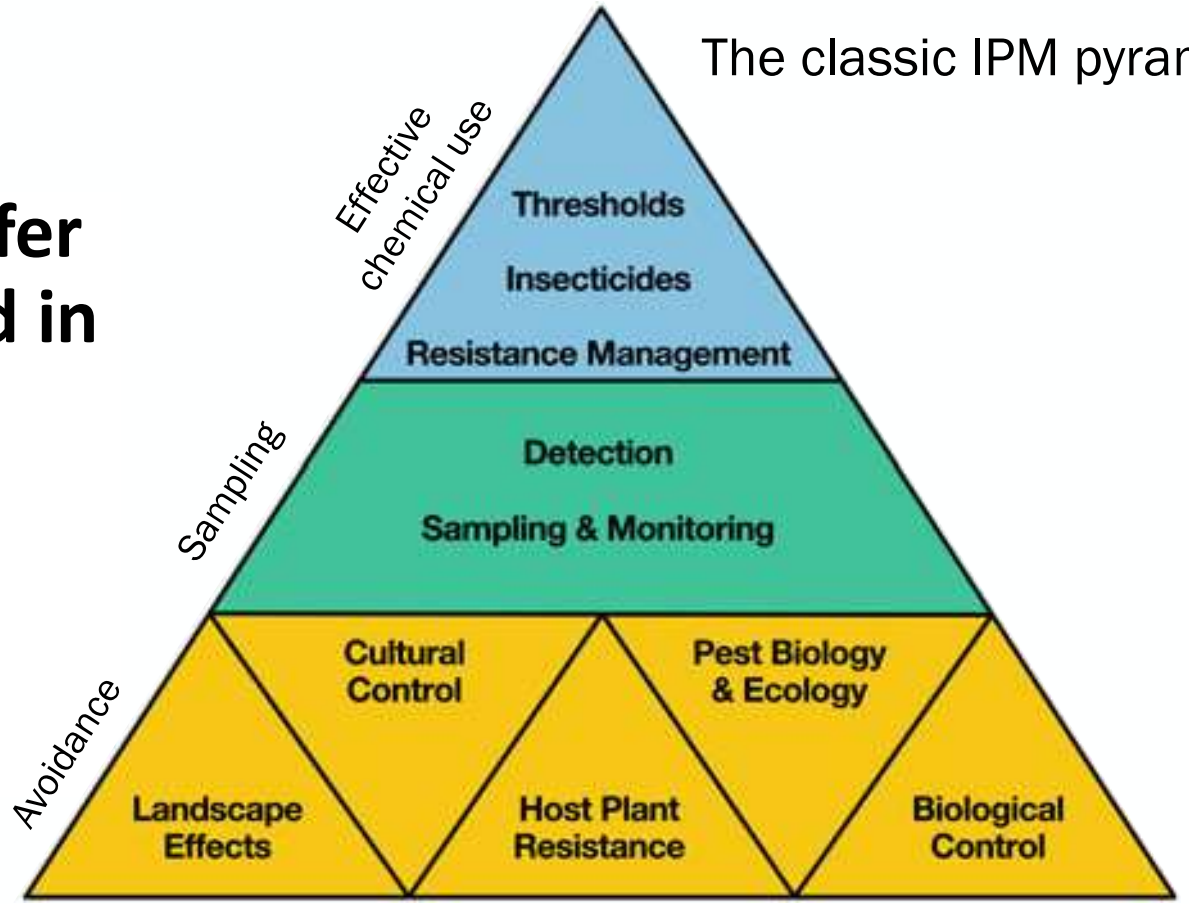
Do pest challenges differ in high tunnels located in urban vs. rural areas?

What are effective options for management?

The classic IPM pyramid



Naranjo 2011

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Describing high tunnels on urban farms in Indiana

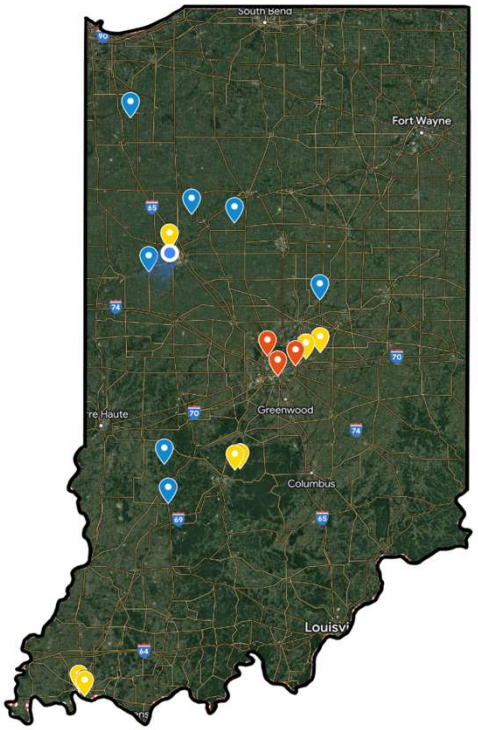
Multi-state grower survey: Dec 2022 – current

Dr. Sam Willden

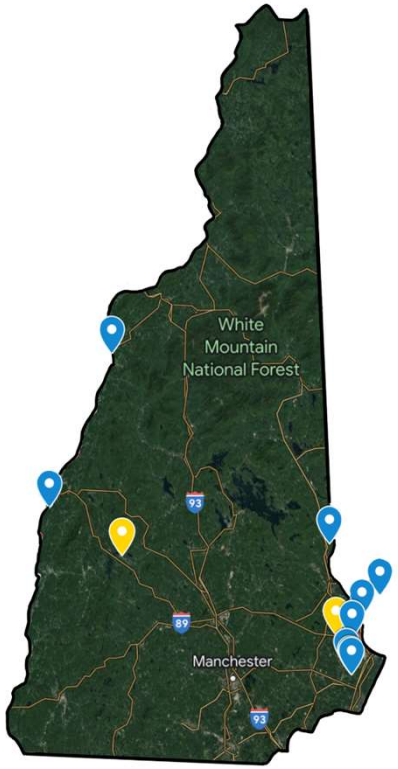
Garima Kohli

Dr. Anna Wallingford

Illinois



Indiana



New England

Map legend: Urban Suburban Rural

Multi-state grower survey: Dec 2022 – current

Dr. Sam Willden

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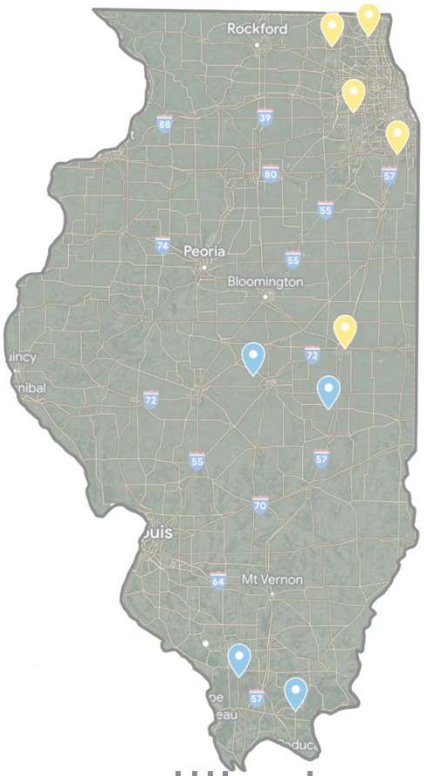


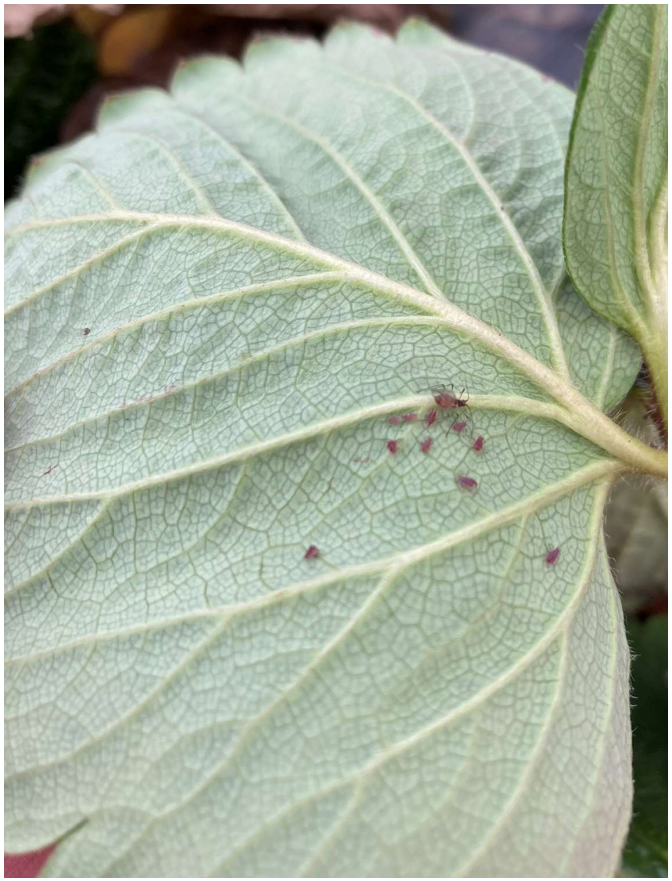
Illinois

Indiana

New England

Map legend: Urban Suburban Rural

In-situ crop counts and inspections



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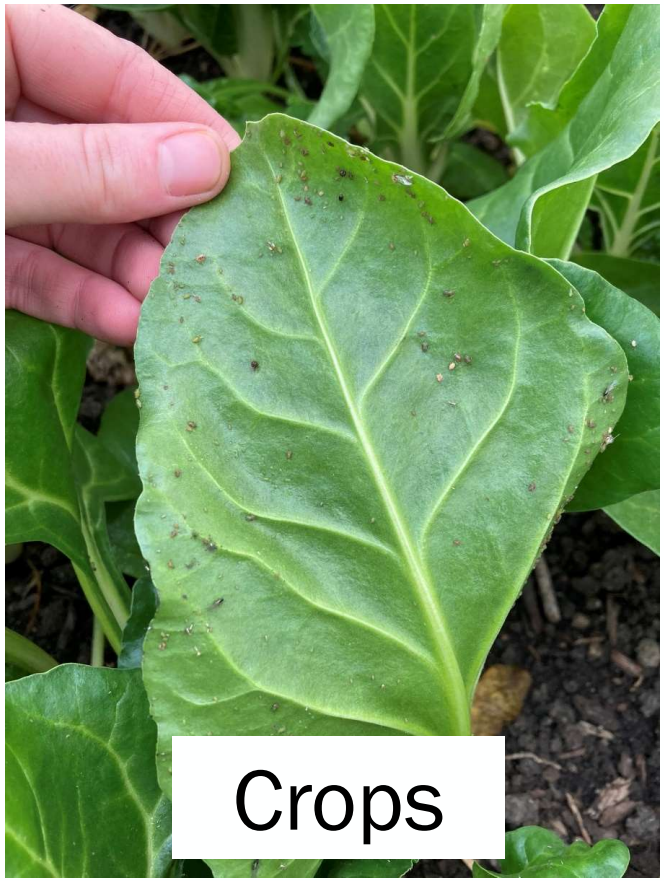
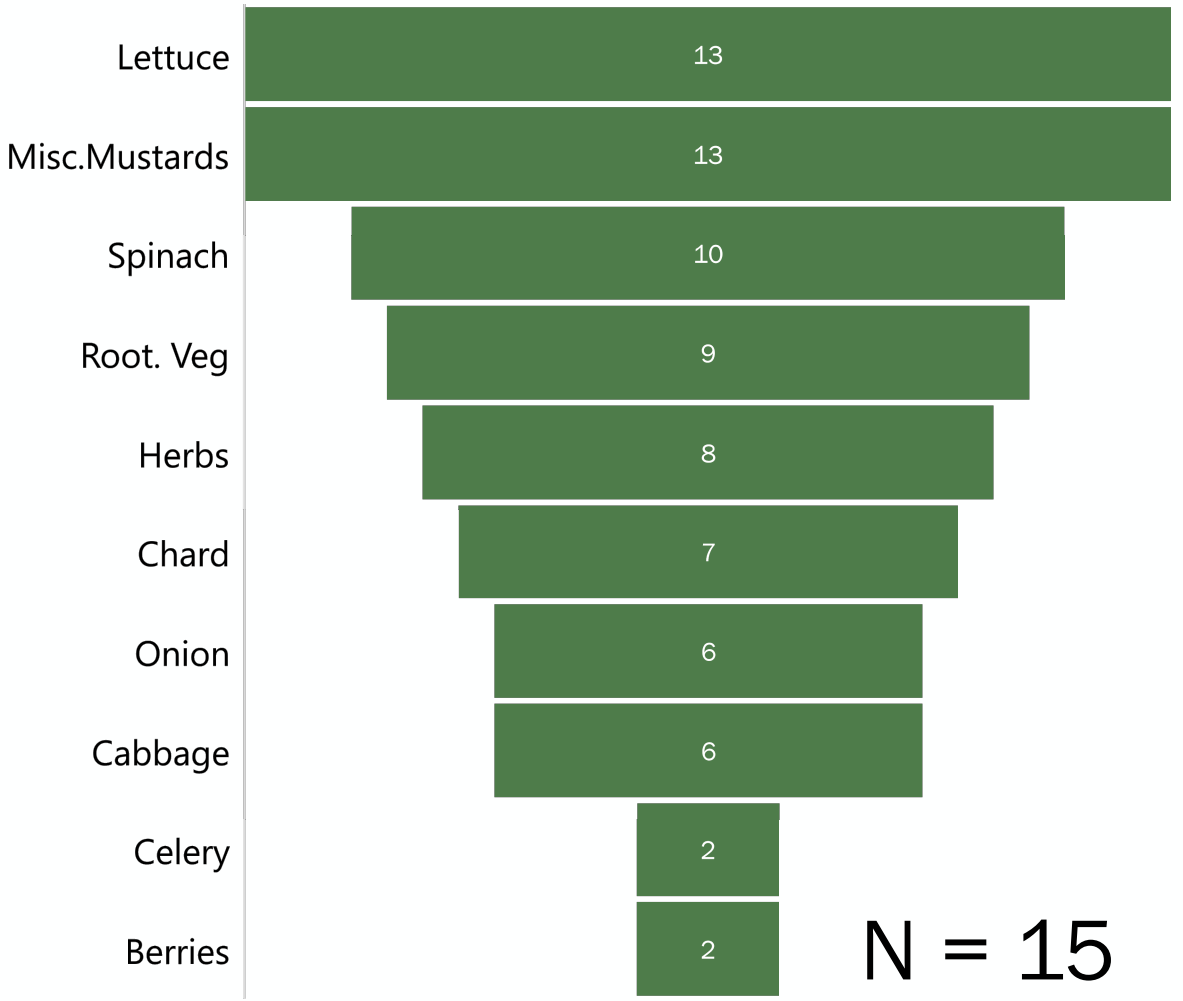
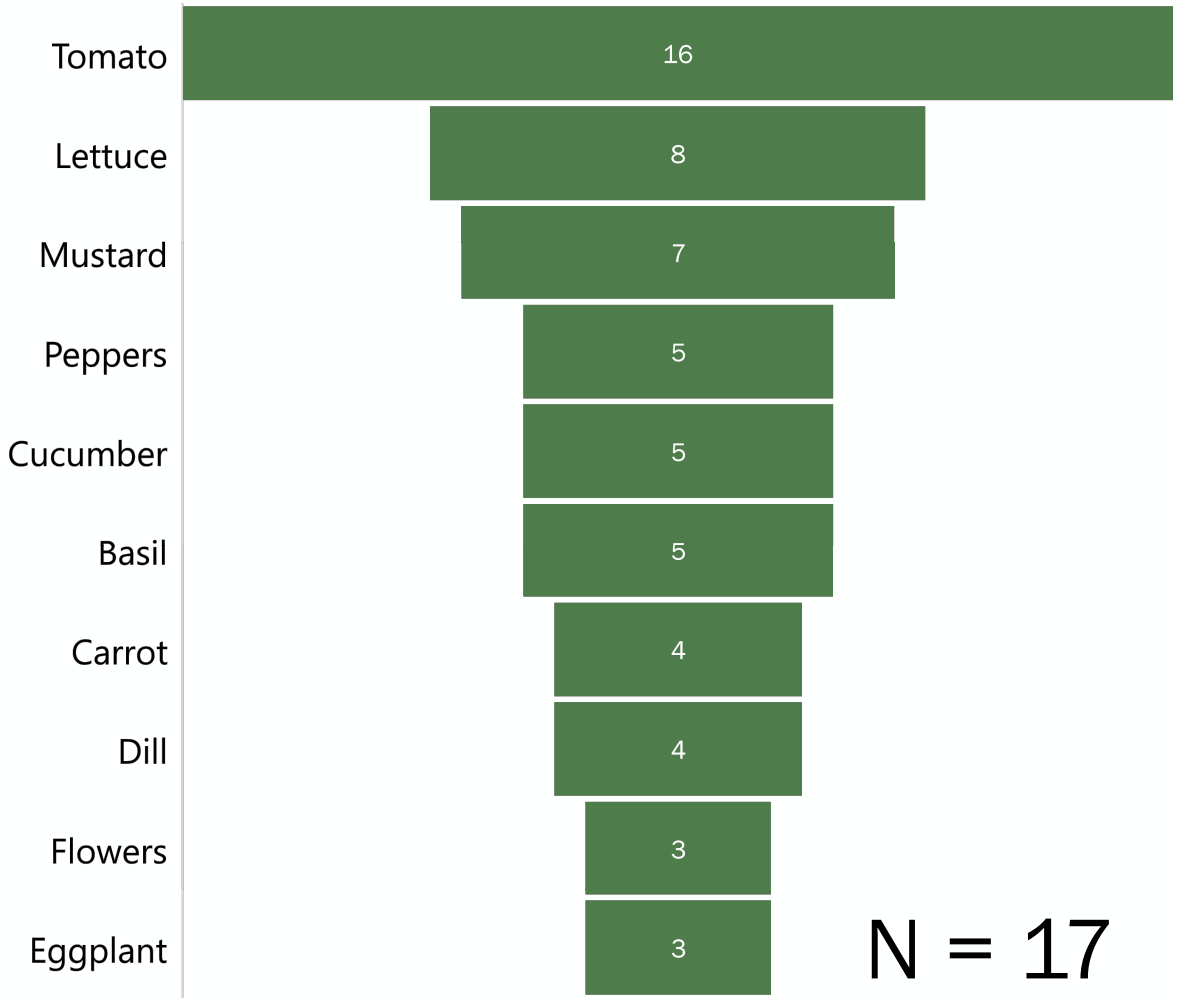


Primary winter crops in Indiana



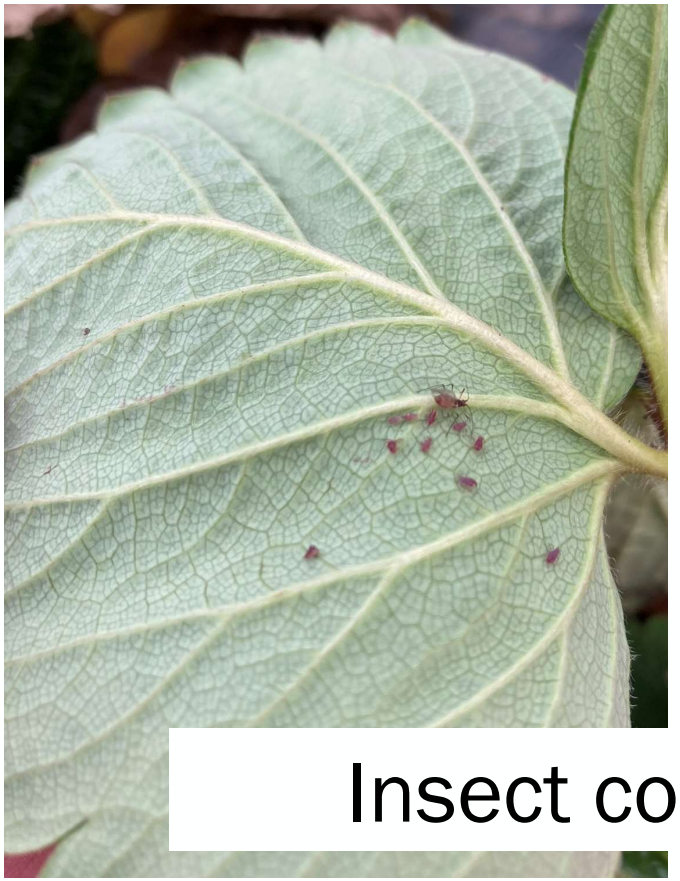
N = 15

Primary summer crops in Indiana



N = 17

In-situ crop counts and inspections



Insect communities

Common pests of concern:

Aphids

Thrips

Mites

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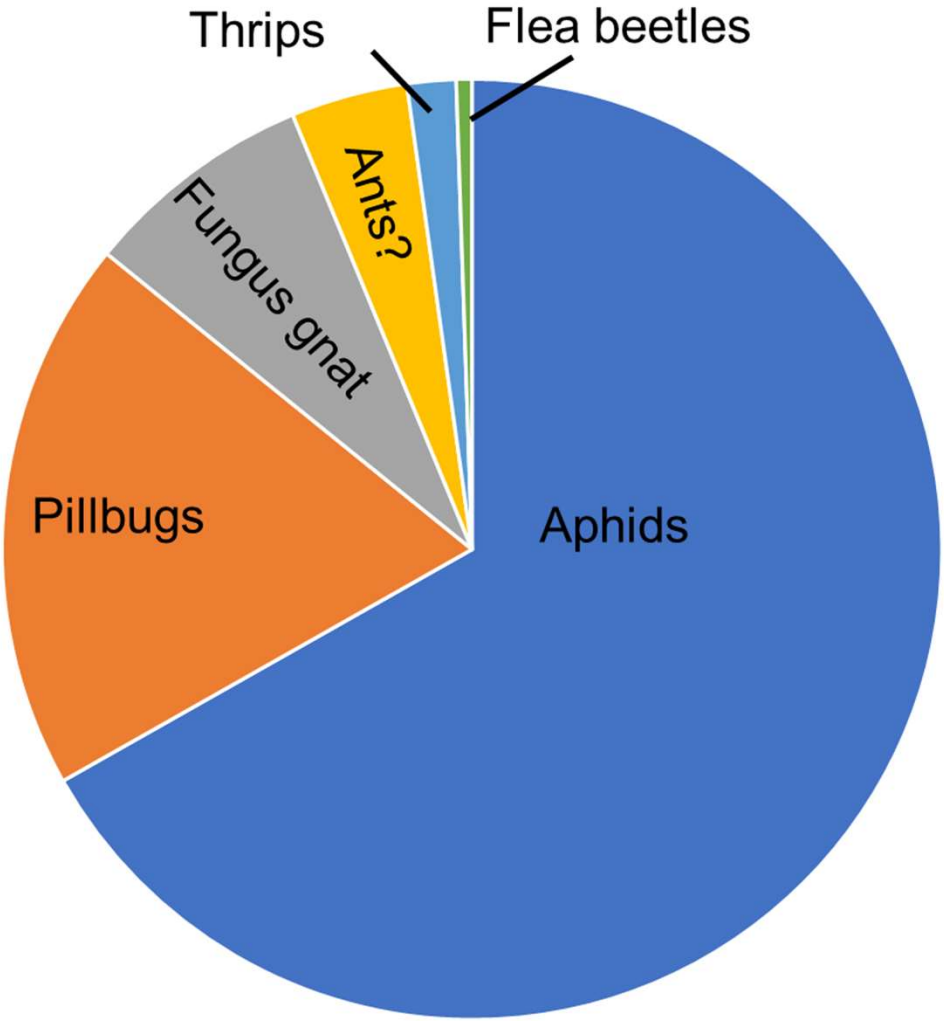
Primary HT winter pests



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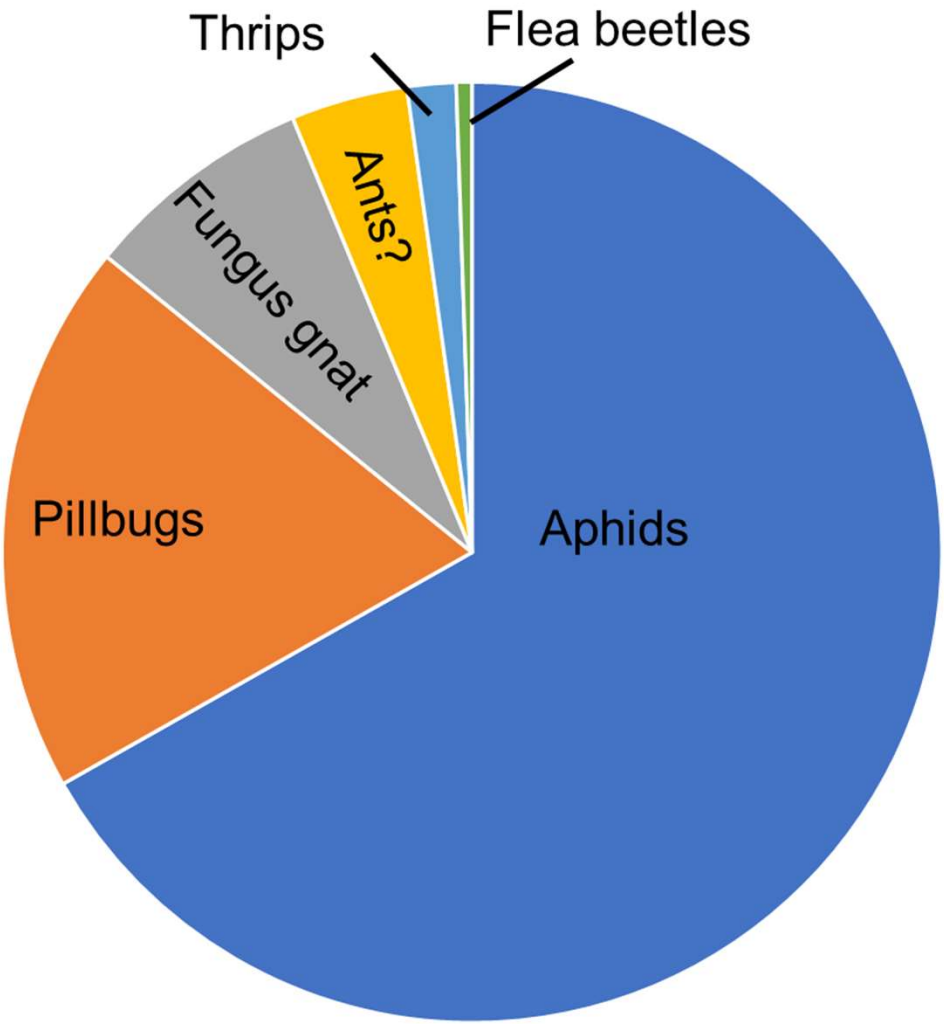

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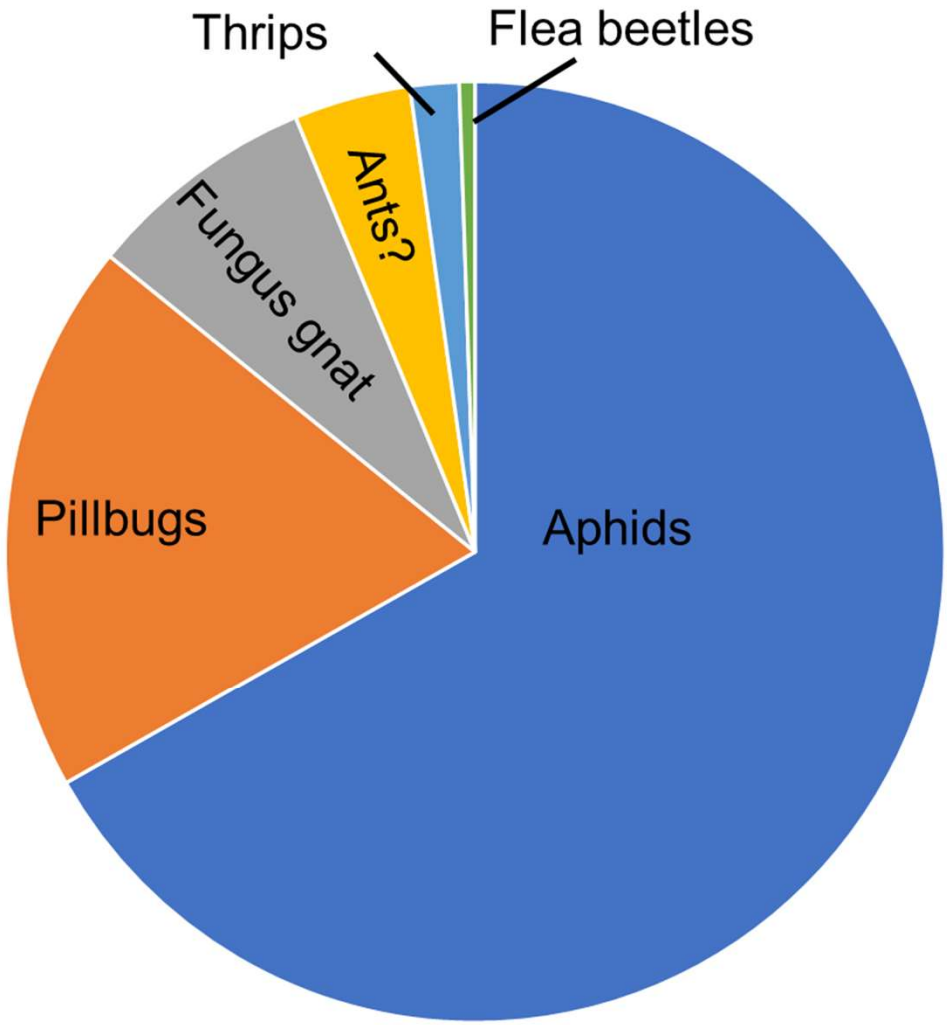

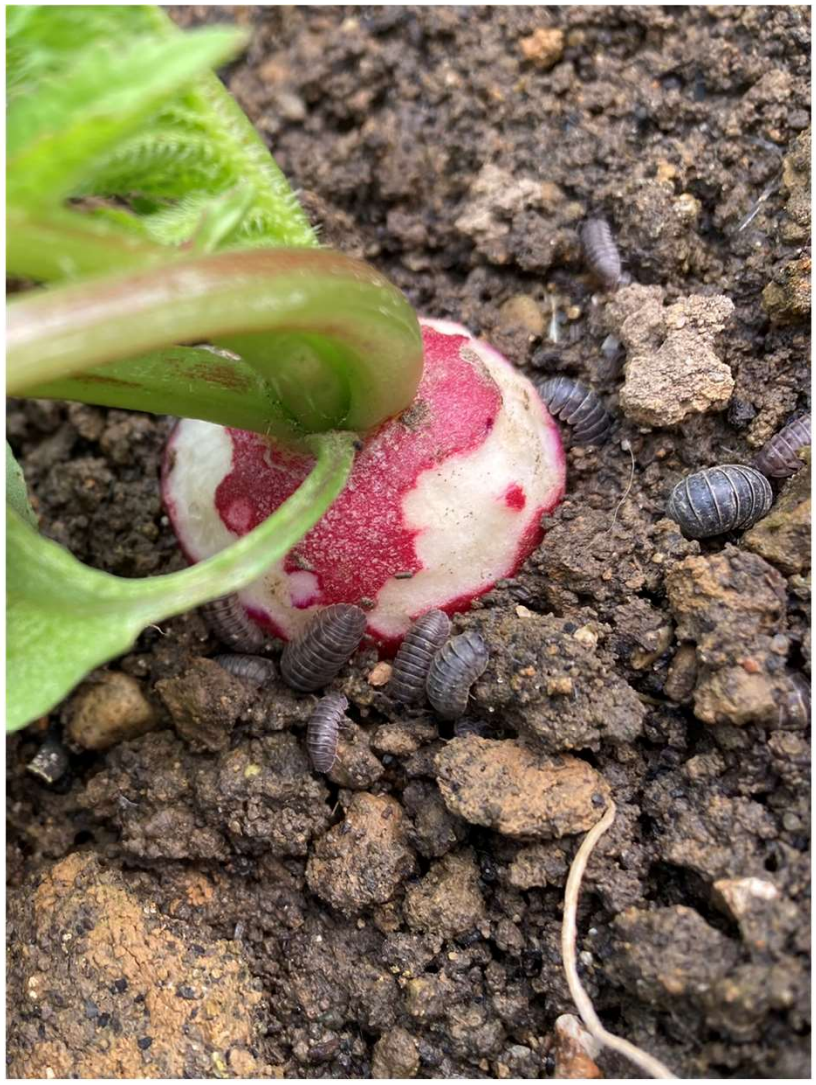

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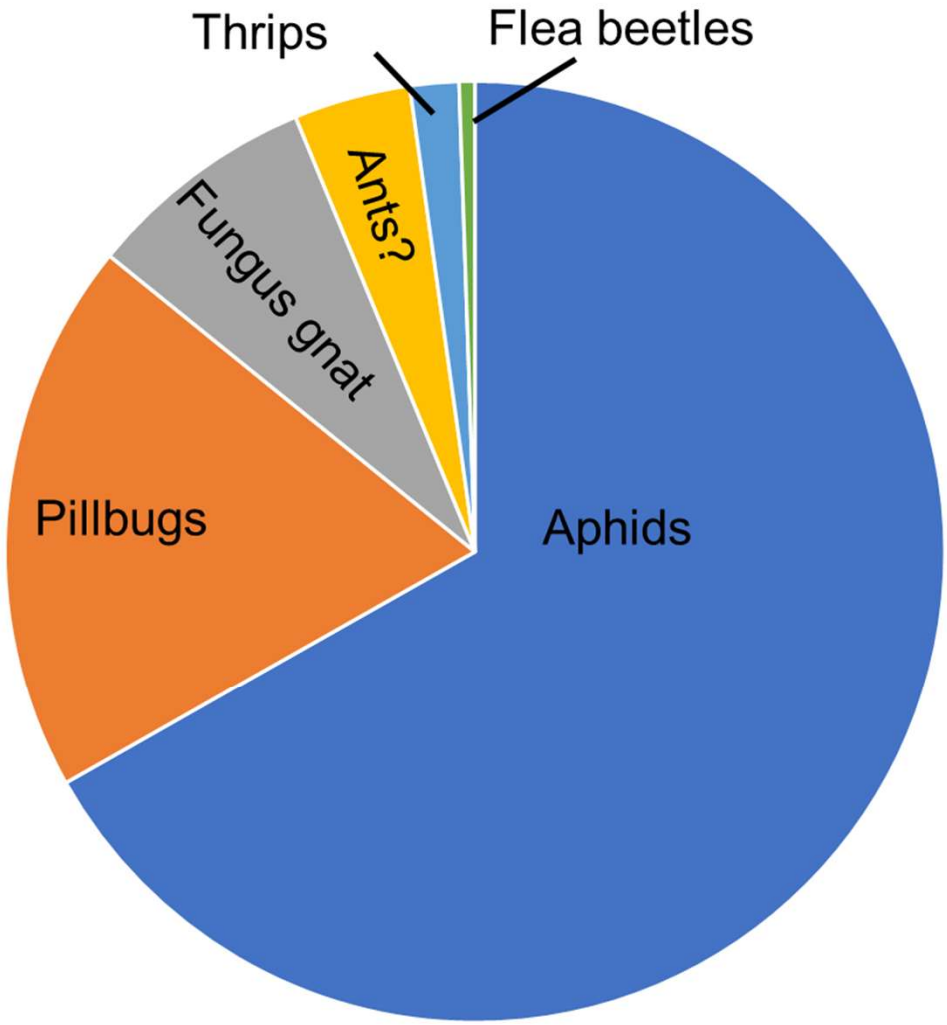

Primary urban winter pests

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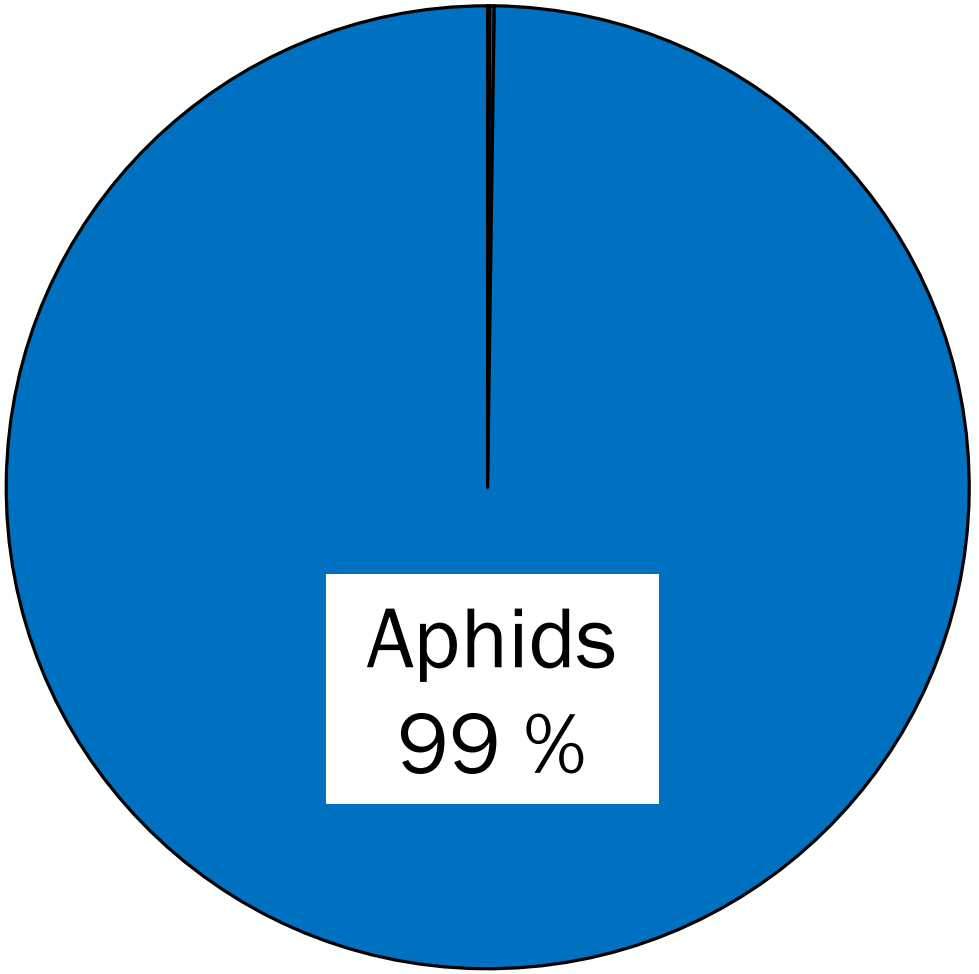

Does urbanization affect winter insect communities?

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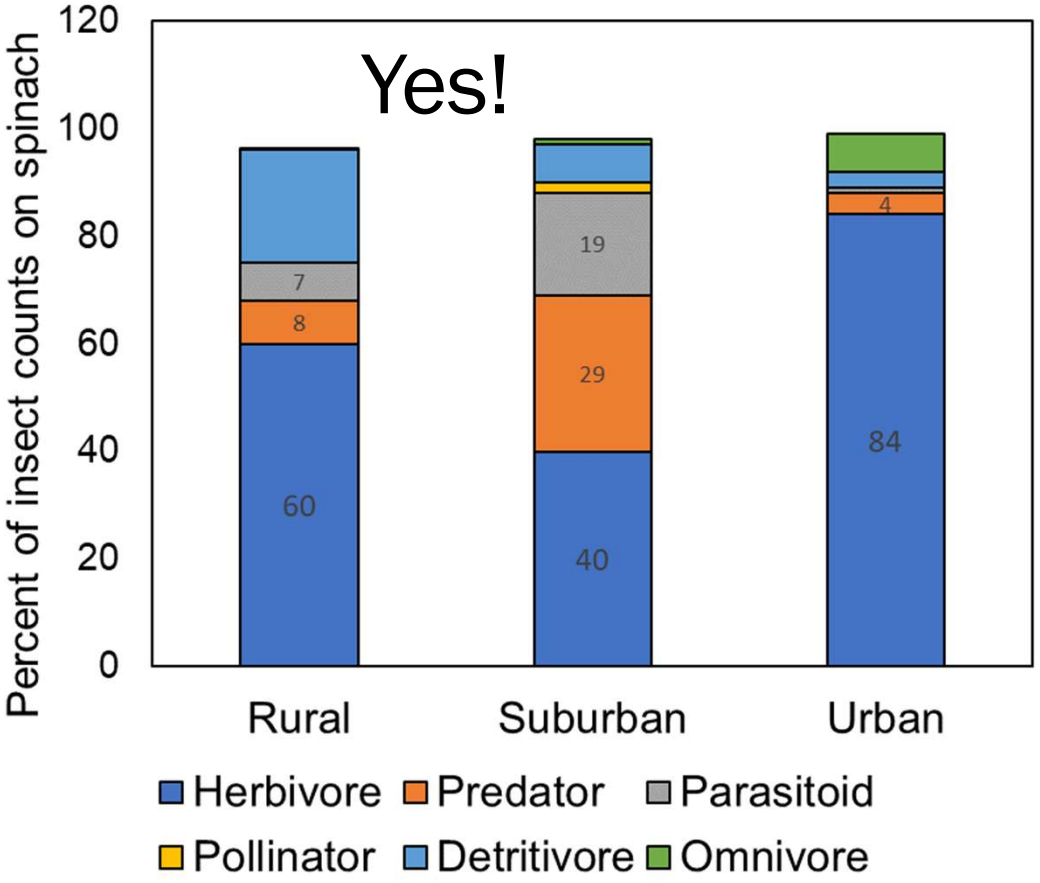
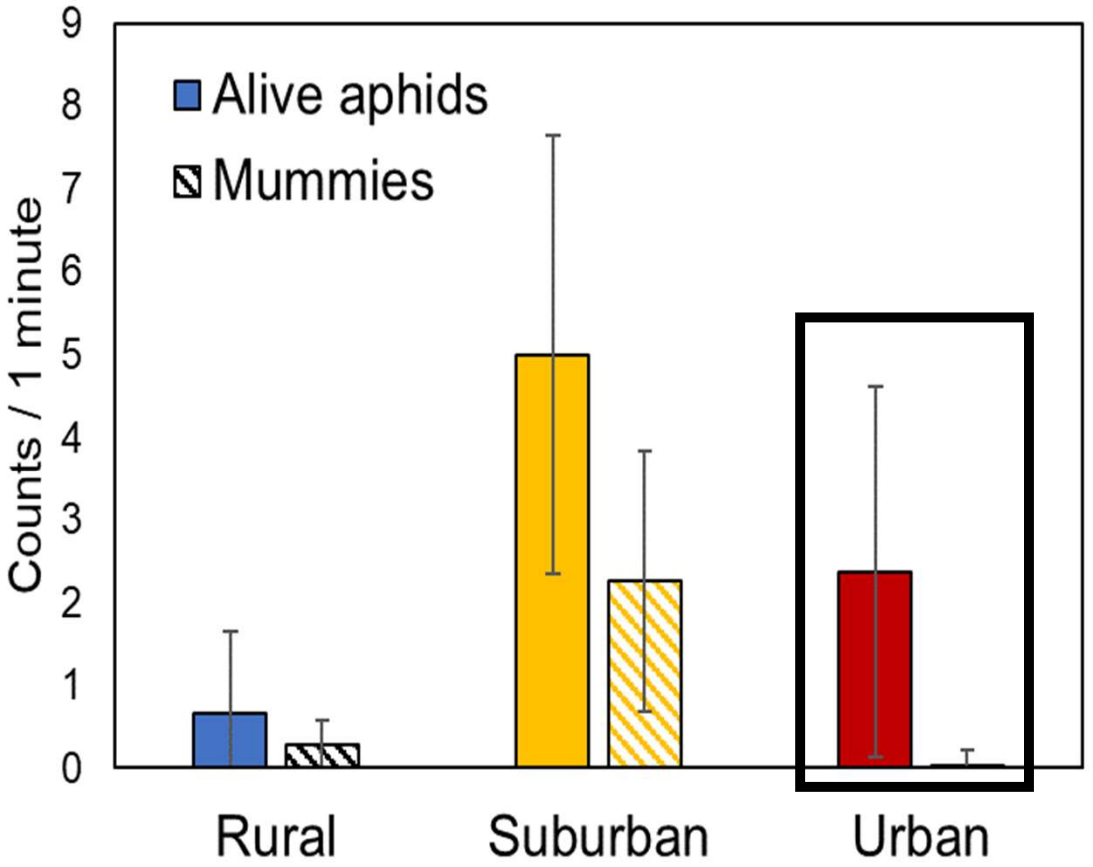


High aphids due to low parasitism?:



Primary HT summer pests

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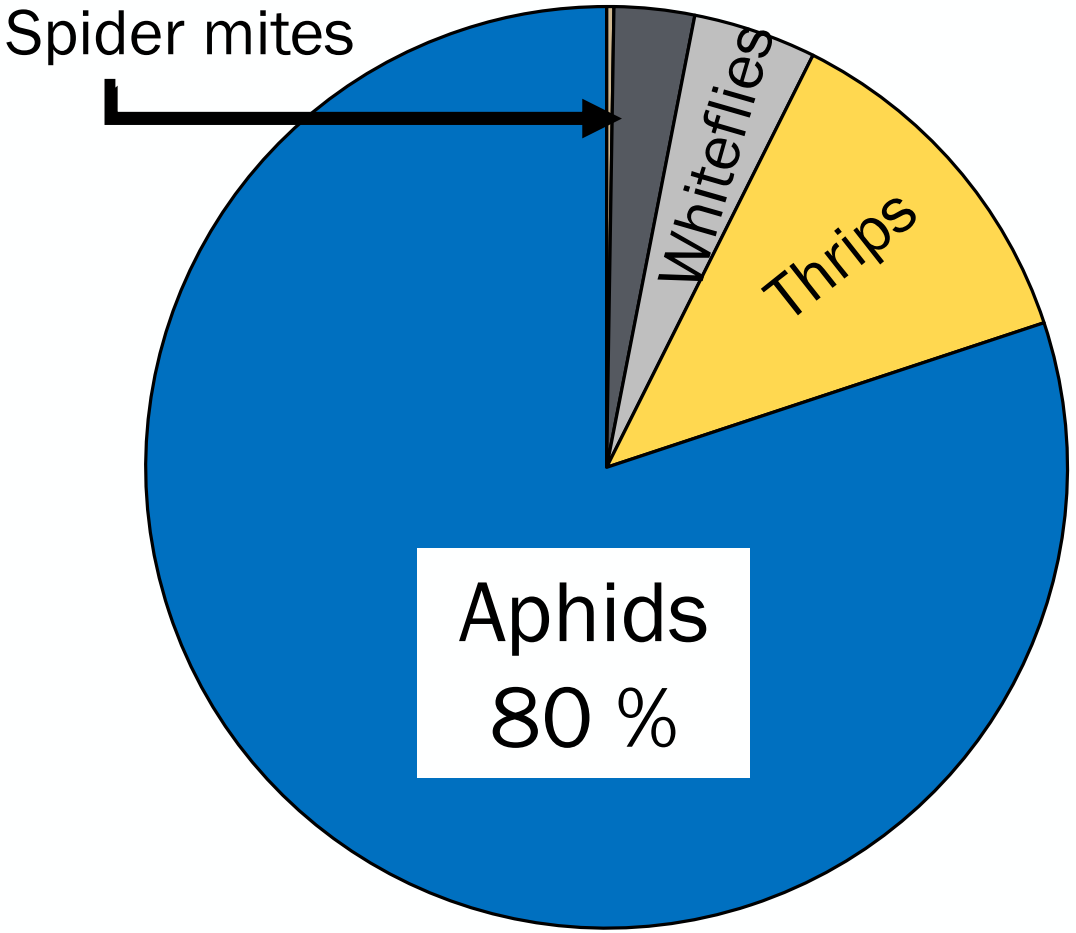

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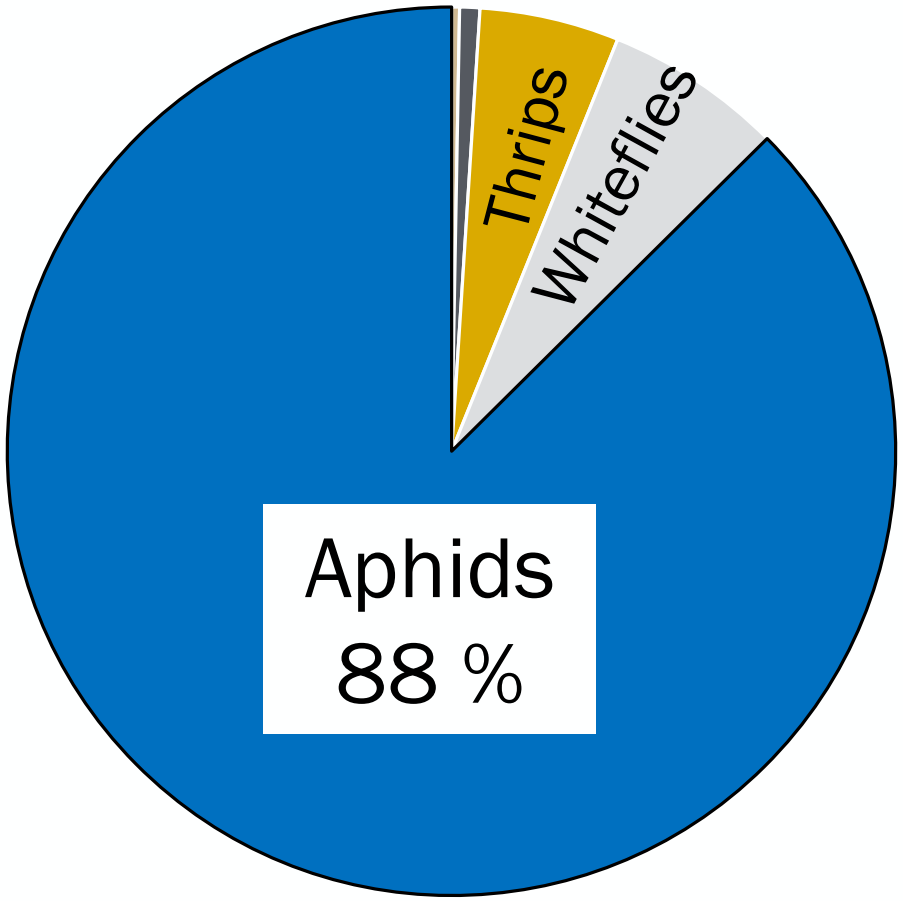

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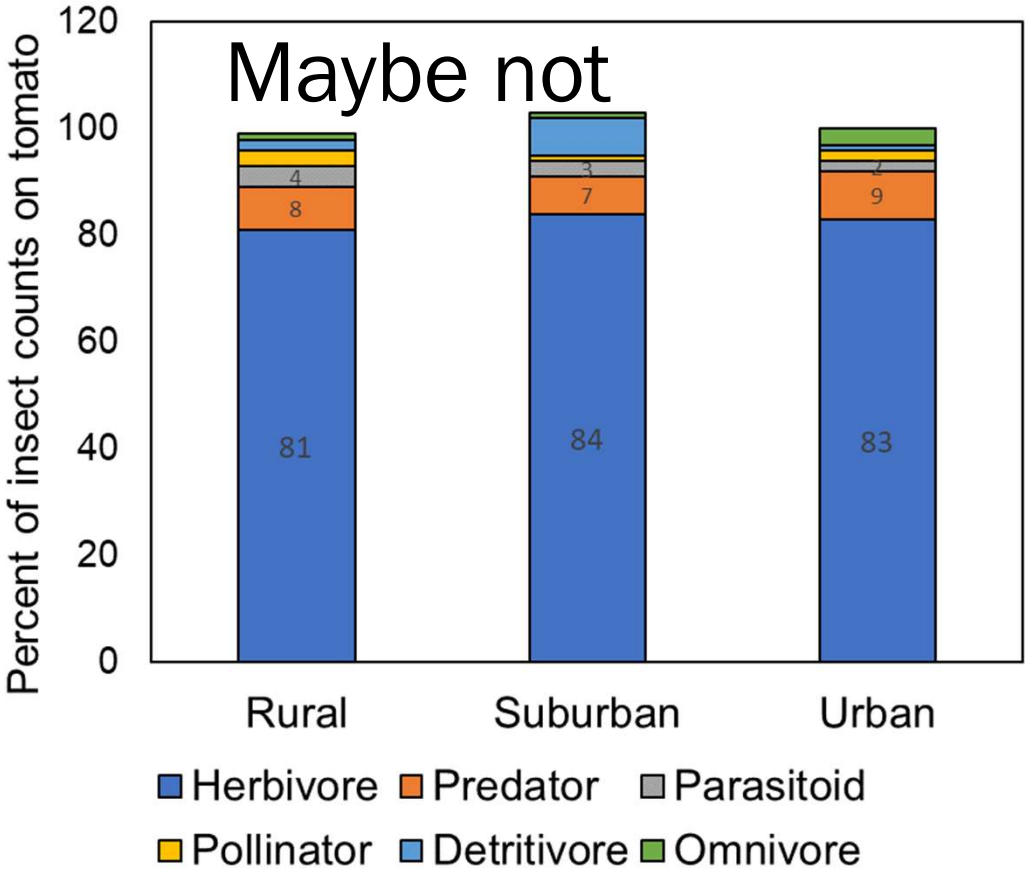
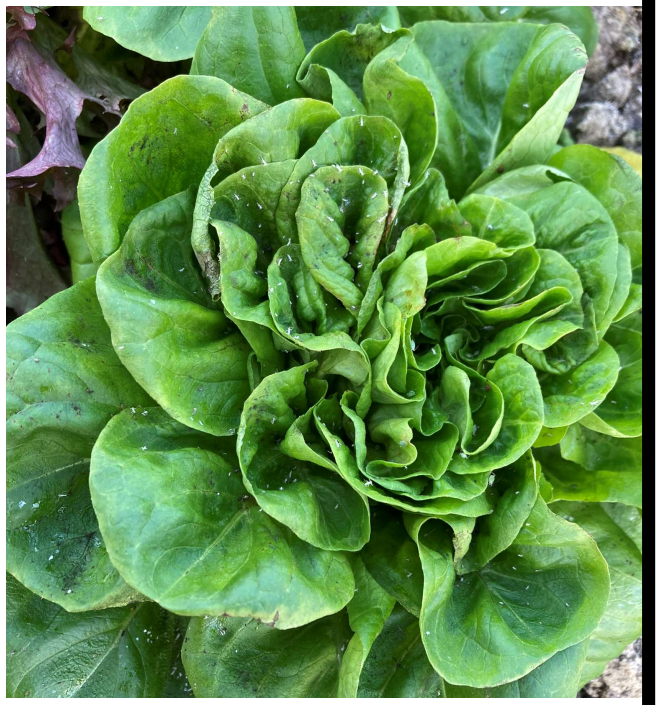


Common pests of concern:

Aphids



Thrips

Mites

What are effective options for management?

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Best management practices: IPM

Best management practices: IPM

IPM approaches:

- Prevention
- Monitoring
- Action Thresholds
- Biological Control
- Chemical Control

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Best management practices: IPM

IPM approaches:

- **Prevention**
- Monitoring
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Best management practices: IPM

Prevention is key!

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- Be cognizant of hitchikers
- Inspect all transplants

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- Minimize reservoirs and secondary hosts (weeds)

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Best management practices: IPM

Prevention is key!

- Be cognizant of hitchikers
- Inspect all transplants
- Order of Entry
- Minimize reservoirs and secondary hosts (weeds)
- Consider netting or screening

  Start clean (no weeds) and put in place as soon as new transplants go in!

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Best management practices: IPM

IPM approaches:

- Prevention
- **Monitoring**
- Action Thresholds
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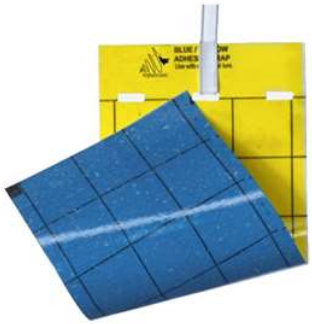
Best management practices: IPM

Monitoring and Early Detection

- Scout early and often
- Top and bottom of leaves
- Old and new vegetation
- Wash water



Jim Jasinski, Ohio State University Extension

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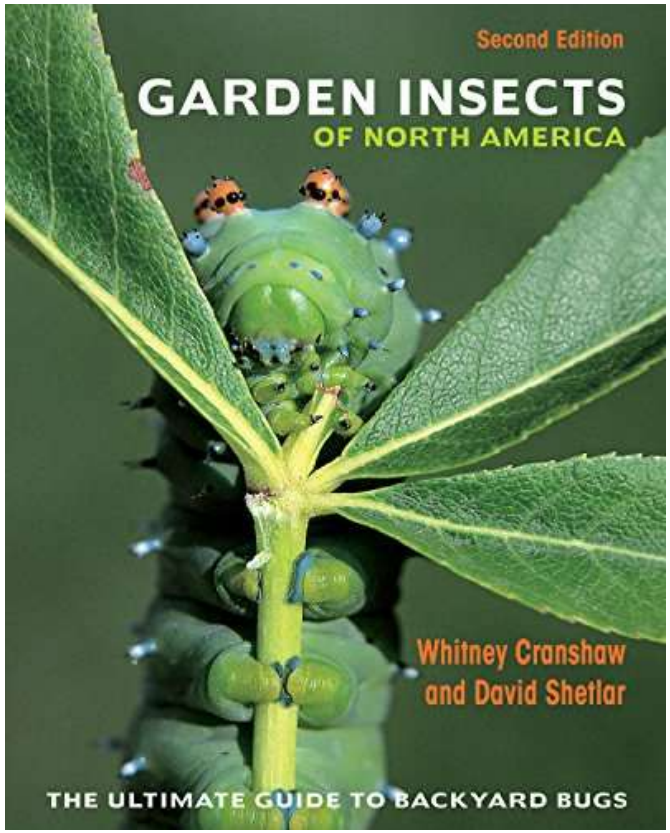
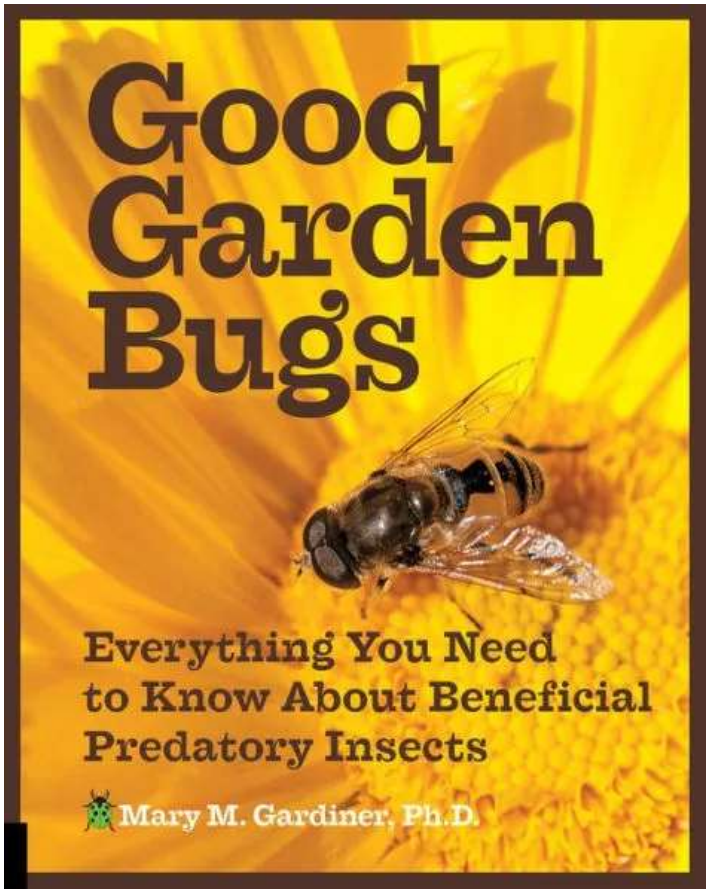
Scout for good bugs!

Photos by John Obermeyer

Scouting tools:





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Scouting tools:

Roll over image to zoom in

Wireless Digital Microscope, Skybasic 50X-1000X Magnification WiFi Portable Handheld Microscopes with Adjustable Stand HD USB Microscope Camera Compatible with iPhone Android iPad Windows Mac Computer

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Scouting tools:

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Purdue Plant & Pest Diagnostic Laboratory

Best management practices: IPM

IPM approaches:

- Prevention
- Monitoring
- **Action Thresholds**
- Biological Control
- Chemical Control

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Best management practices: IPM

Action Thresholds

- Is the population increasing?
- What part of the plant are they feeding on?
- How big is the plant?
- Are there natural enemies present?
- Find thresholds in extension publications.

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Best management practices: IPM

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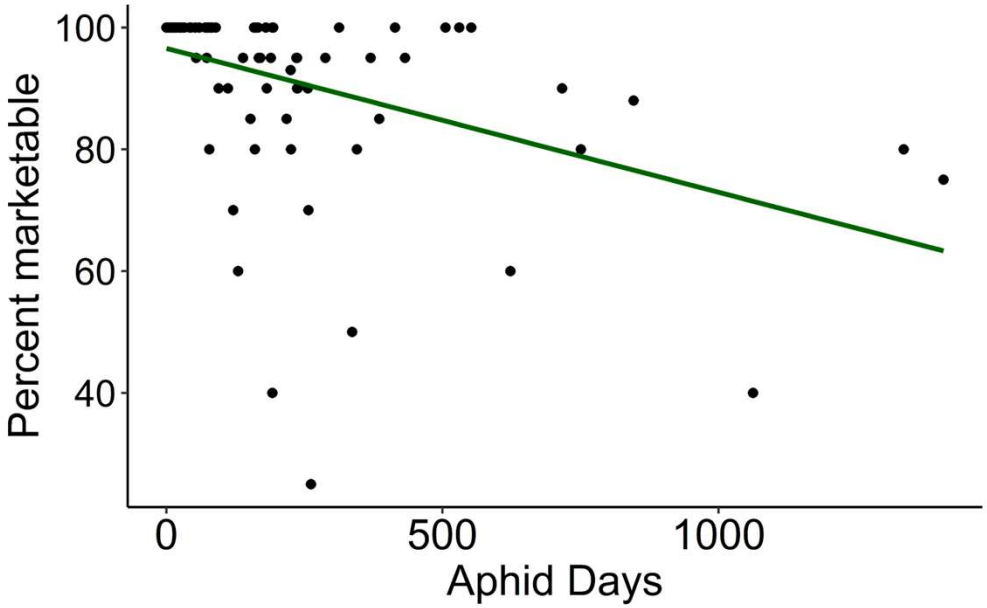

No clear thresholds for aphids on winter spinach… but they matter

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Best management practices: IPM

Action Thresholds

- Is the population increasing?
- What part of the plant are they feeding on?
- How big is the plant?
- Are there natural enemies present?
- Find thresholds in extension publications.

Current AT for tomato hornworm is 0.5 young larvae/plant

University of Minnesota VegEdge

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Best management practices: IPM

IPM approaches:

- Prevention
- Monitoring
- Action Thresholds
- **Biological Control**
- Chemical Control

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BIOLOGICAL CONTROL: Augmentation

Purchasing natural enemies for release

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Predators and parasitoids: great options for aphids, thrips and spider mites

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BIOLOGICAL CONTROL: Augmentation

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Predators and parasitoids: great options for aphids, thrips and spider mites

BIOLOGICAL CONTROL: Augmentation

Purchasing natural enemies for release

A few suppliers:

- IPM Labs
- BioBee
- Biobest
- Certis
- Arbico
- Koppert

Check biocontrol agents for survival before application (if possible) and follow application and storage instructions carefully!

Slower acting than conventional pesticides. Requires some monitoring

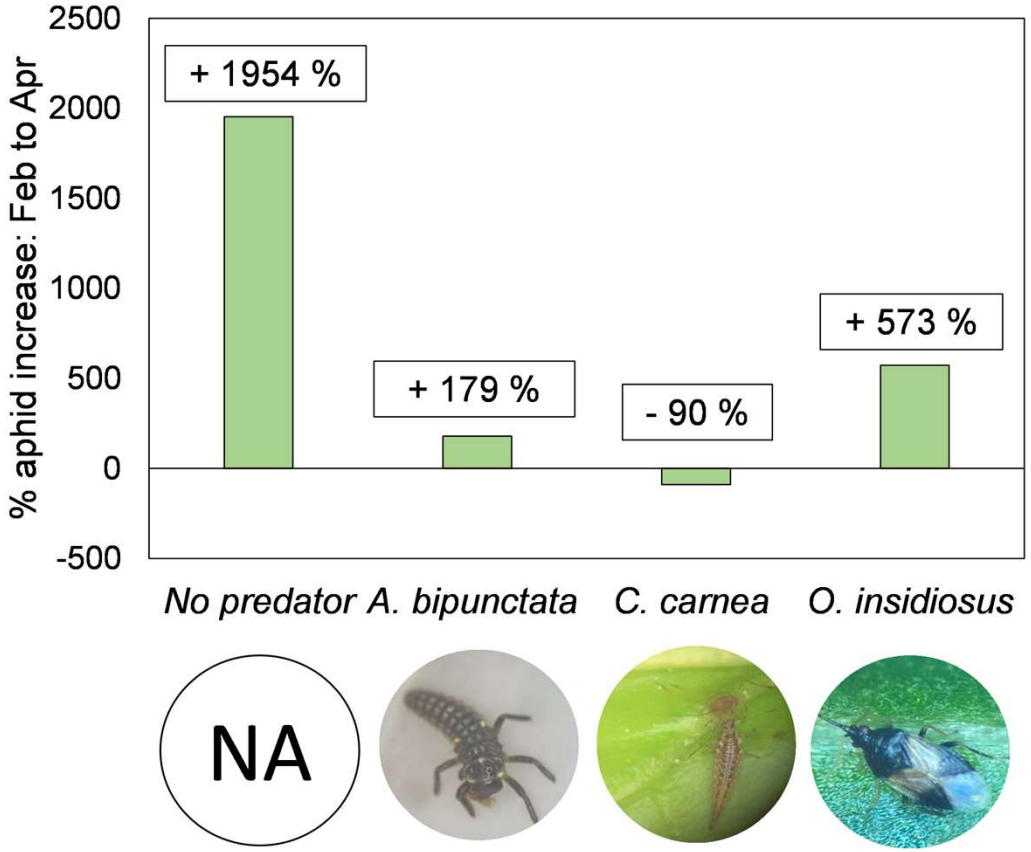
BIOLOGICAL CONTROL: Augmentation

For winter aphid management on spinach:

Agent	Product	Source	Release rate per tunnel	Cost per tunnel
Adalia bipunctata	Adalia system	BioBest®	200 larvae	$ 67.98
Chrysoperla carnea	BioCarnea cylinders of larvae and egg tabs	BioBee®	1,000 larvae 8,000 eggs	$ 41.40 for larvae $ 20.70 for egg tabs
Orius insidiosus	BioOrius bottles	BioBee®	1,000 adults	$46.74
Control	NA	NA	NA	NA

BIOLOGICAL CONTROL: Augmentation

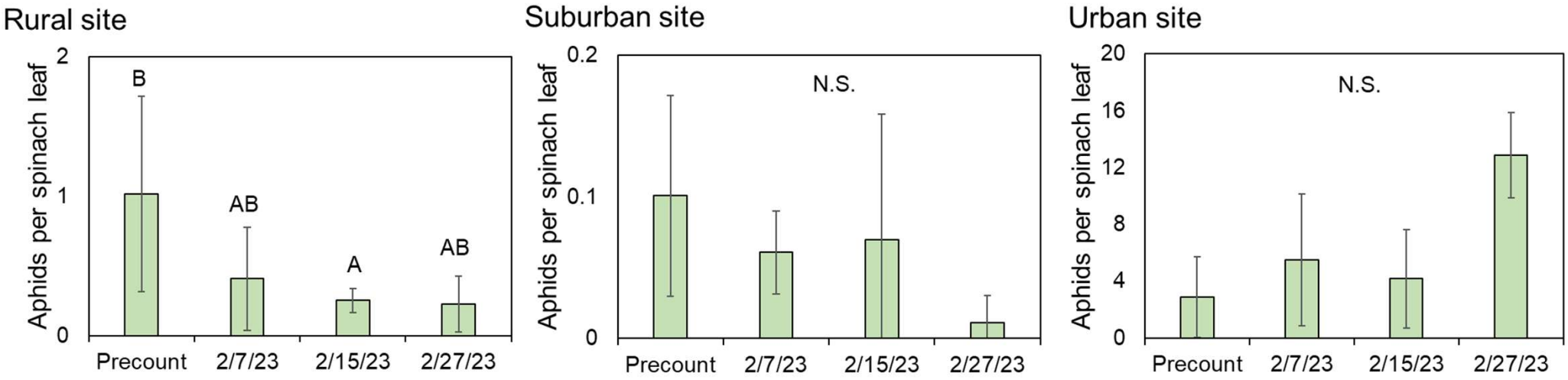
For winter aphid management on spinach:



- All predators suppressed aphid outbreaks
- Among them, lacewings (*C. carnea*) worked the best.
  - It was also the most cost effective!

BIOLOGICAL CONTROL: Augmentation

For winter aphid management on farms: Spinach



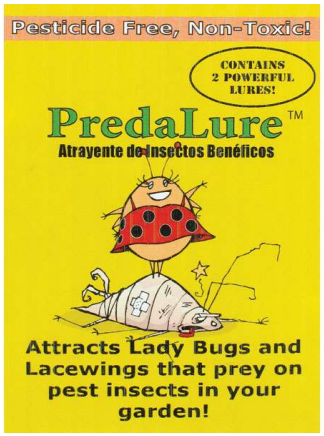
Some indication that biocontrol success declines with urbanization → low non-crop habitat?

BIOLOGICAL CONTROL: Conservation

Conserving the presence of naturally occurring natural enemies

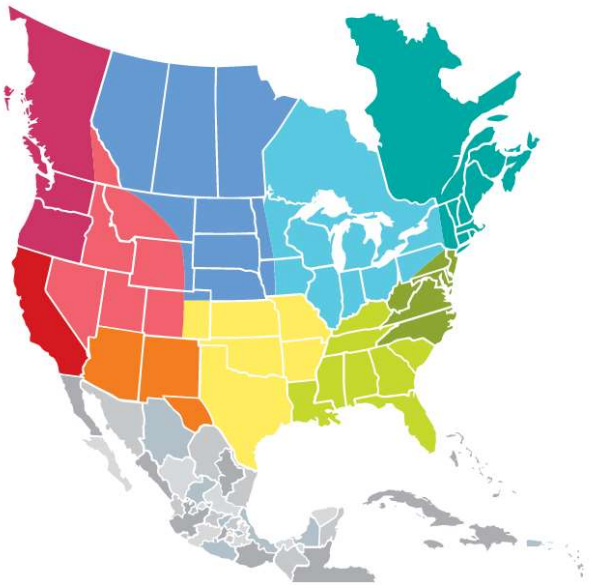
- Banker plants or attractants
- Companion plants
- Supplements (pollen)

Which ones??



Bird cherry oat aphid on winter wheat as alternative prey for aphid parasitoids for hemp aphid management

XERCES SOCIETY for Invertebrate Conservation



How does crop diversity impact insect diversity?

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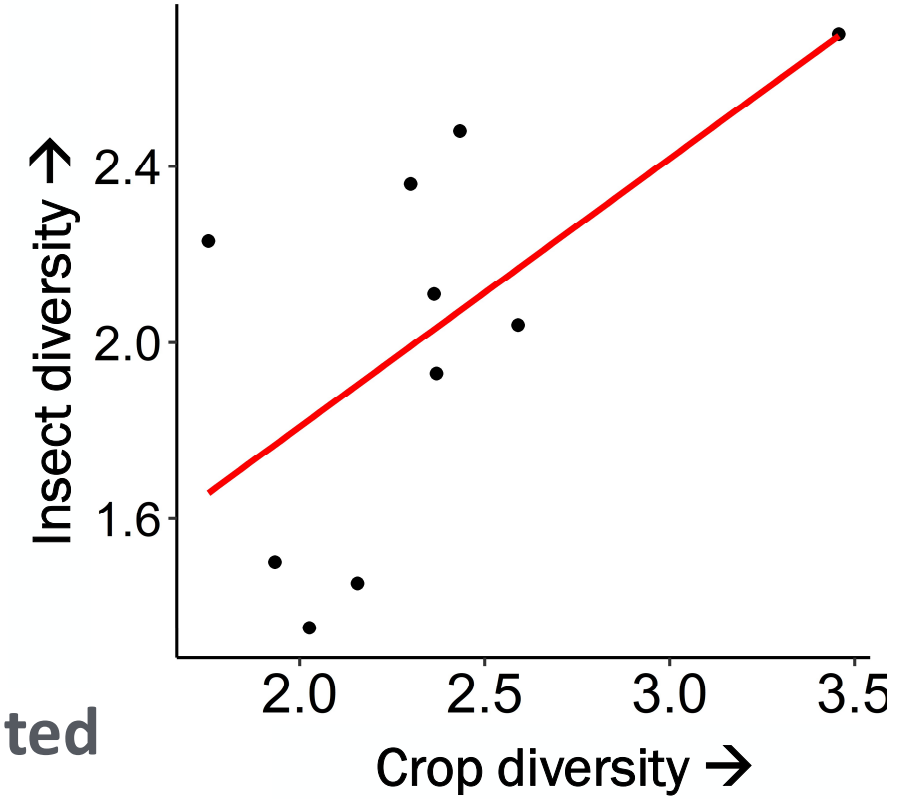

Higher crop diversity was correlated with higher insect diversity

Best management practices: IPM

IPM approaches:

- Prevention
- Monitoring
- Action Thresholds
- Biological Control
- **Chemical Control**

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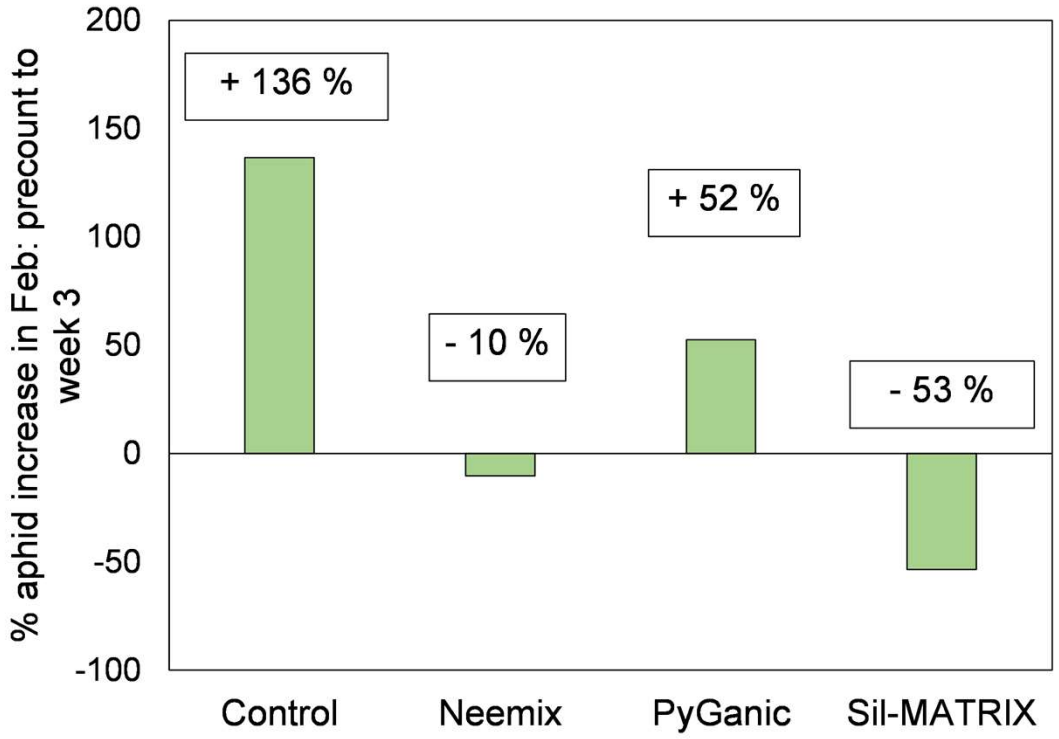
CHEMICAL CONTROL

For winter aphid management on spinach:

Product	Active Ingredient	Mode of action	Solution per liter	Spray rate (ml of product per plant)
Sil-MATRIX	Potassium silicate	Multiple	10 ml	20
PyGanic	Pyrethrin	3A	1.42 ml	20
Neemix	Azadiractin	Multiple	1.27 ml	20
Water	NA	NA	NA	20

CHEMICAL CONTROL

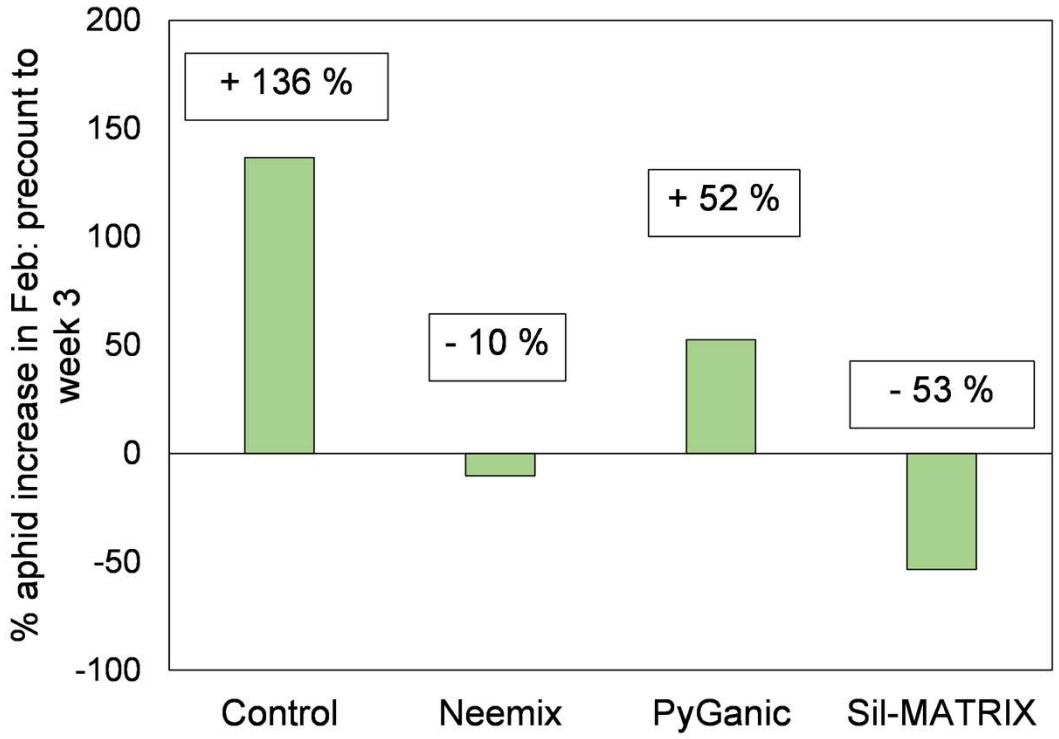
For winter aphid management on spinach:



- When applied to low populations in February, all products reduced aphid population increase for 3 weeks.
- Among the products, Sil-MATRIX worked best.
- However…

CHEMICAL CONTROL

For winter aphid management on spinach:

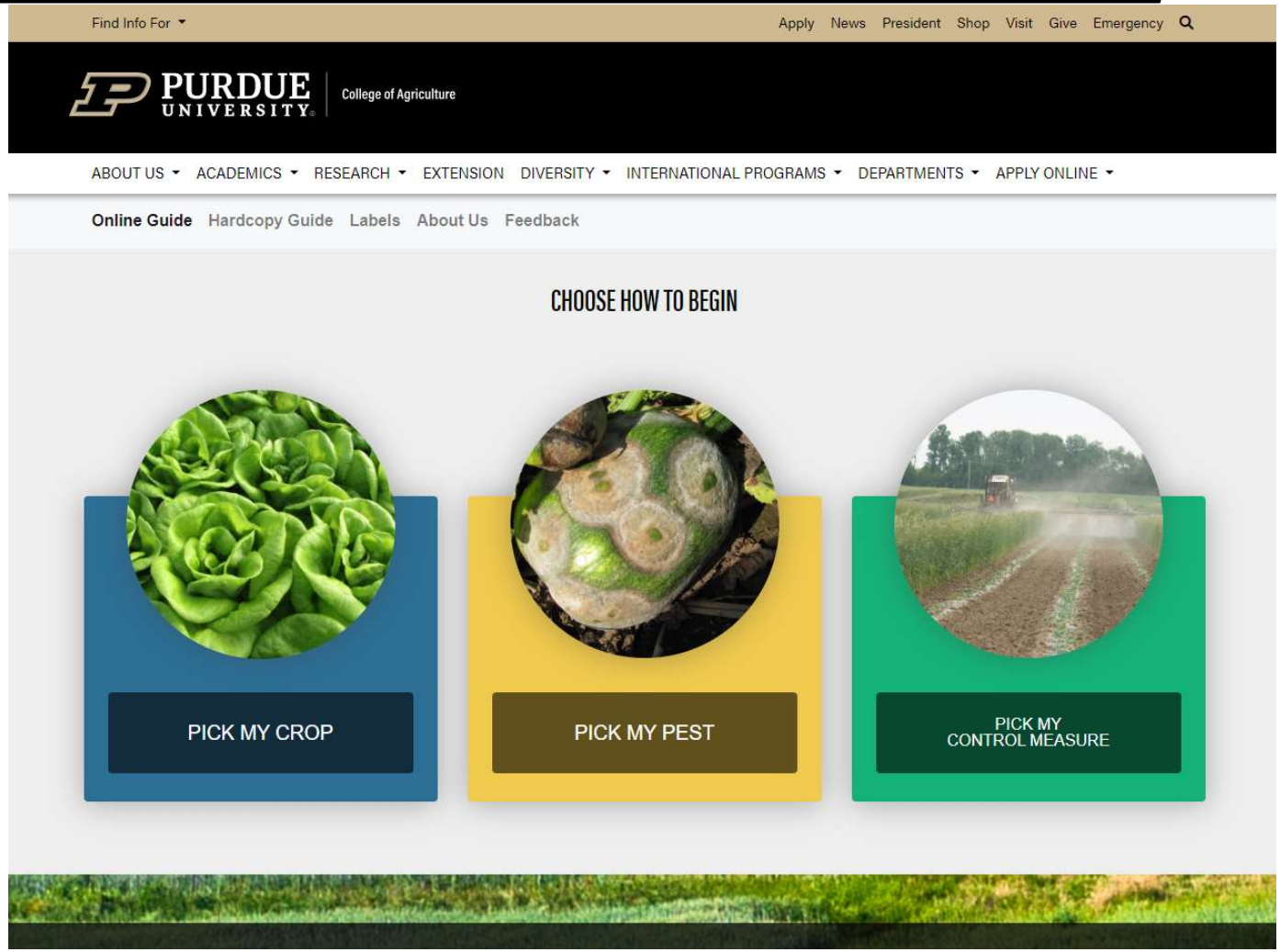


- When applied to low populations in February, all products reduced aphid population increase for 3 weeks.
- Among the products, Sil-MATRIX worked best.
- However…

They need to be reapplied every 3 weeks

Spray information:

Midwest vegetable production guide



Spray information:

Midwest vegetable production guide

TOMATO

Restricted-Entry Interval (REI)

- [ ] 0-hour to 4-hour
- [ ] 5-hour to 12-hour
- [ ] 13-hour to 24-hour
- [ ] 24-hour to 48-hour

Pre-Harvest Interval (PHI)

- [ ] 0-day to 3-day
- [ ] 4-day to 7-day
- [ ] 8-day to 14-day
- [ ] 15-day to 30-day
- [ ] 31-day to 50-day
- [ ] 51-day to 90-day
- [ ] 91-day to 180-day

Other Attributes

- [ ] Non-Restricted Use Pesticides
- [ ] OMRI-listed
- [ ] Greenhouse uses allowed

CONTROLS FOR CATERPILLARS

Pest Information

PESTICIDE

Asana XL (0.66EC) ESFENVALERATE	IRAC 03A
Avaunt (30WDG) INDOXACARB	IRAC 22
Baythroid XL (1EC) BETA-CYFLUTHRIN	IRAC 03A
Brigade 2EC BIFENTHRIN	IRAC 03A
Bt (Bacillus thuringiensis) products for caterpillars	
BACILLUS THURINGIENSIS AIZAWAI STRAIN GC-91	IRAC 11A
BACILLUS THURINGIENSIS KURSTAKI STRAIN ABTS-351	IRAC 11A
BACILLUS THURINGIENSIS AIZAWAI STRAIN ABTS-1857	IRAC 11A
BACILLUS THURINGIENSIS KURSTAKI STRAIN SA-11	IRAC 11A
BACILLUS THURINGIENSIS KURSTAKI STRAIN EVB-113-19	IRAC 11A
Coragen (1.67SC)	

Spray information: CAUTION!

States vary in their definition of high and low tunnels.

Indiana considers a tunnels to be a form of greenhouse.

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When in doubt, follow label for greenhouse application.

Recap:

- Pest pressure may be higher on urban farms, especially in winter. Likely driven by aphids and the lack of natural enemy services.
- Adding plant diversity may help to attract and retain natural enemies on urban farms.
- Biological control, especially when using green lacewings, was effective at managing aphids at most sites.
- Sprays Neemix, Sil-MATRIX, and PyGanic showed efficacy against aphids, but they must be applied early and regularly.
- Plan an IPM program for your farm. Please reach out to Purdue Extension with questions.


6/17/2
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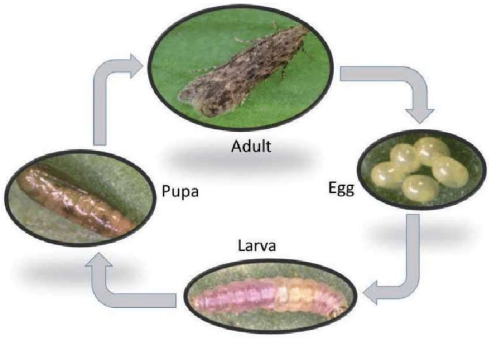
Meet the tomato pinworm

Gelechiidae: *Keiferia lycopersicella*



Gelechiidae: *Tuta absoluta*

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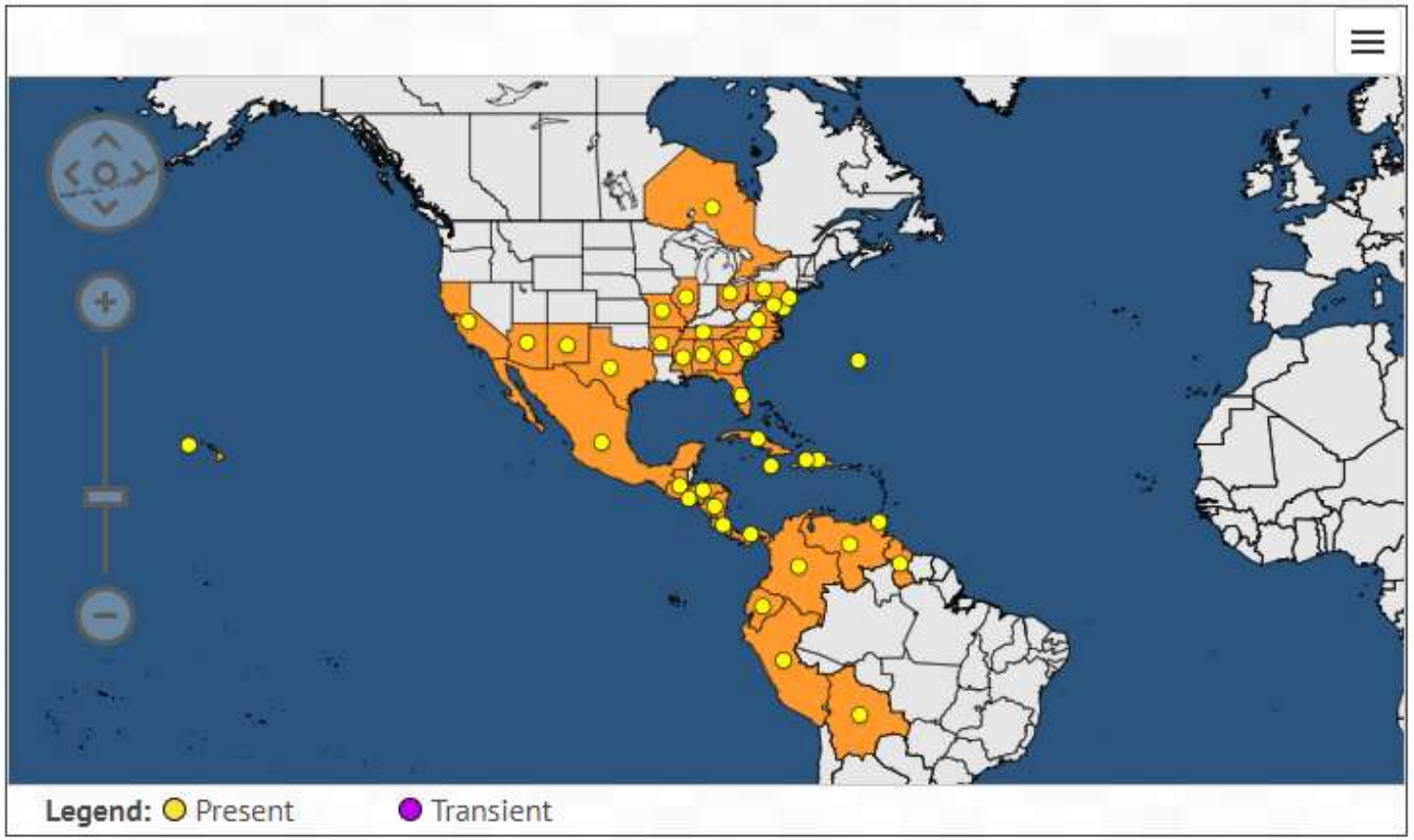
Distribution

Last updated: 2022-10-13



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Tomato Pinworm

Oviposition

- Lay their eggs on leaf surface, next to vein in grooves
- Under high pressure, can be found on underside
- Single egg OR 2-3 in a cluster
- Less than 1 mm
- Elliptical, bright yellow gradually darkening

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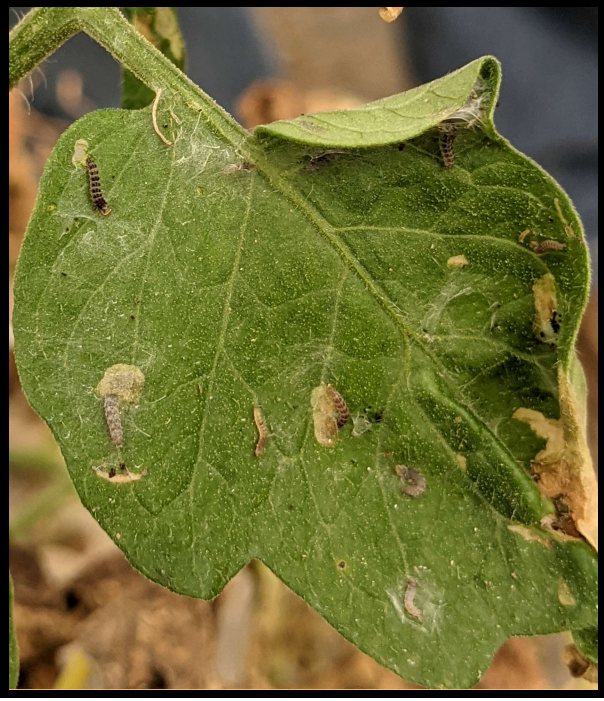
Tomato Pinworm

Larval development

- Head capsule is dark brown
- Body yellowish-grey changing to purple
- Neonates (newly hatched) 0.85 mm in length



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Tomato Pinworm

Larval development

- When reach 3rd instar, leave the mine
- Fold the tip of the leaf or join two leaves to create a space for next two instars
- 4th instar (last caterpillar) 5.8 – 7.9 mm

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Tomato Pinworm

Pupae

- Pupate in the soil OR in a rolled leaf
- Pupal case is made of frass and silk
- In the soil, incorporate soil particles
- 6-7 days until adult emergence

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Pupation on the leaves

Tomato Pinworm

Adults

- Brownish-grey moth 5 mm long
- Wing spread 9-12 mm
- Adults are nocturnal
- Initiate flight and oviposition at dusk
- Lay eggs when temperature 15.5 °C (60 °F) or higher
- Moths rest in shaded areas of plant during the day
- Single female deposits 50-200 eggs

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Host Range

Crops

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Host Range

Weeds

Carolina nightshade

Bittersweet nightshade

Silverleaf nightshade

American black nightshade

Tropical soda apple

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Lower development threshold 11 ºC (51.8 ºF), below 10 ºC (50 ºF) prohibits survival

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Temperature on high tunnel farms

Measured air and soil temperature

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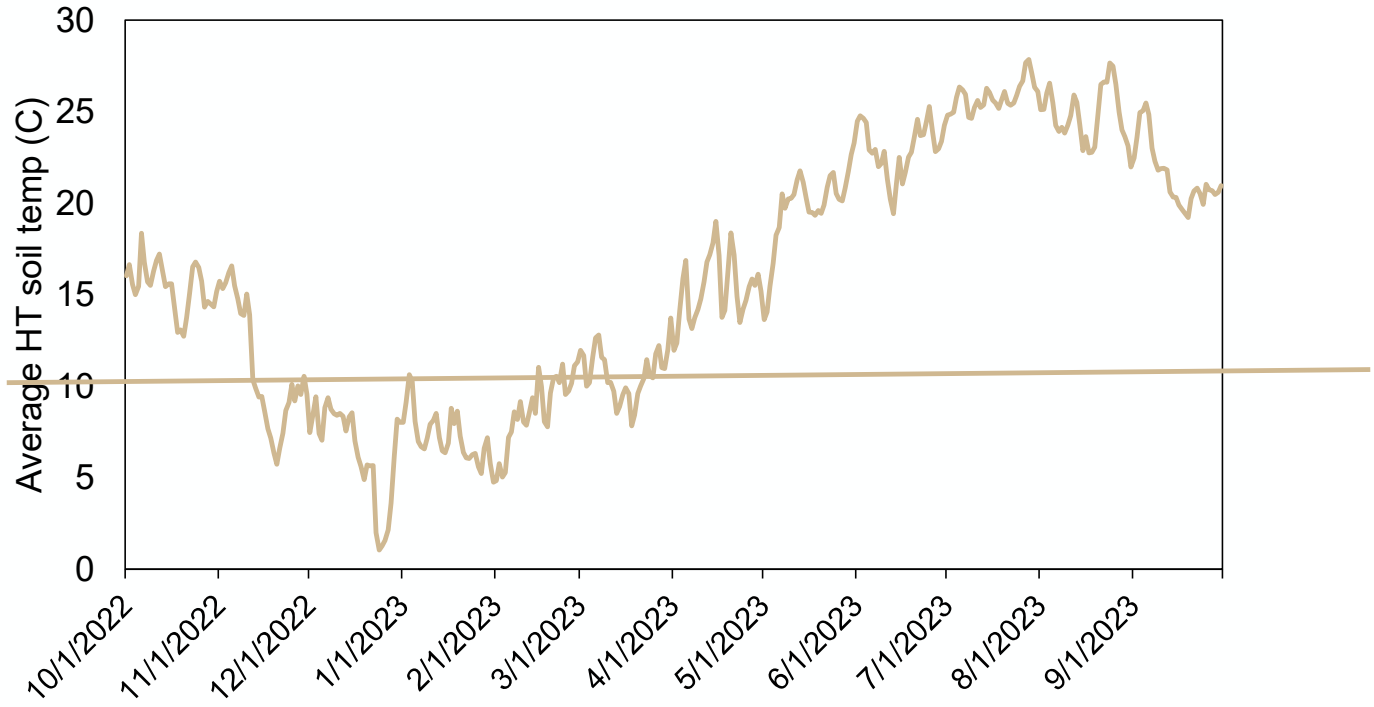
Temperature on high tunnel farms

Soil temp for TPW: farms combined



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Management

Sanitation

- If using transplants, be cautious!
- Packing and shipping containers should be free of soil
- Inspect transplants to be free of mines or pinholes
- Destroy crop residues

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Management

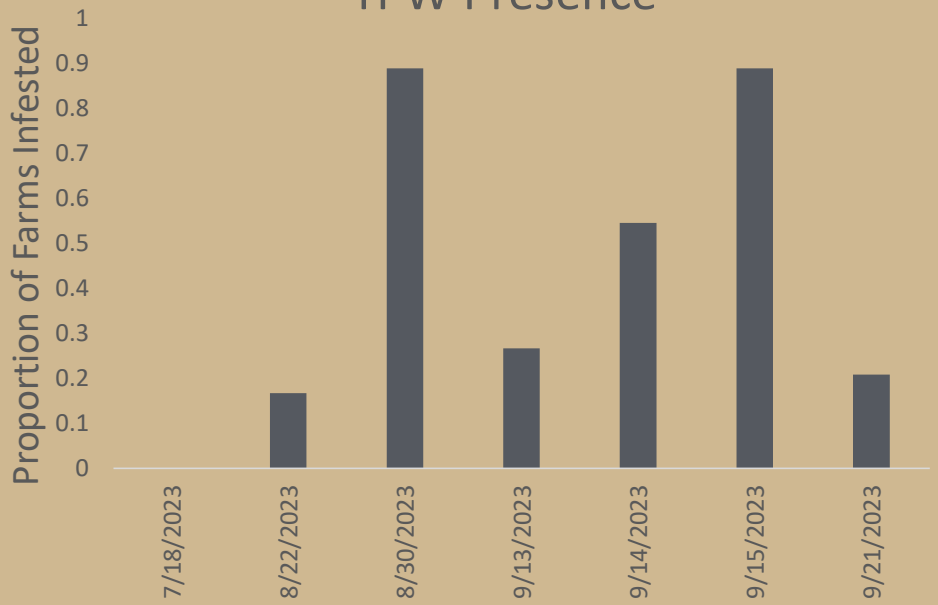
Monitoring and Mating Disruption

- Pheromone lures placed inside wing-style traps
- Lure smells like female moth, attract males
- Monitor population, detect peak mating flights

SCENTRY TOMATO PINWORM KIT, 4 STATION

A complete insect monitoring kit with traps, pheromone lures and extra liners. Any unused lures may be stored in the freezer and used the following season.

- Disruption: overwhelm the area with the scent of females, making it hard for males to find them



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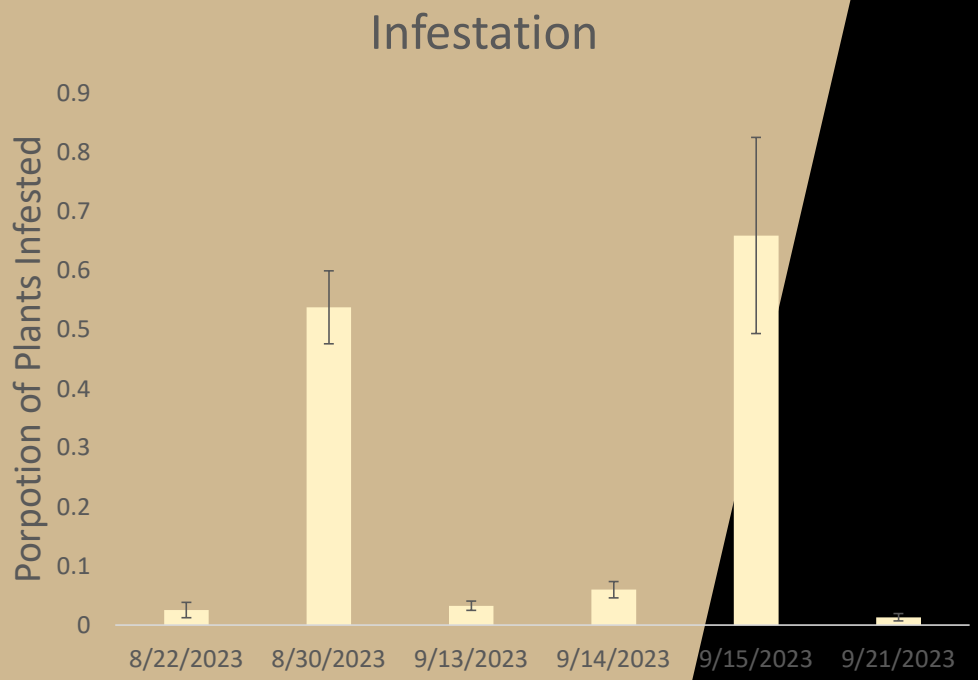

Management

Organic pesticide options

- Product needs to be consumed by the insect
- Short window of exposure
  - Egg hatches and chews into mine
  - 3rd instar exits mine, rolls the leaf
- Bt, Spinosad, pyrethrin

THANK YOU!

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High tunnel production website

USDA National Institute of Food and Agriculture
U.S. DEPARTMENT OF AGRICULTURE

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