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

Key winter pests on high tunnel spinach and effective options for management

HIGH TUNNEL PRODUCTION RESOURCES

BACKGROUND INFORMATION

- High tunnels, and other forms of protected culture, are rising in popularity (Janke et al. 2017), especially on **urban farms** where space is limited (Shoaf and Ingwell, 2021).
- Higher pest pressure and management is a major barrier in this production system (Ingwell et al. 2017).
- Little research has focused on the shoulder seasons (spring and fall) and during the winter.

OBJECTIVE 1

Describe biotic trends in winter high tunnels on farms along the rural-urban landscape gradient

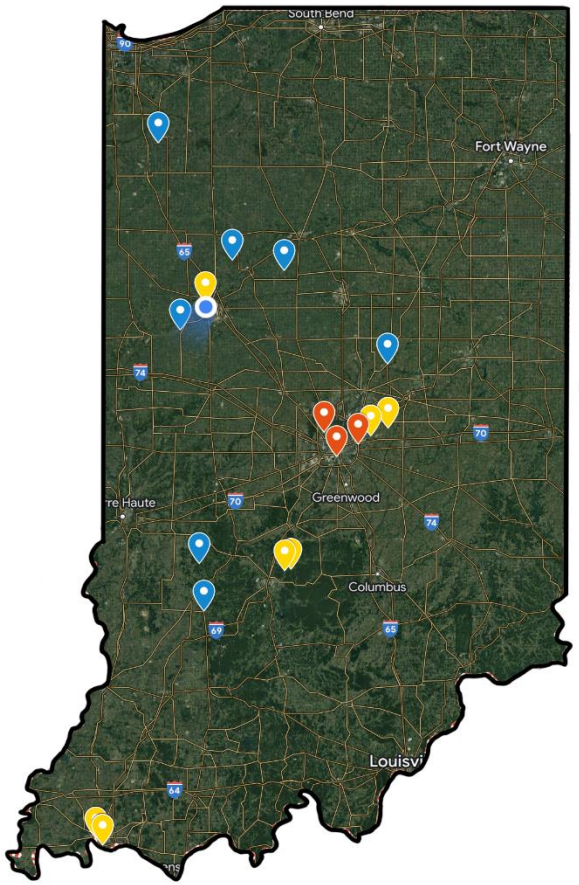
Multi-state grower survey: Dec 2022 – Mar 2023

Dr. Sam Willden

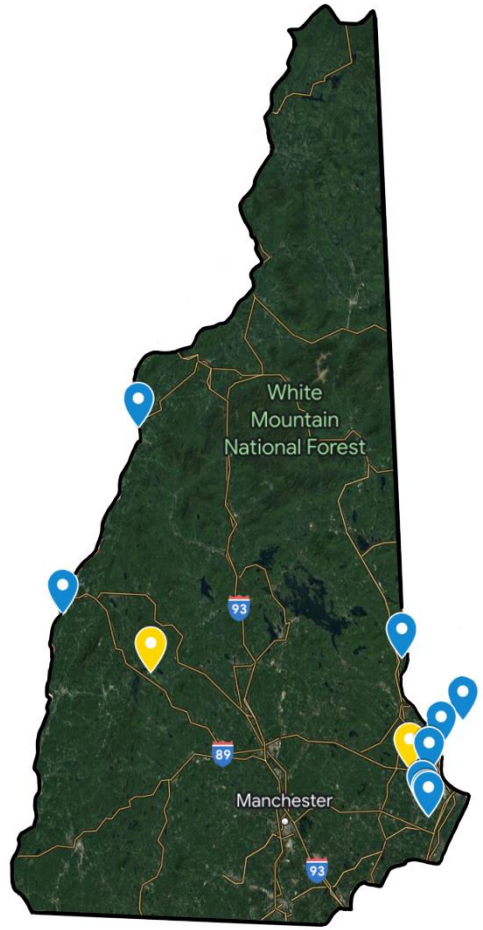
Garima Kohli

Dr. Anna Wallingford

Illinois



Indiana



New England

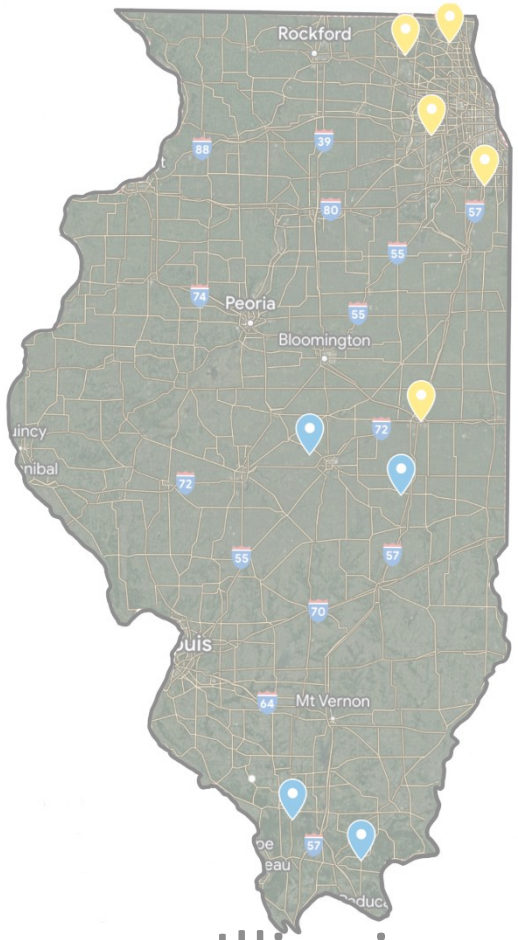
Map legend: Urban Suburban Rural

Multi-state grower survey: Dec 2022 – Mar 2023

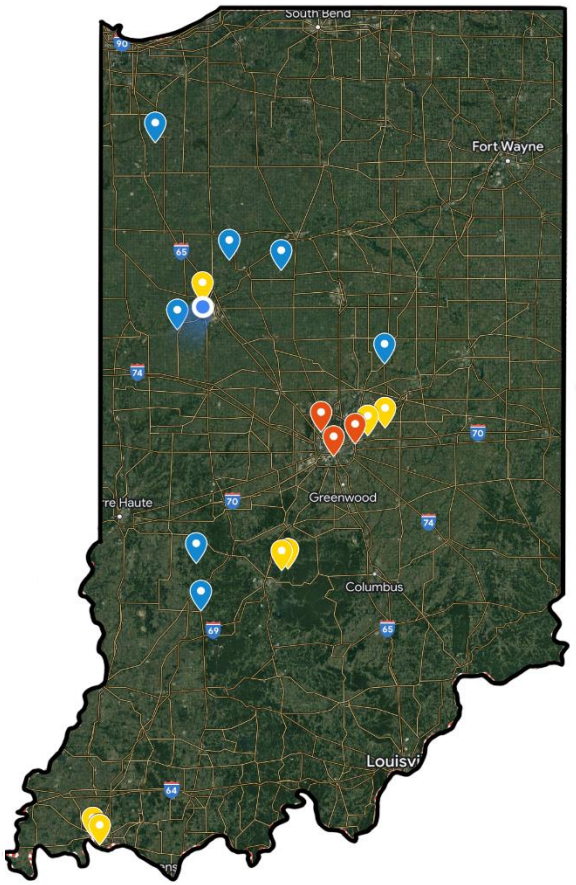
Dr. Sam Willden

Garima Kohli

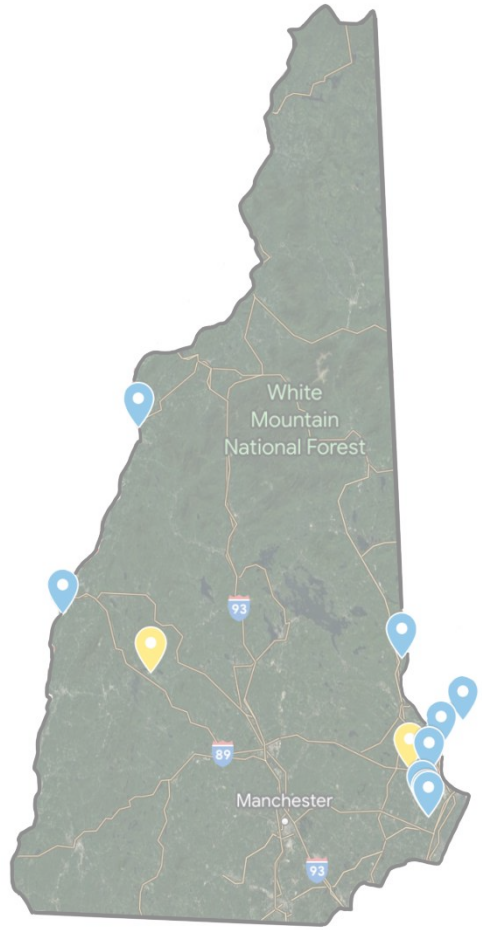
Dr. Anna Wallingford



Illinois



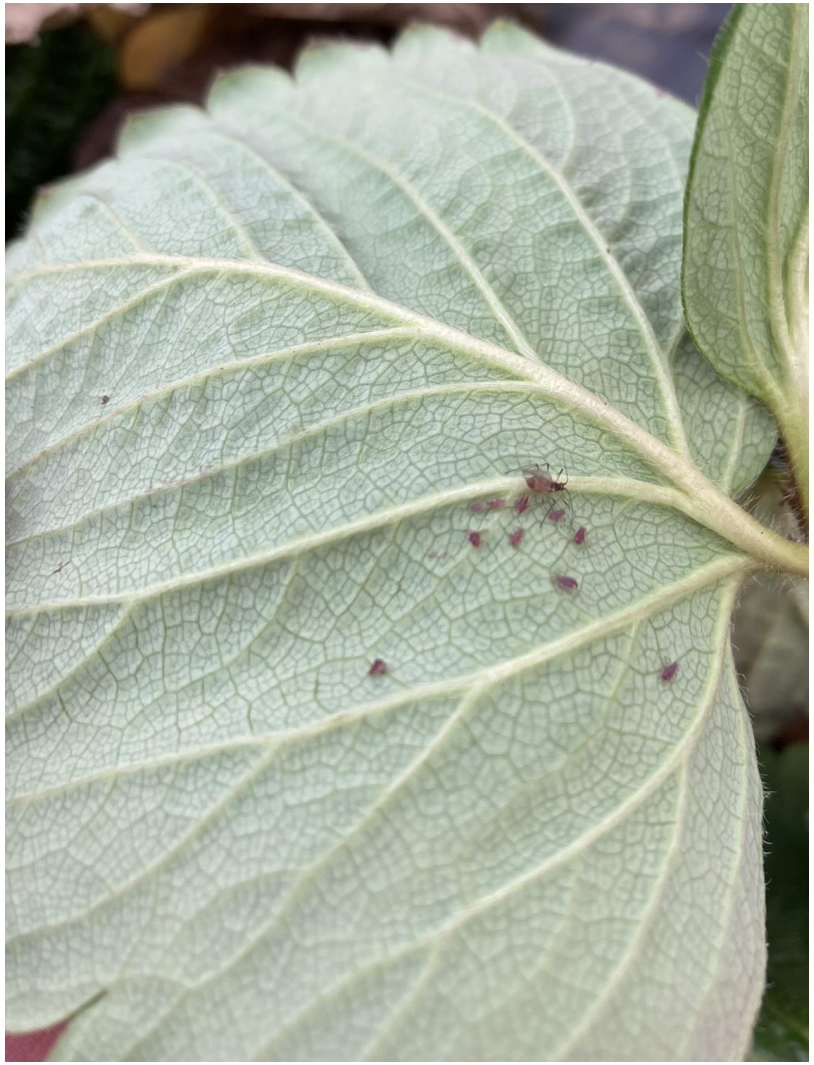
Indiana



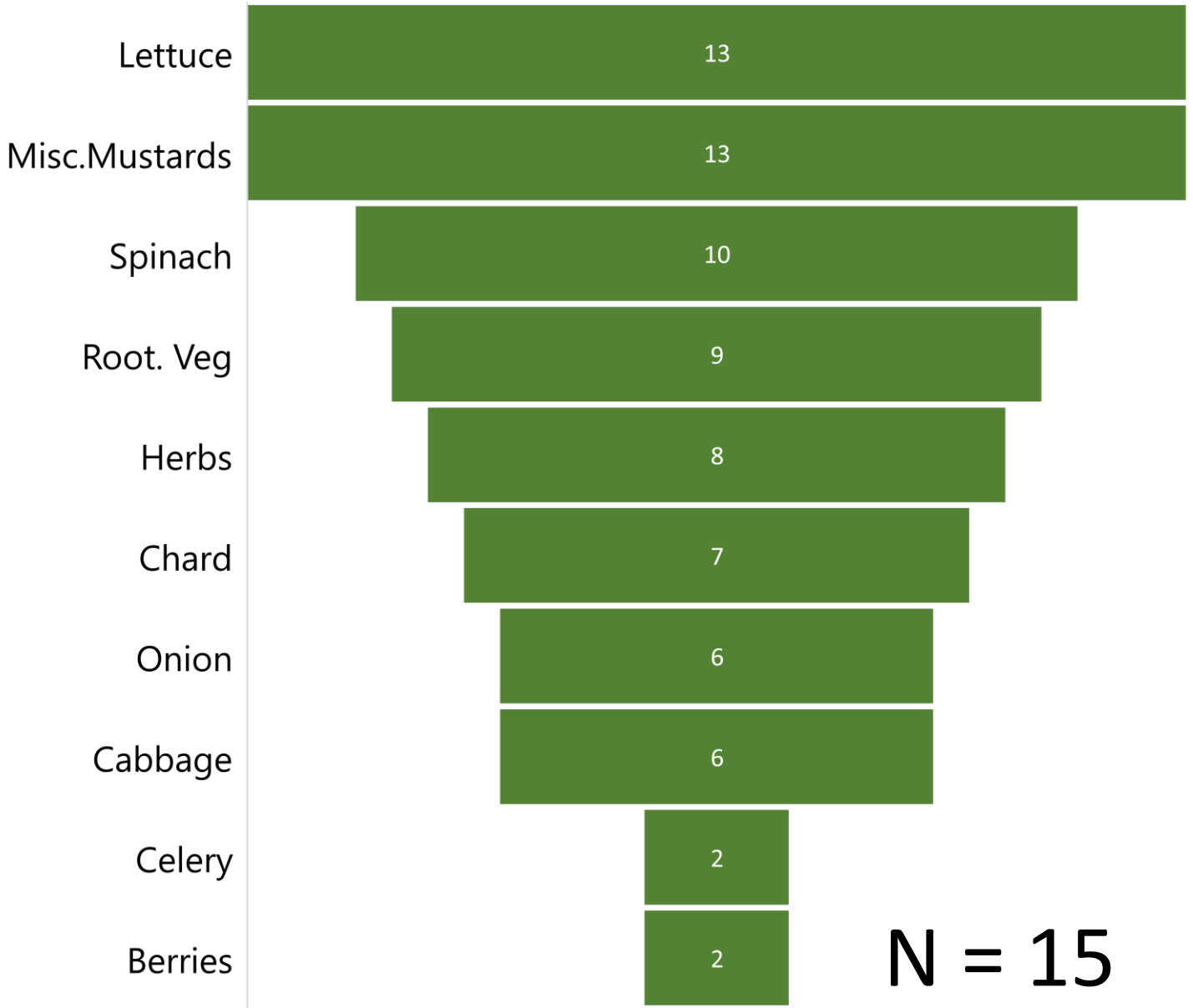
New England

Map legend: Urban Suburban Rural

In-situ crop counts and inspections



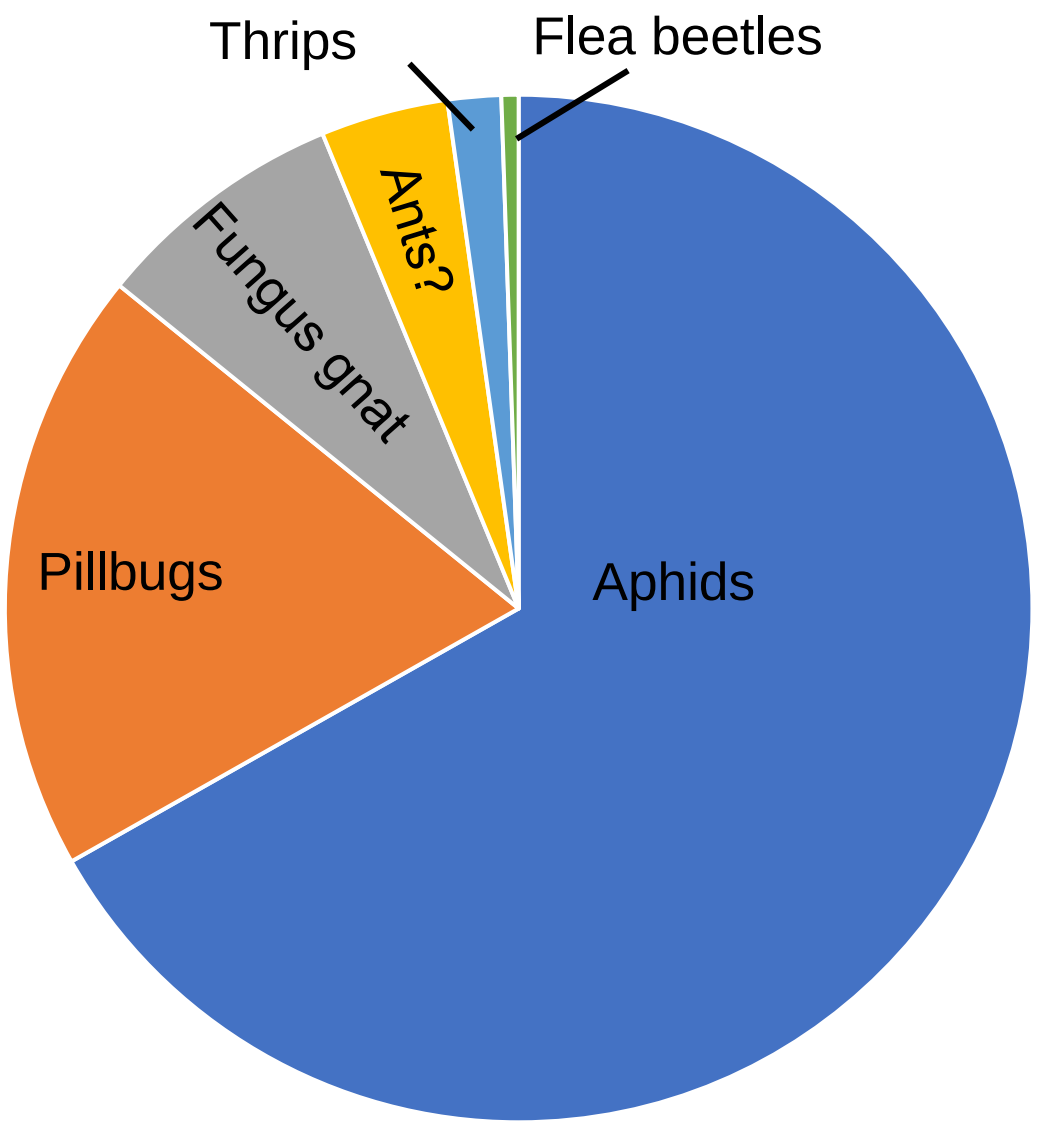
Primary winter crops in Indiana



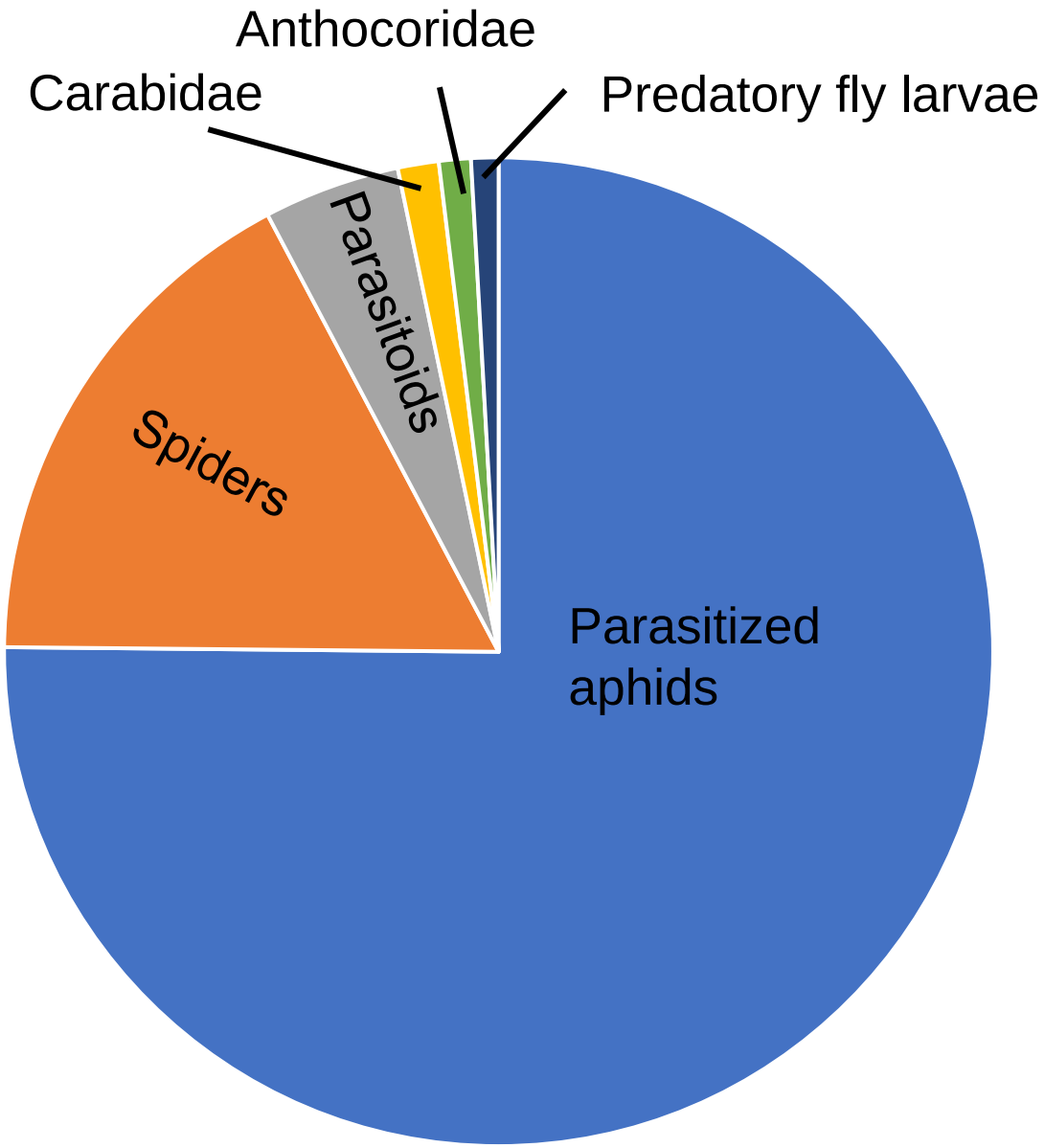
N = 15

Primary insect pests:

Primary insect pests: **aphids** and pillbugs



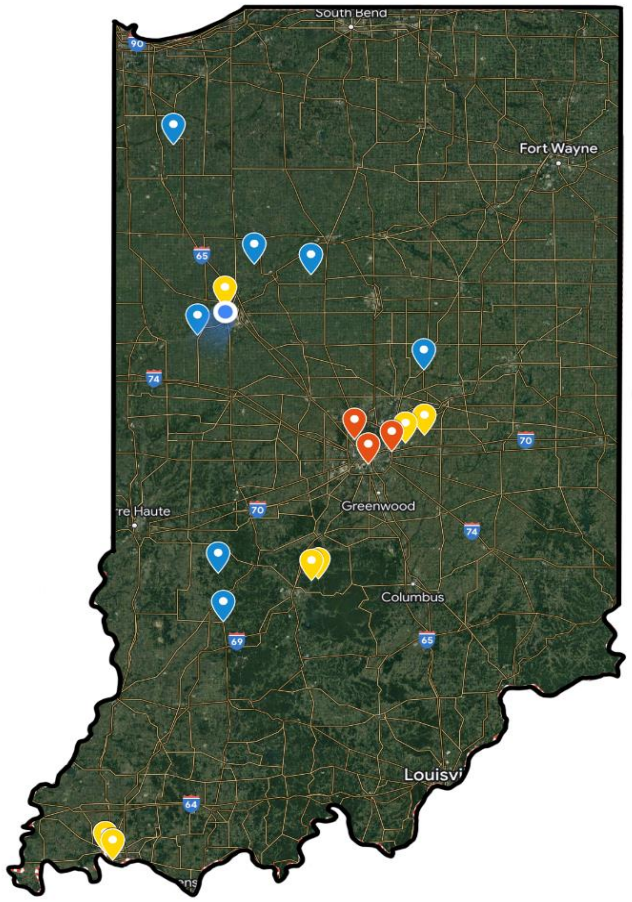
Primary natural enemies: **aphid parasitoids** and spiders



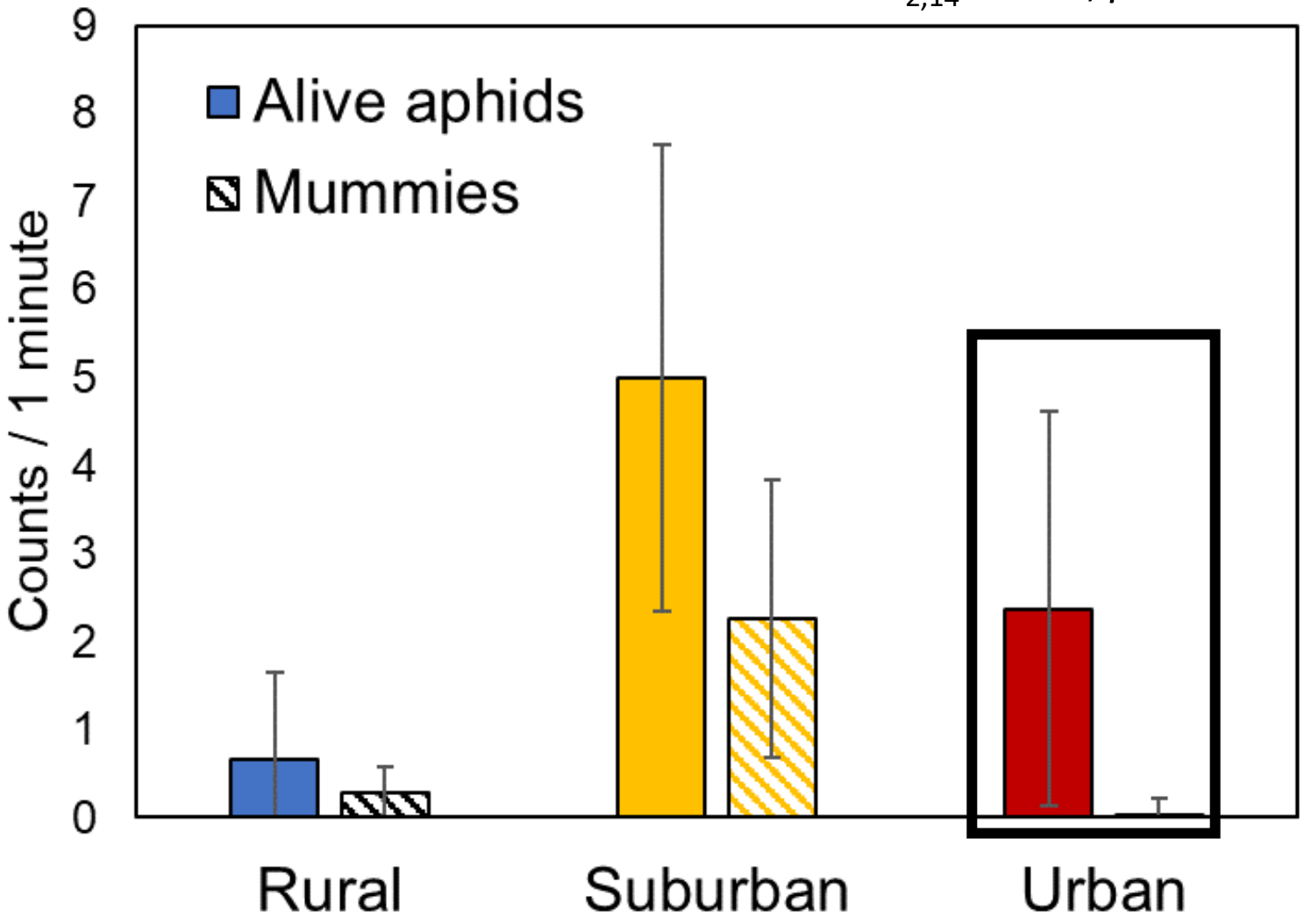
Aphids/parasitoids across landscapes:

Aphids: $F_{2,14} = 0.19$, $p = 0.22$

Mummies: $F_{2,14} = 1.09$, $p = 0.36$



Urban Suburban Rural



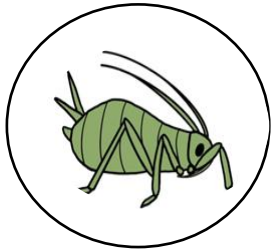
OBJECTIVE 2:

Develop a management plan for aphids on winter crops.

What combination of biocontrol agents and Organic sprays are most effective?

Winter management of aphids: lab bioassay

Biocontrol agents:



Macrosiphum euphorbiae, N=20

Adalia bipunctata, N=10

Chrysoperla carnea, N=10

Orius insidiosus, N=10

Biorational pesticide:

Water control

PyGanic*

Neemix

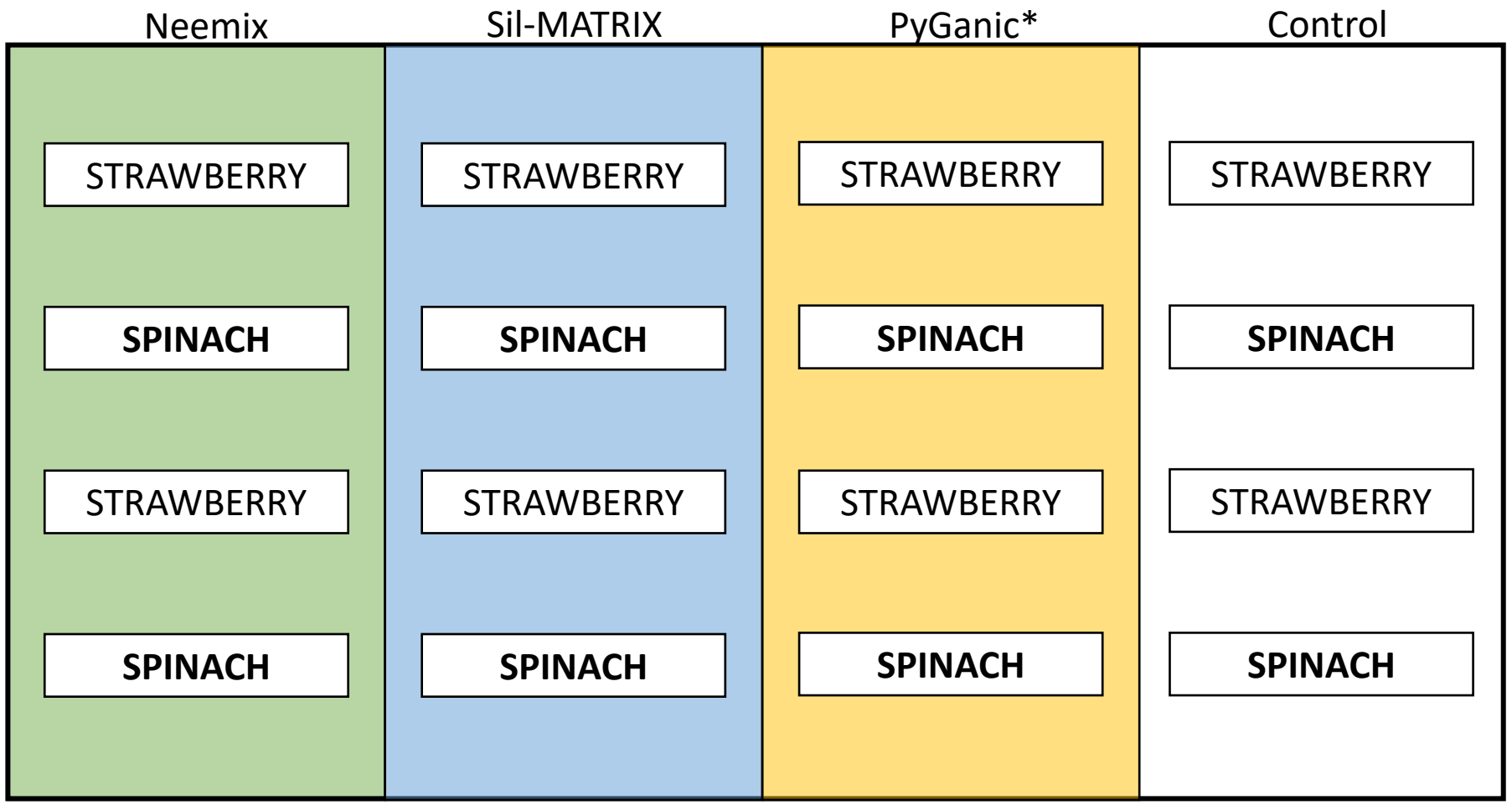
Sil-MATRIX

Lab bioassay: 11L:13D, 10C, 70% RH

Winter management of aphids: field trial

Winter management of aphids: field trial

Split-split plot design. Each subplot was 3 X 10 ft with 12 spinach plants. Row covers deployed.



Winter management of aphids: field trial

Split-split plot design. Each subplot was 3 X 10 ft with 12 spinach plants. Row covers deployed.

Each subplot was inoculated with 15 *Macrosiphum euphorbiae* adults

Neemix	Sil-MATRIX	PyGanic*	Control
STRAWBERRY	STRAWBERRY	STRAWBERRY	STRAWBERRY
SPINACH	**SPINACH**	**SPINACH**	**SPINACH**
STRAWBERRY	STRAWBERRY	STRAWBERRY	STRAWBERRY
SPINACH	**SPINACH**	**SPINACH**	**SPINACH**

Winter management of aphids: field trial

NA

No release, N=3

Orius insidiosus, N=3

Adalia bipunctata, N=3

Chrysoperla carnea, N=3

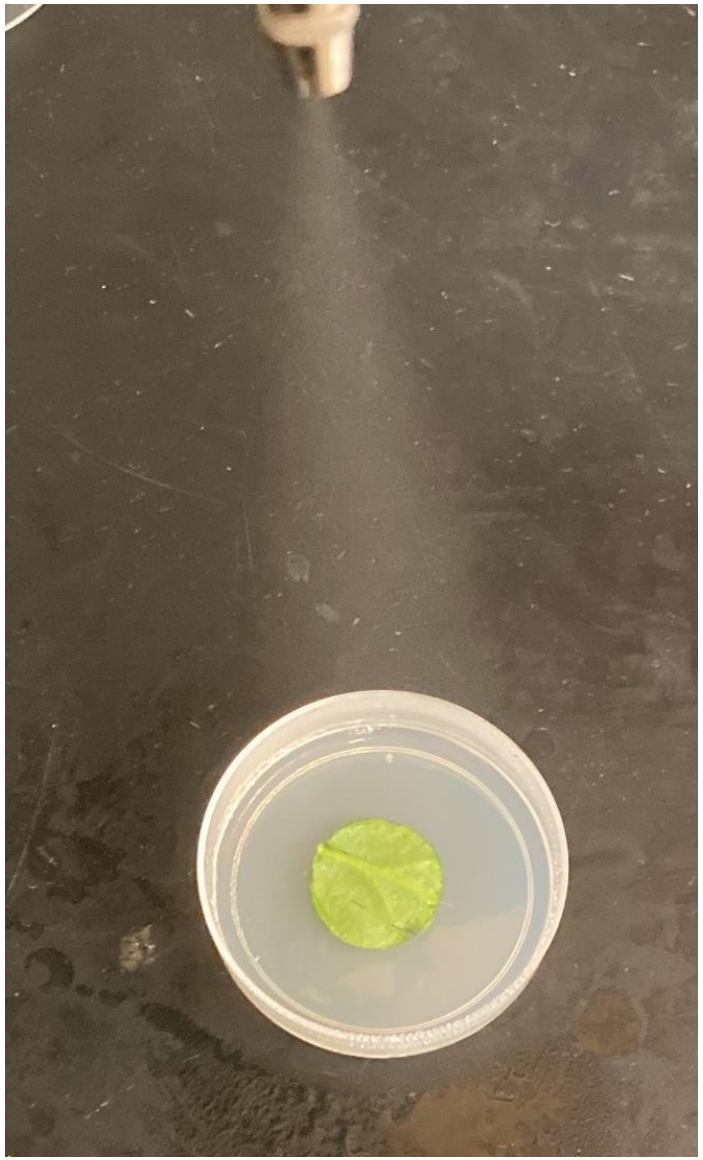
Split-split plot design. Each subplot was 3 X 10 ft with 12 spinach plants. Row covers deployed.

Neemix	Sil-MATRIX	PyGanic*	Control
STRAWBERRY	STRAWBERRY	STRAWBERRY	STRAWBERRY
SPINACH	**SPINACH**	**SPINACH**	**SPINACH**
STRAWBERRY	STRAWBERRY	STRAWBERRY	STRAWBERRY
SPINACH	**SPINACH**	**SPINACH**	**SPINACH**

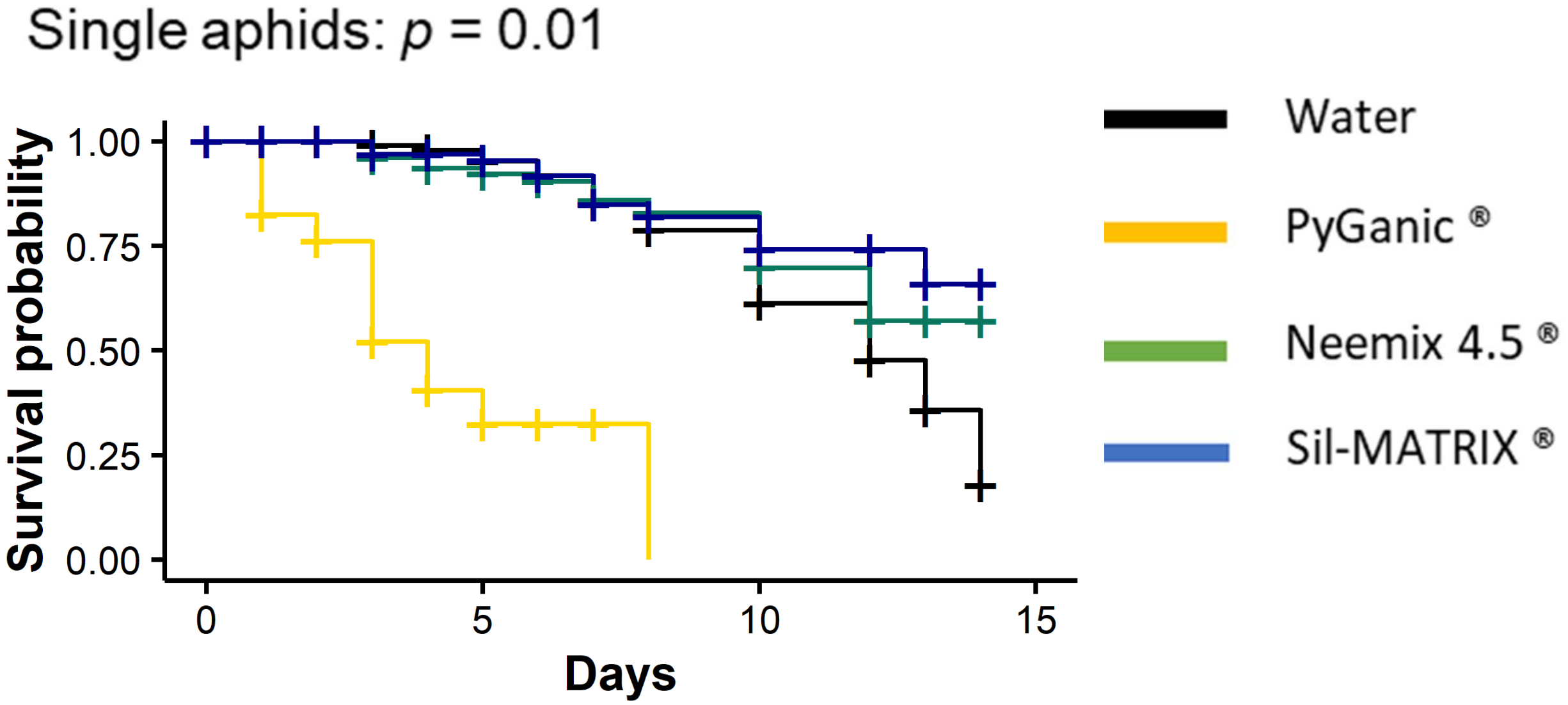
Biocontrol release information:

Agent	Product	Source	Release per tunnel (380ft^2)	Cost per tunnel
Adalia bipunctata	Adalia system	BioBest®	400 larvae	$ 135.96
Chrysoperla carnea	BioCarnea cylinders of larvae and egg tabs	BioBee®	2,000 larvae 16,000 eggs	$ 82.80 for larvae $ 41.40 for egg tabs
Orius insidiosus	BioOrius bottles	BioBee®	2,000 adults	$ 93.48
Control	NA	NA	NA	NA

Results: lab bioassay

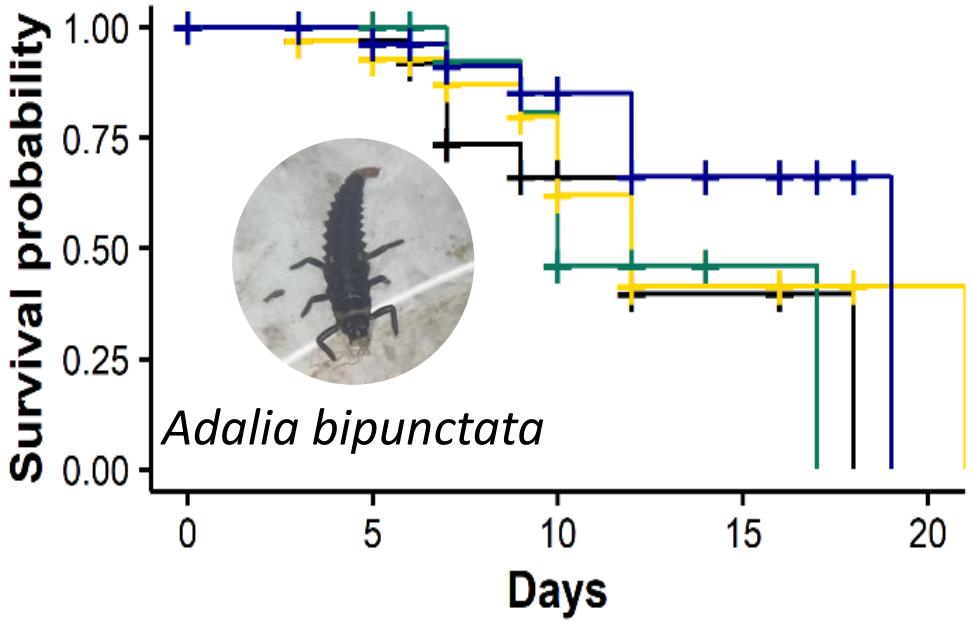


Spray impacts on aphids: lab bioassay



Spray and biocontrol compatibility:

Spray and biocontrol compatibility:



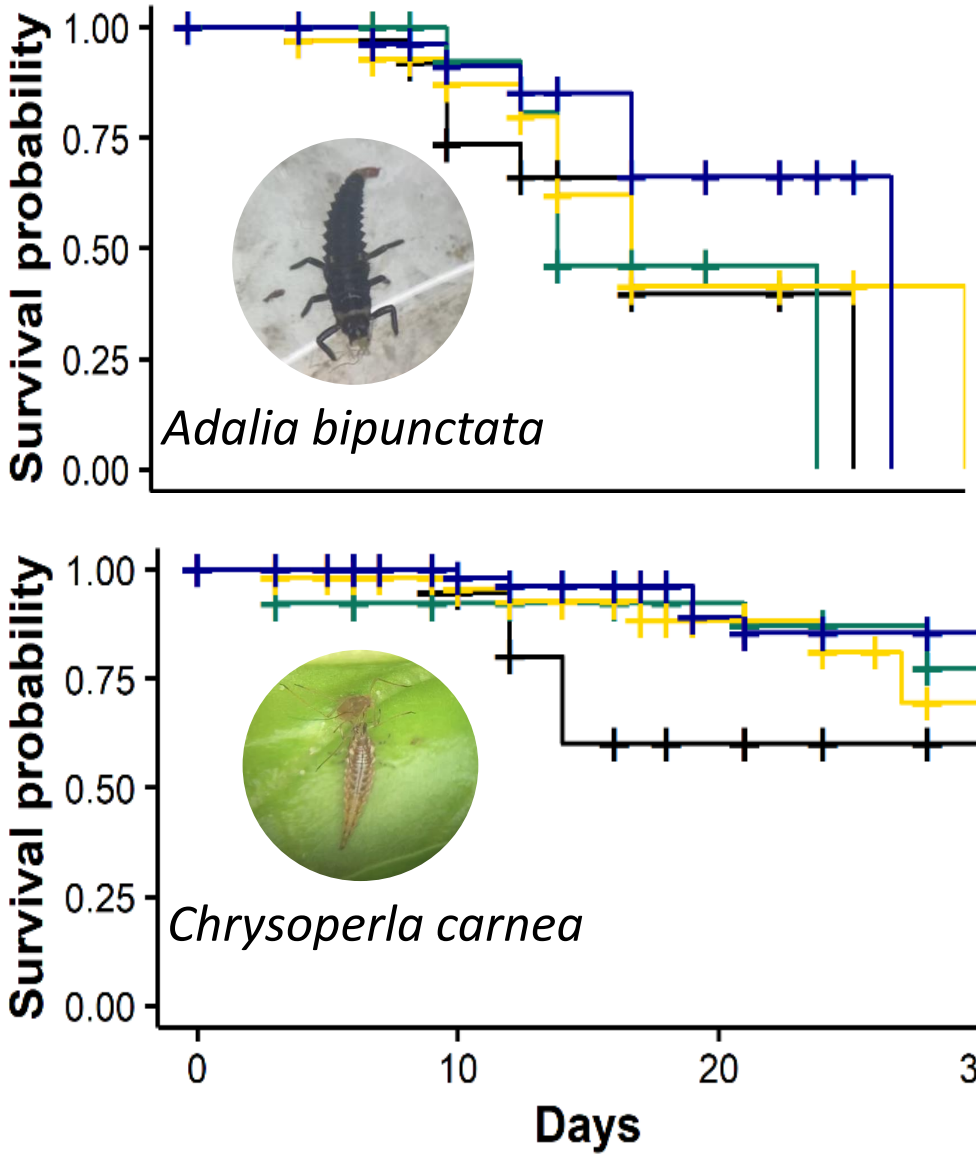
Water

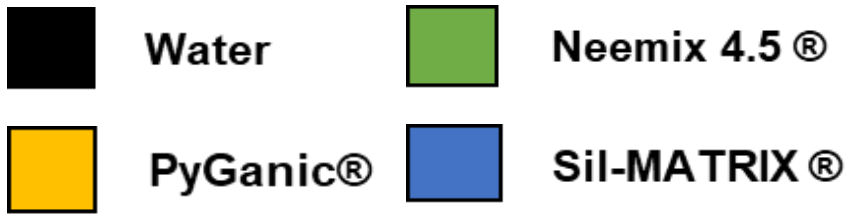
Neemix 4.5 ®

PyGanic®

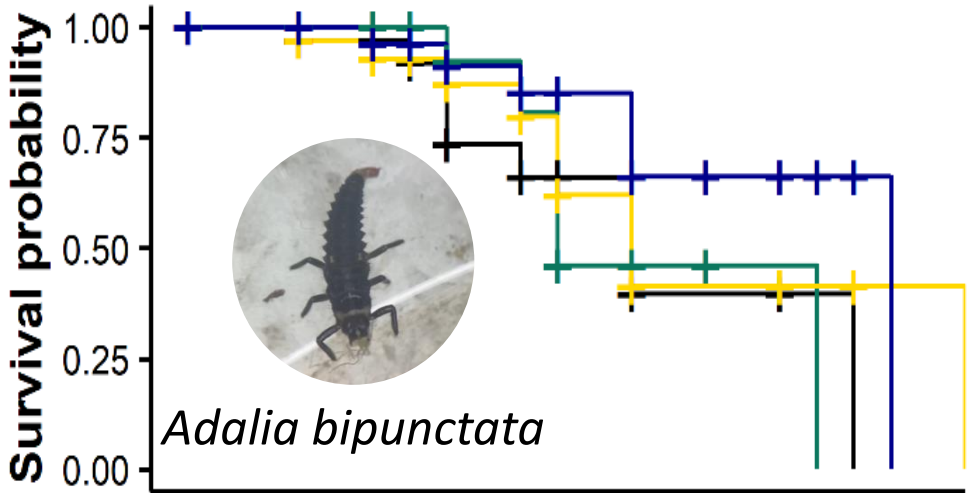
Sil-MATRIX ®

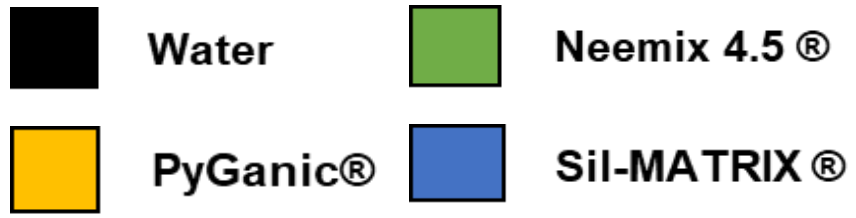
Spray and biocontrol compatibility:

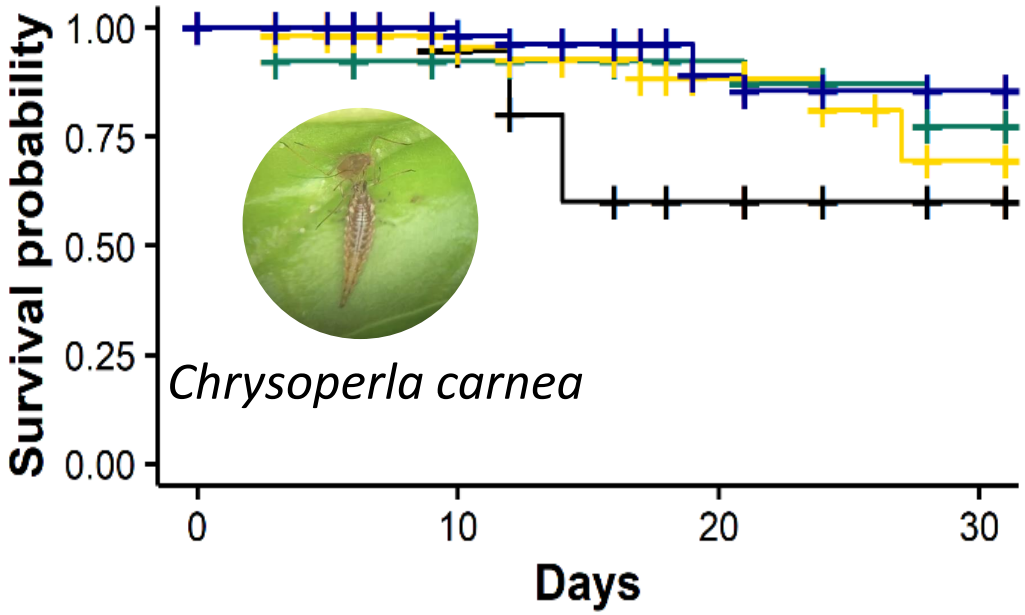


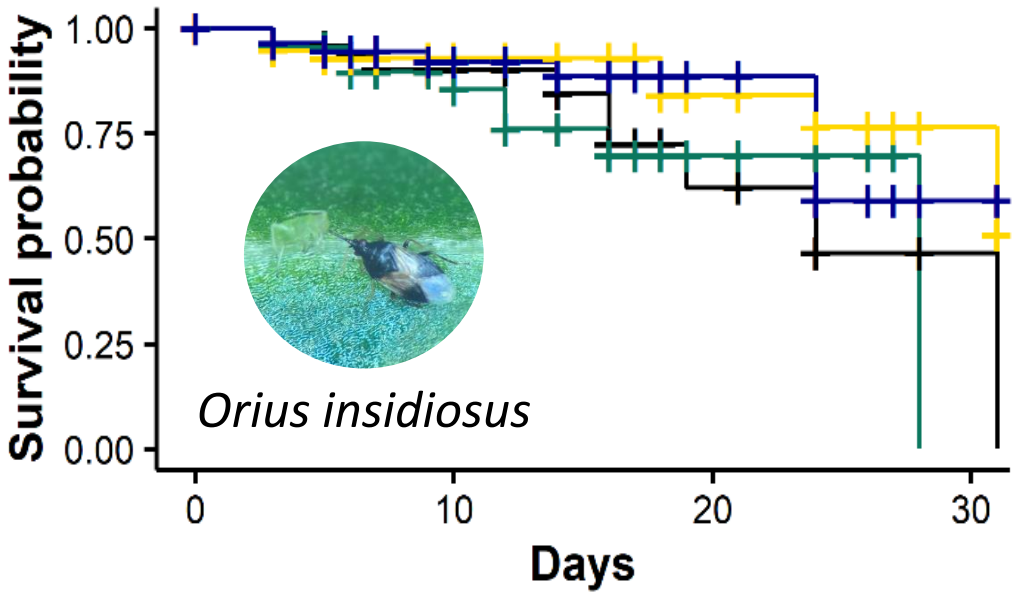


Spray and biocontrol compatibility:



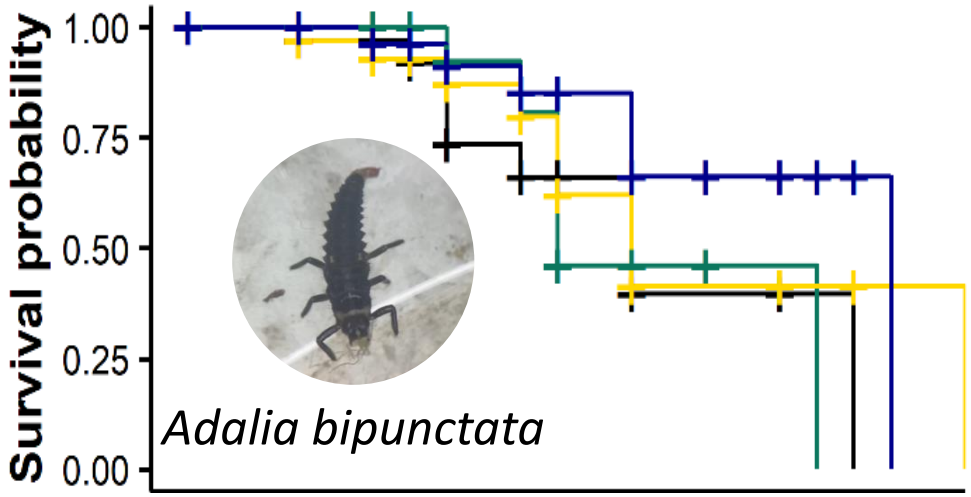


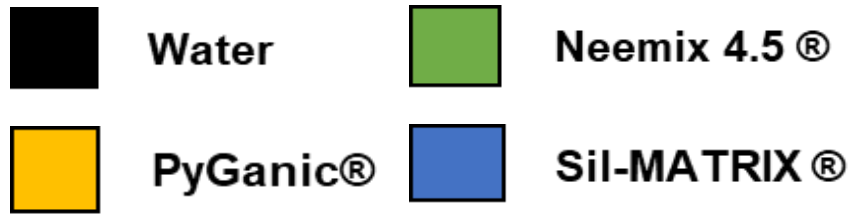


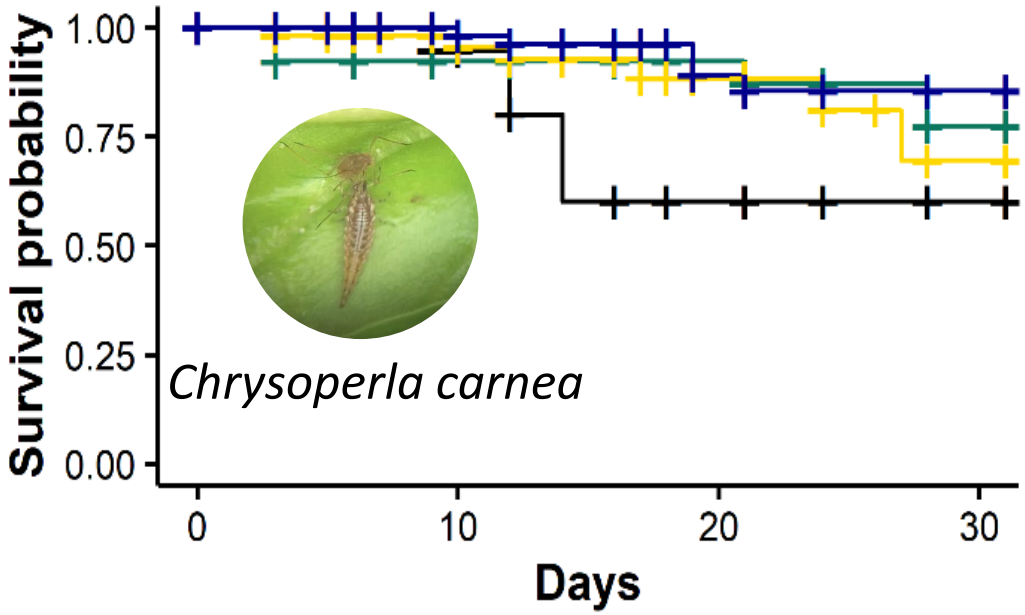


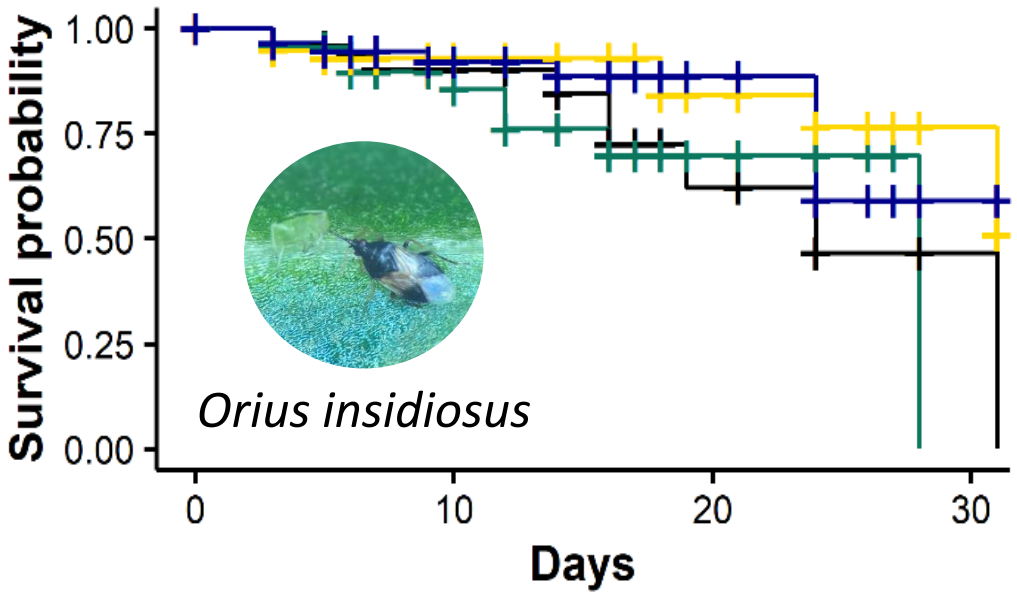
Spray and biocontrol compatibility:

Little impact of spray on predator survival



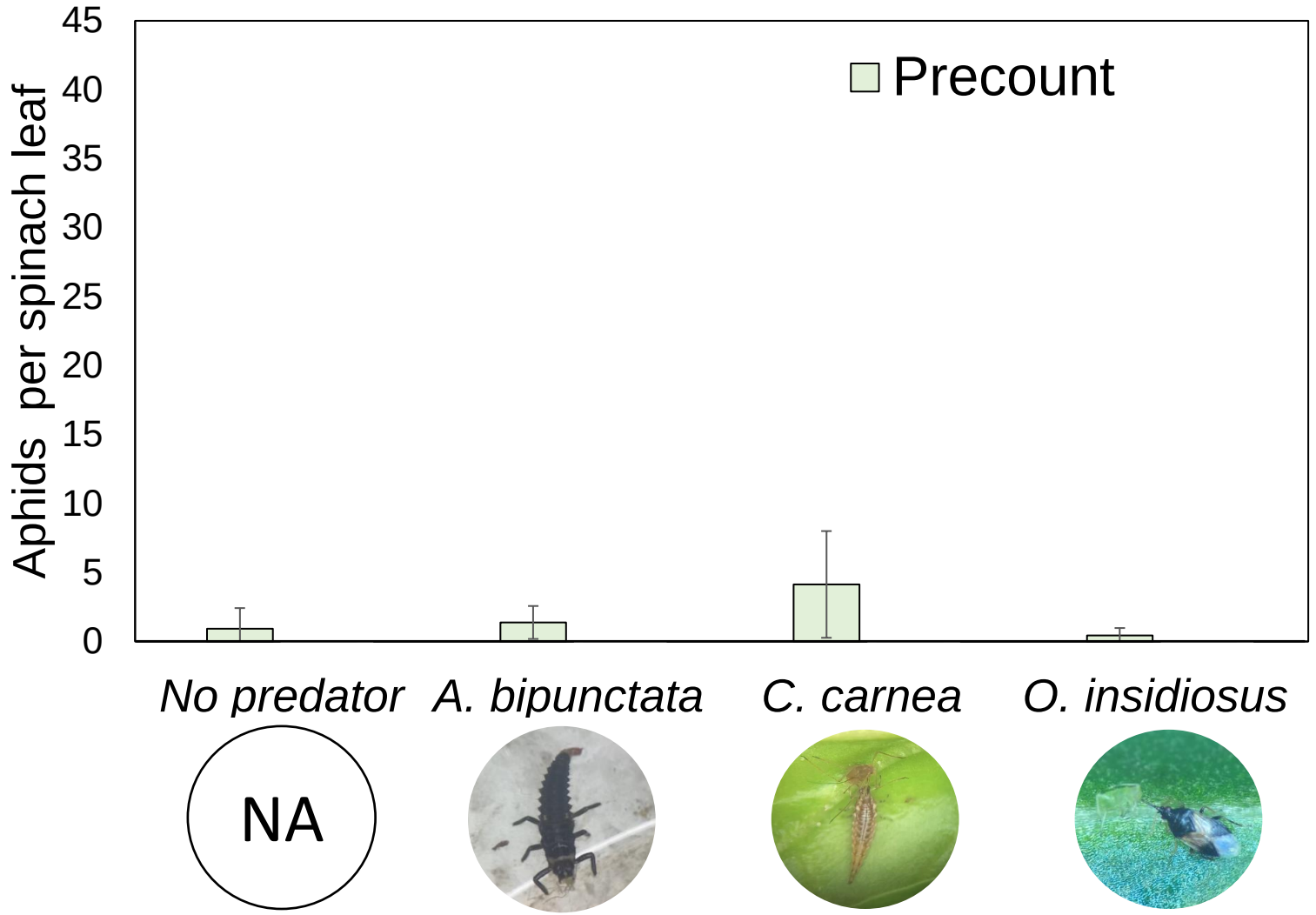




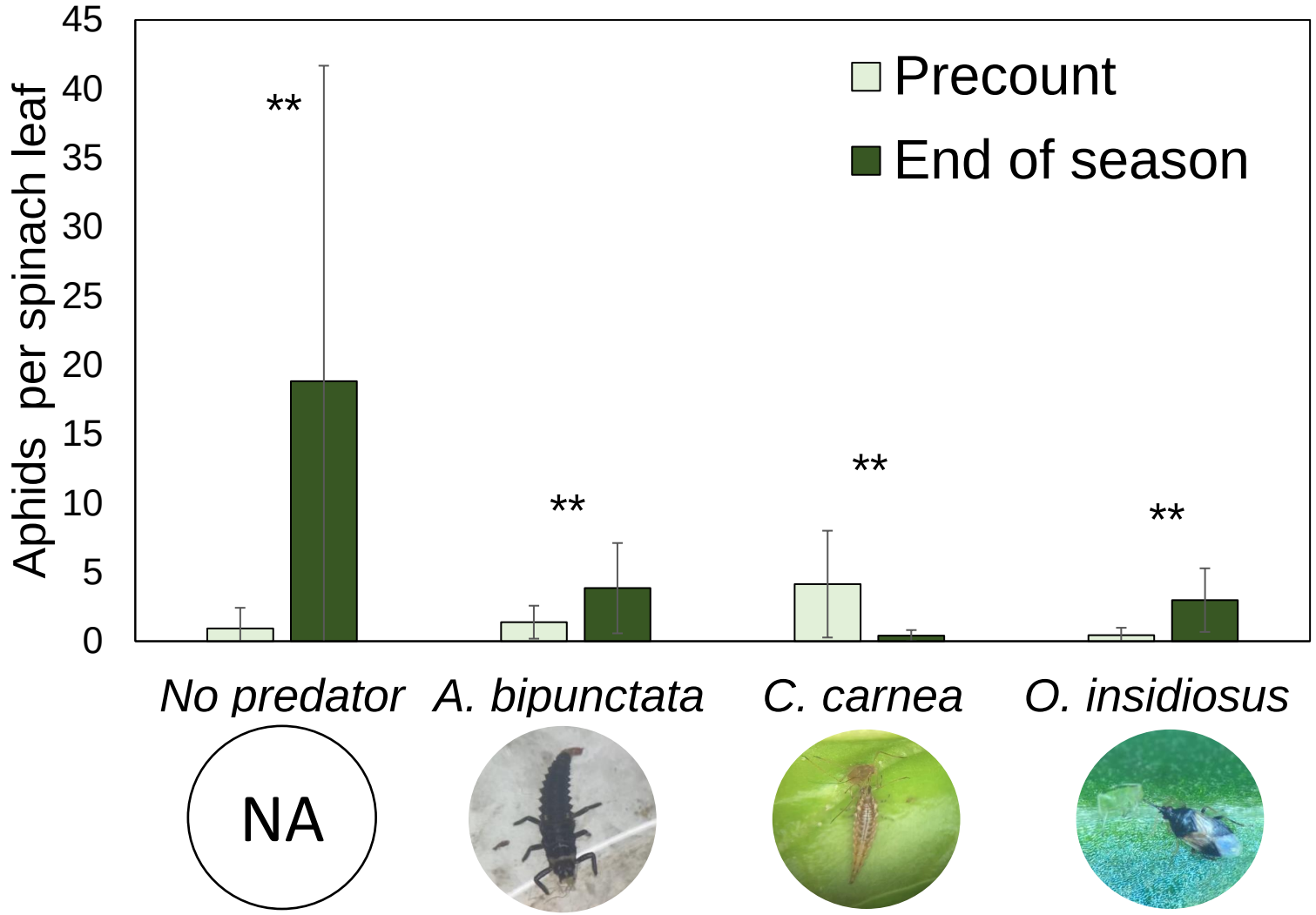


Winter management of aphids: field trial

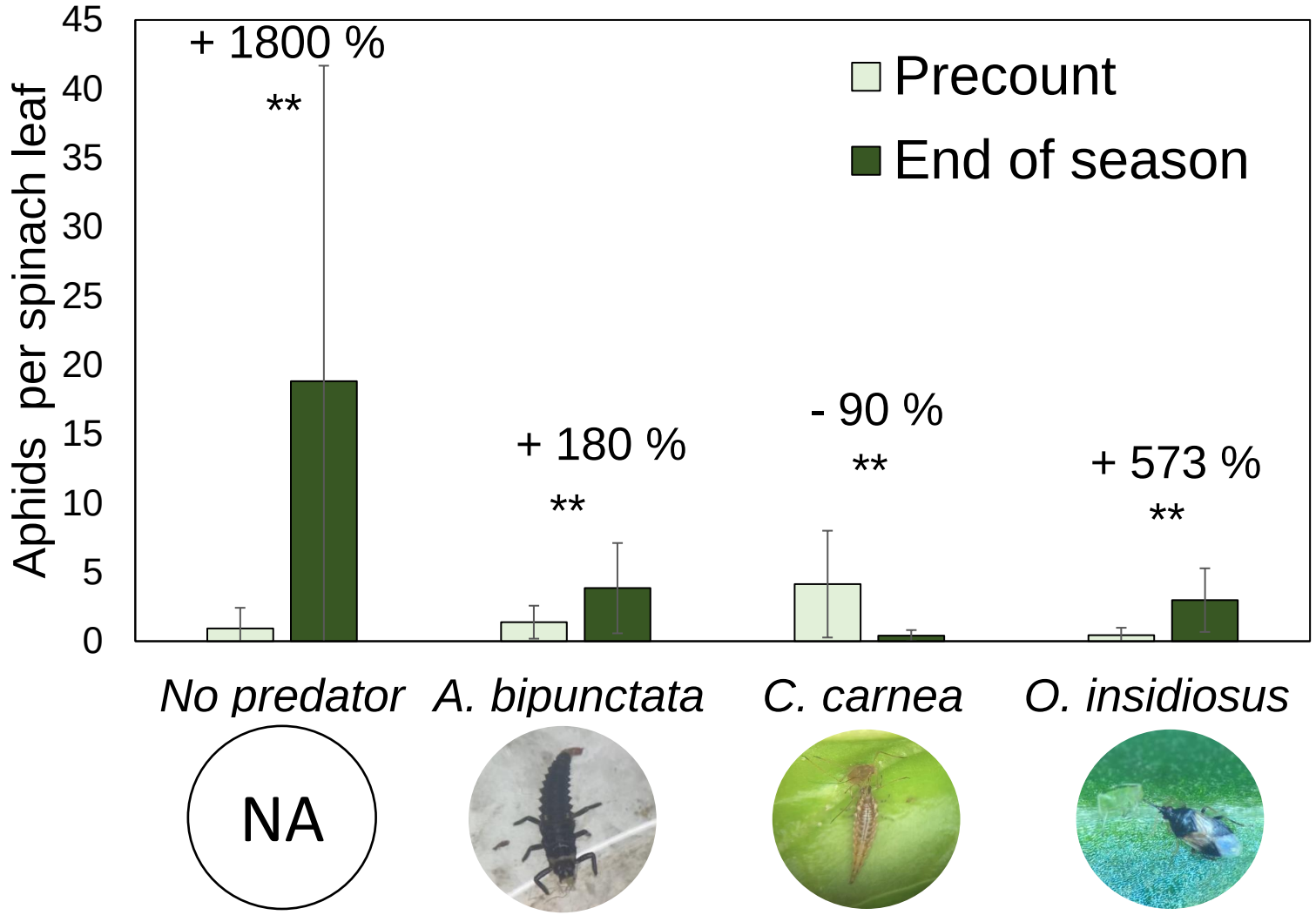
Winter management of aphids: field trial precount vs. end of season



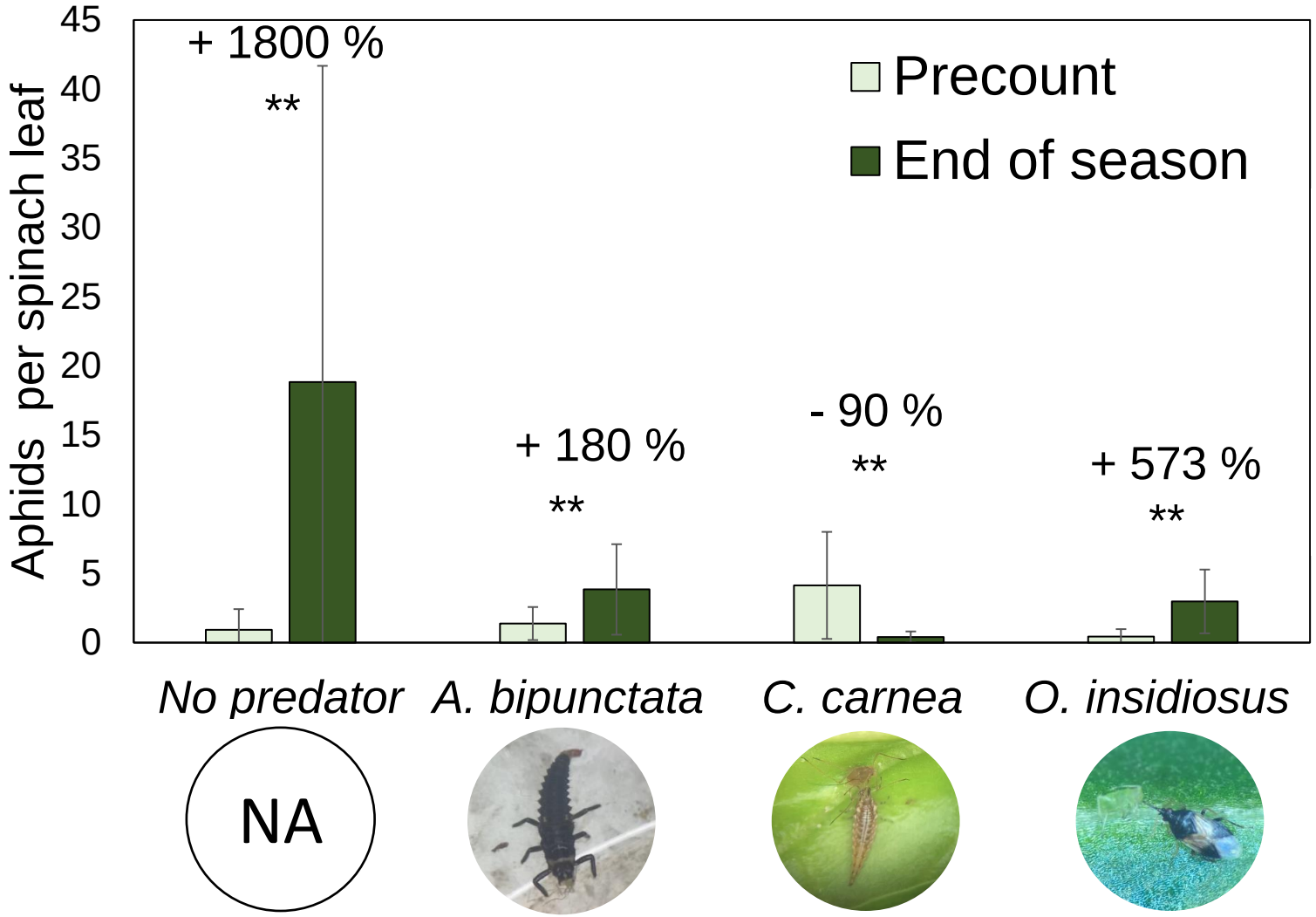
Winter management of aphids: field trial precount vs. end of season



Winter management of aphids: field trial precount vs. end of season



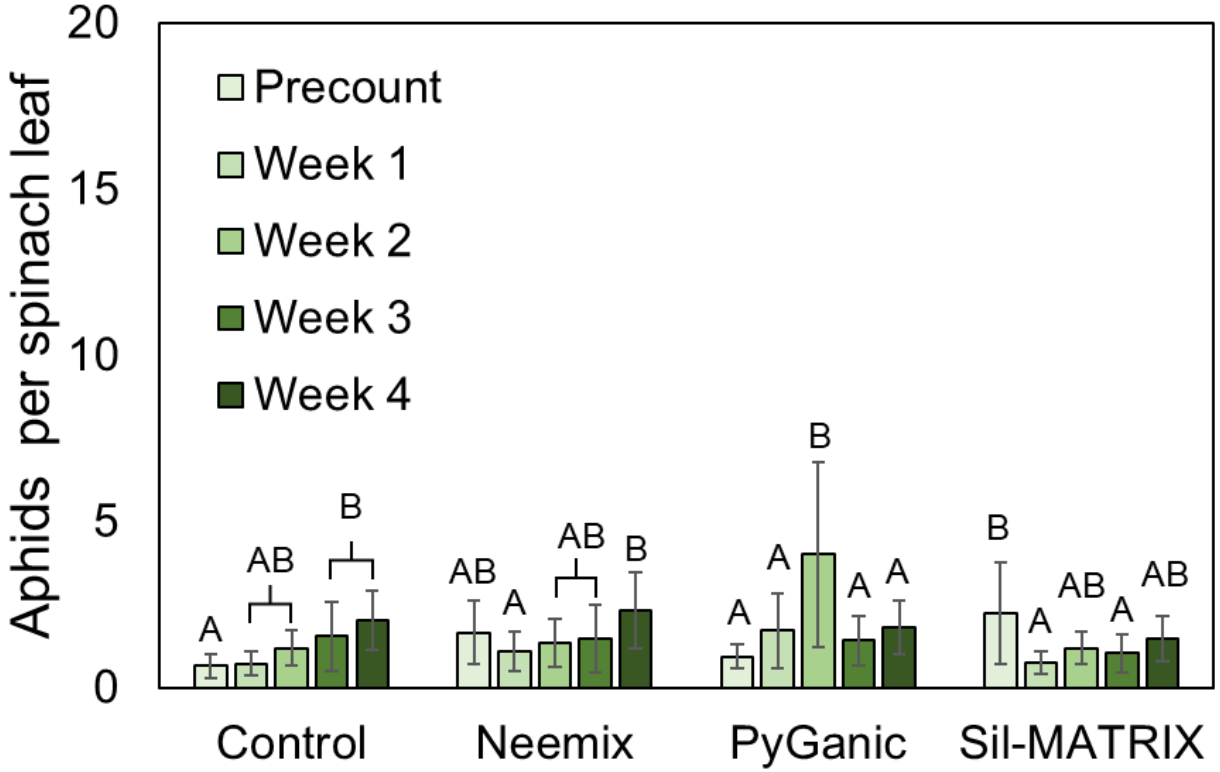
Winter management of aphids: field trial precount vs. end of season



All predator treatments reduced the rate of aphid population increase compared to the control

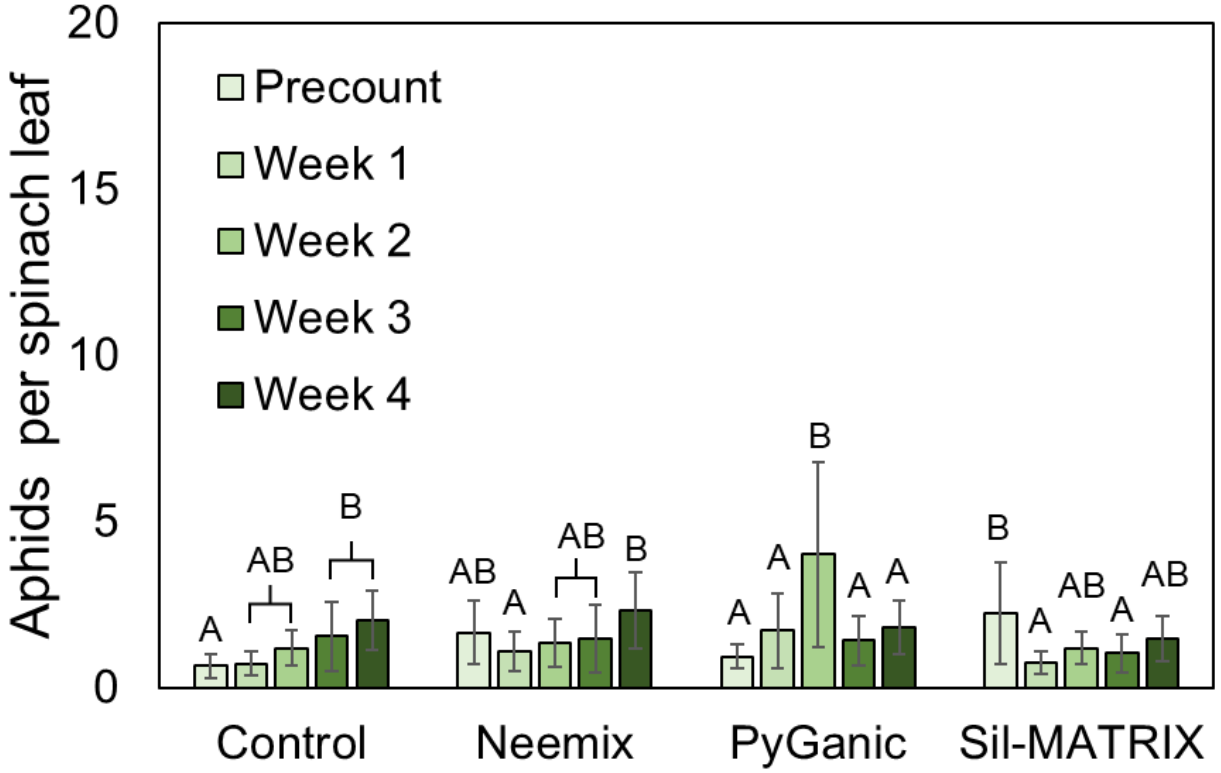
Spray impacts on aphids: field experiment

Trial 1: February

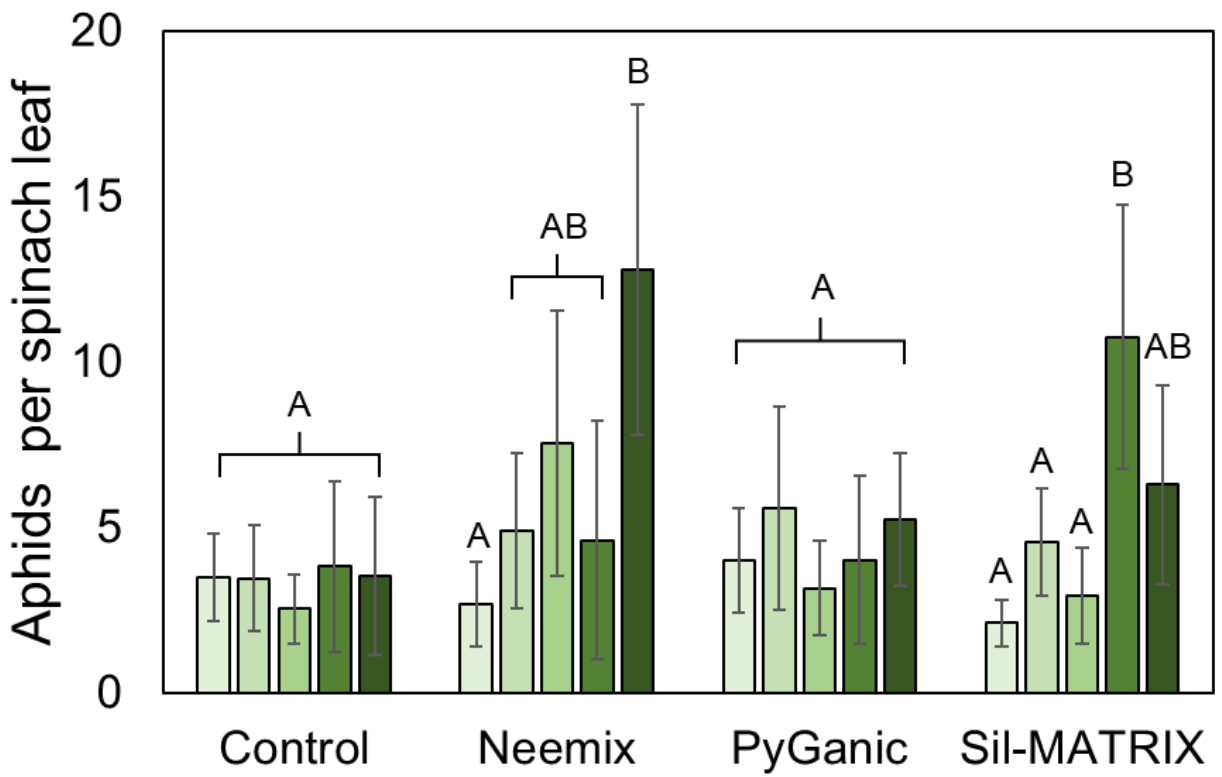


Spray impacts on aphids: field experiment

Trial 1: February

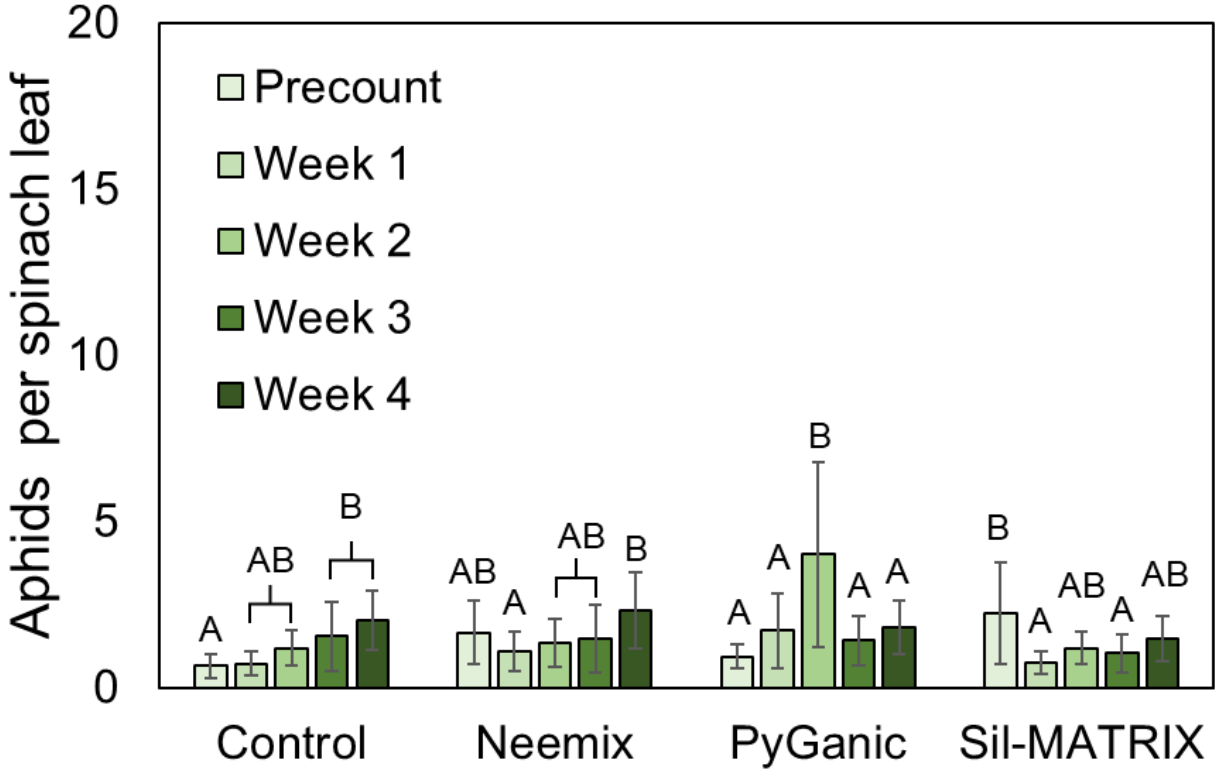


Trial 2: April

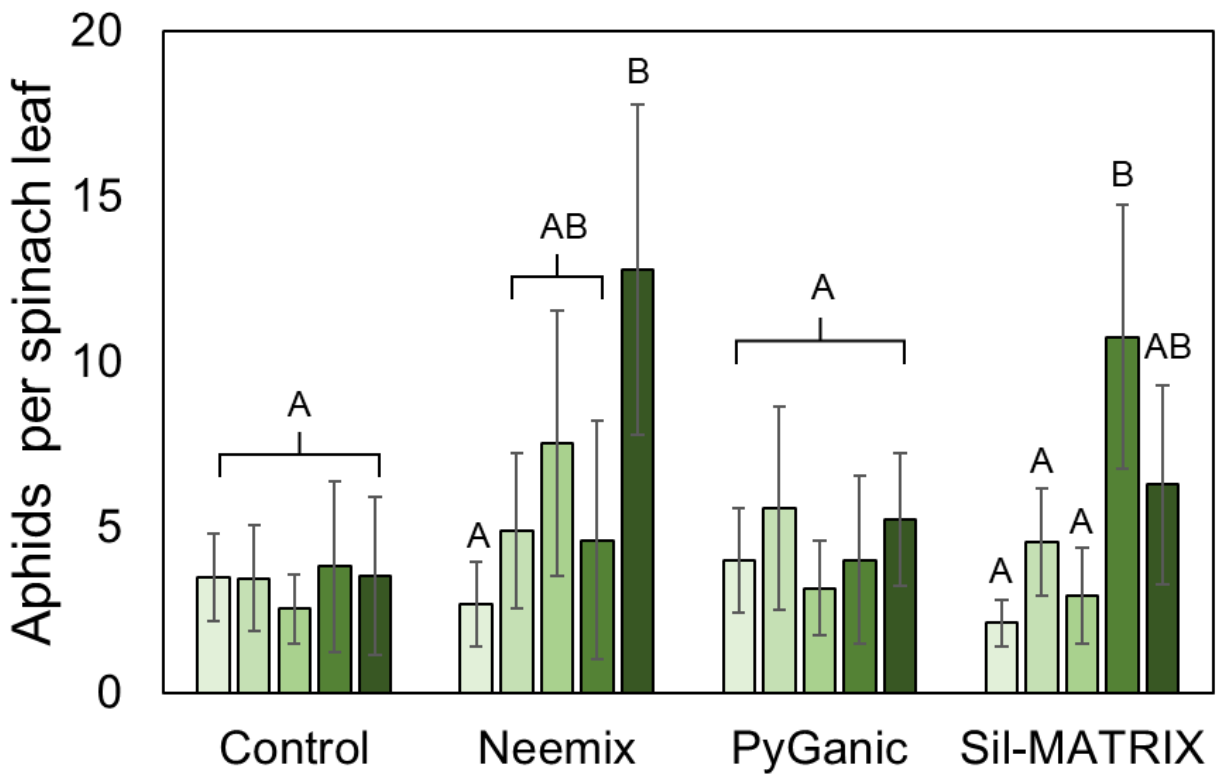


Spray impacts on aphids: field experiment

Trial 1: February



Trial 2: April



Early management efforts are most effective:

→ Neemix and Sil-MATRIX had the greatest impact

Aphid impacts on yield:

$$Cumulative\ aphid\ days = \sum_{i=sampling\ periods}^{n} \frac{\Delta T \text{ x } (Y_i + Y_{i+1})}{2}$$

Aphid impacts on yield:

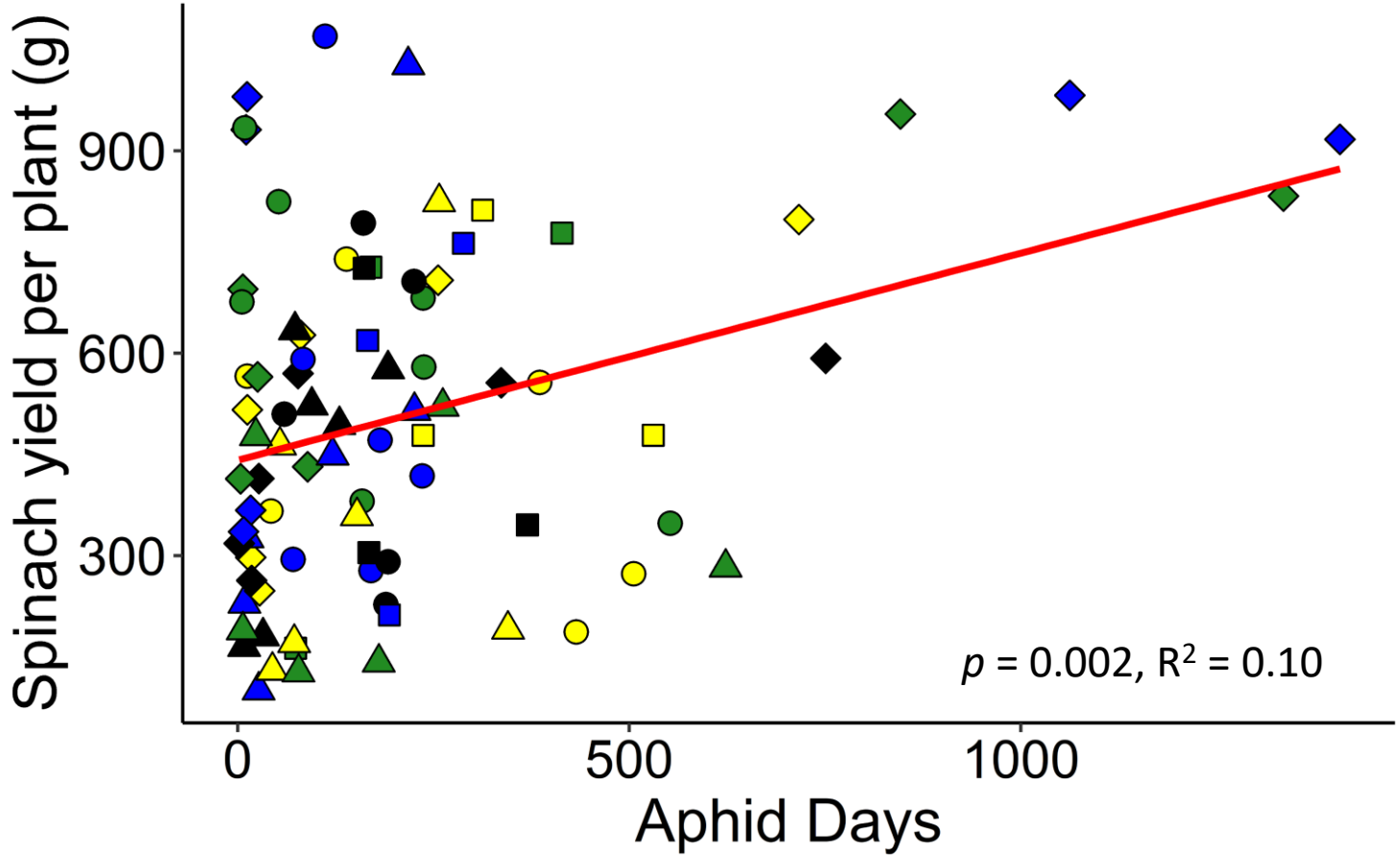
$$\text{Cumulative aphid days} = \sum_{i=\text{sampling periods}}^{n} \frac{\Delta T \times (Y_i + Y_{i+1})}{2}$$

Biocontrol

- No predator
- *A. bipunctata*
- *C. carnea*
- *O. insidiosus*

Spray

- Control
- Neemix
- PyGanic
- Sil-MATRIX



Compensatory growth?: response to herbivore damage

Aphid impacts on yield:

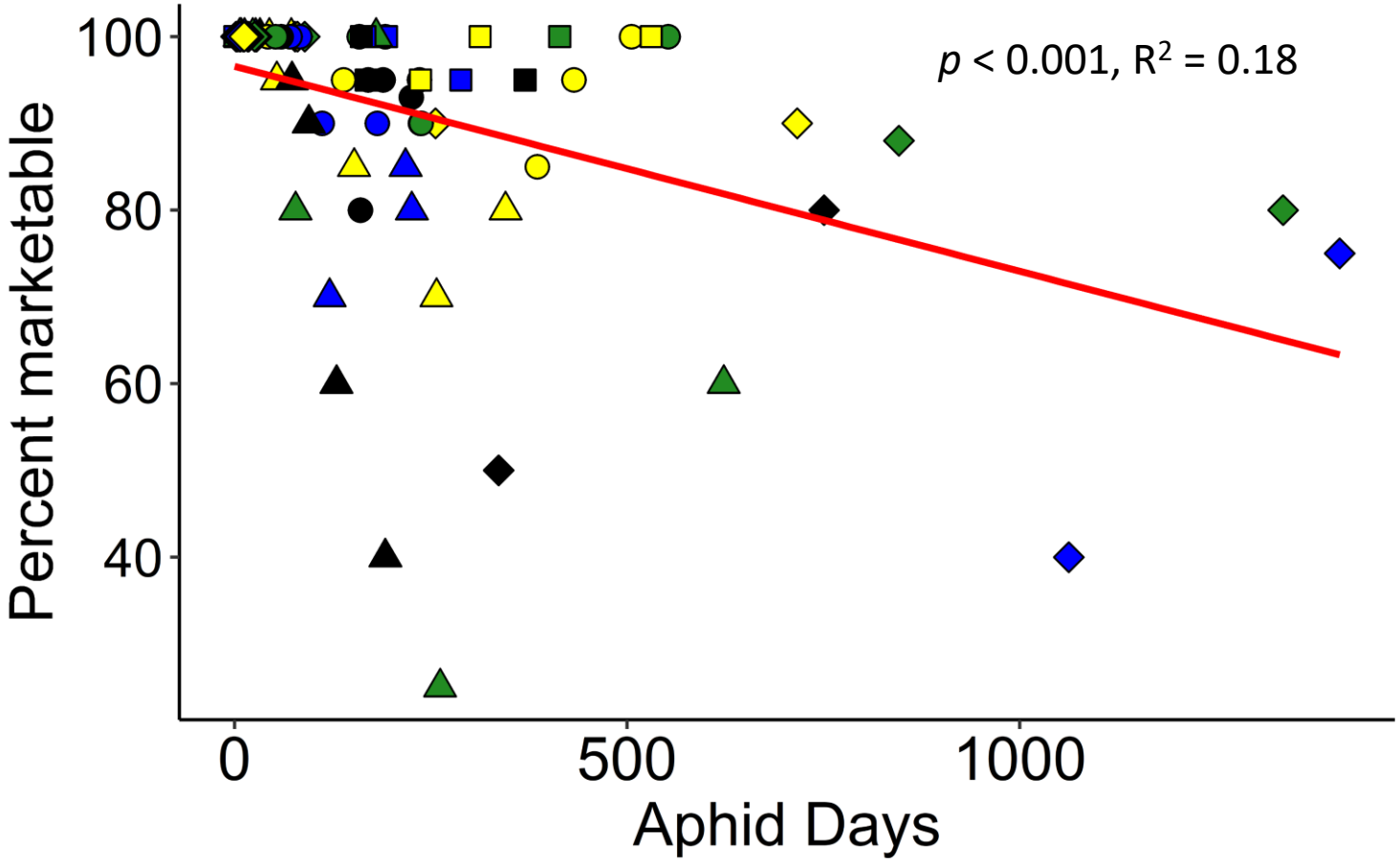
$$\text{Cumulative aphid days} = \sum_{i=\text{sampling periods}}^{n} \frac{\Delta T \times (Y_i + Y_{i+1})}{2}$$

Biocontrol

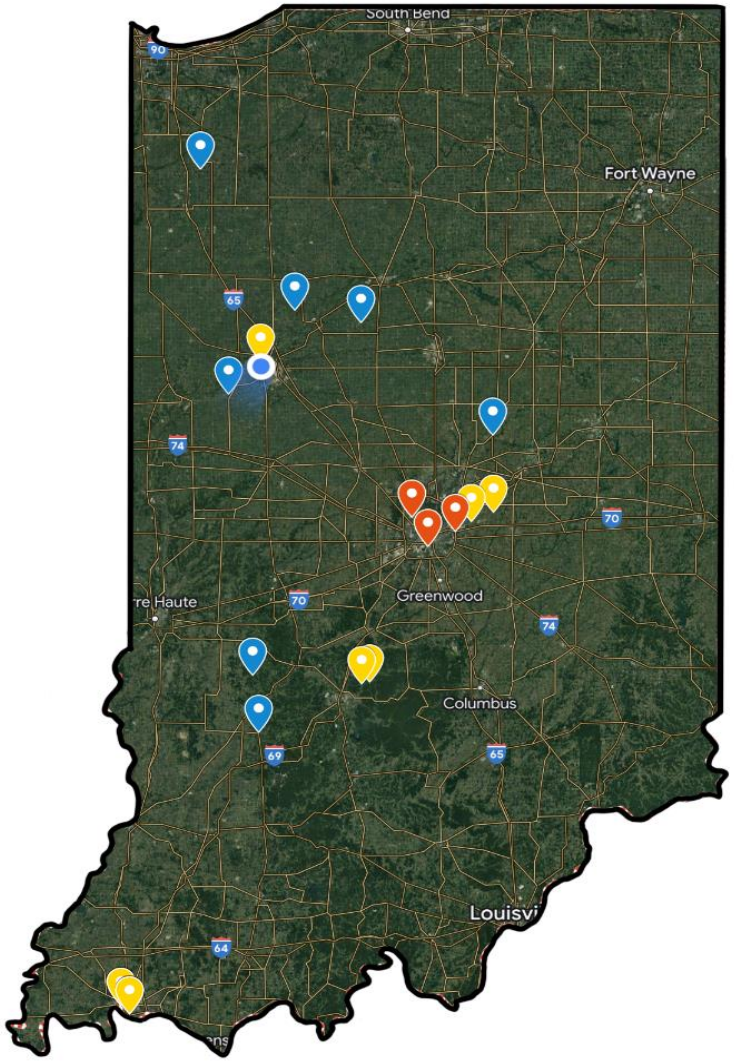
- No predator
- *A. bipunctata*
- *C. carnea*
- *O. insidiosus*

Spray

- Control
- Neemix
- PyGanic
- Sil-MATRIX



CONCLUSIONS



Urban Suburban Rural

- Aphids are the dominant pests on winter high tunnel crops on farms
- Parasitoids are the dominant natural enemy, but they may have poor establishment on urban farms

Recommendation for winter aphid mgmt:

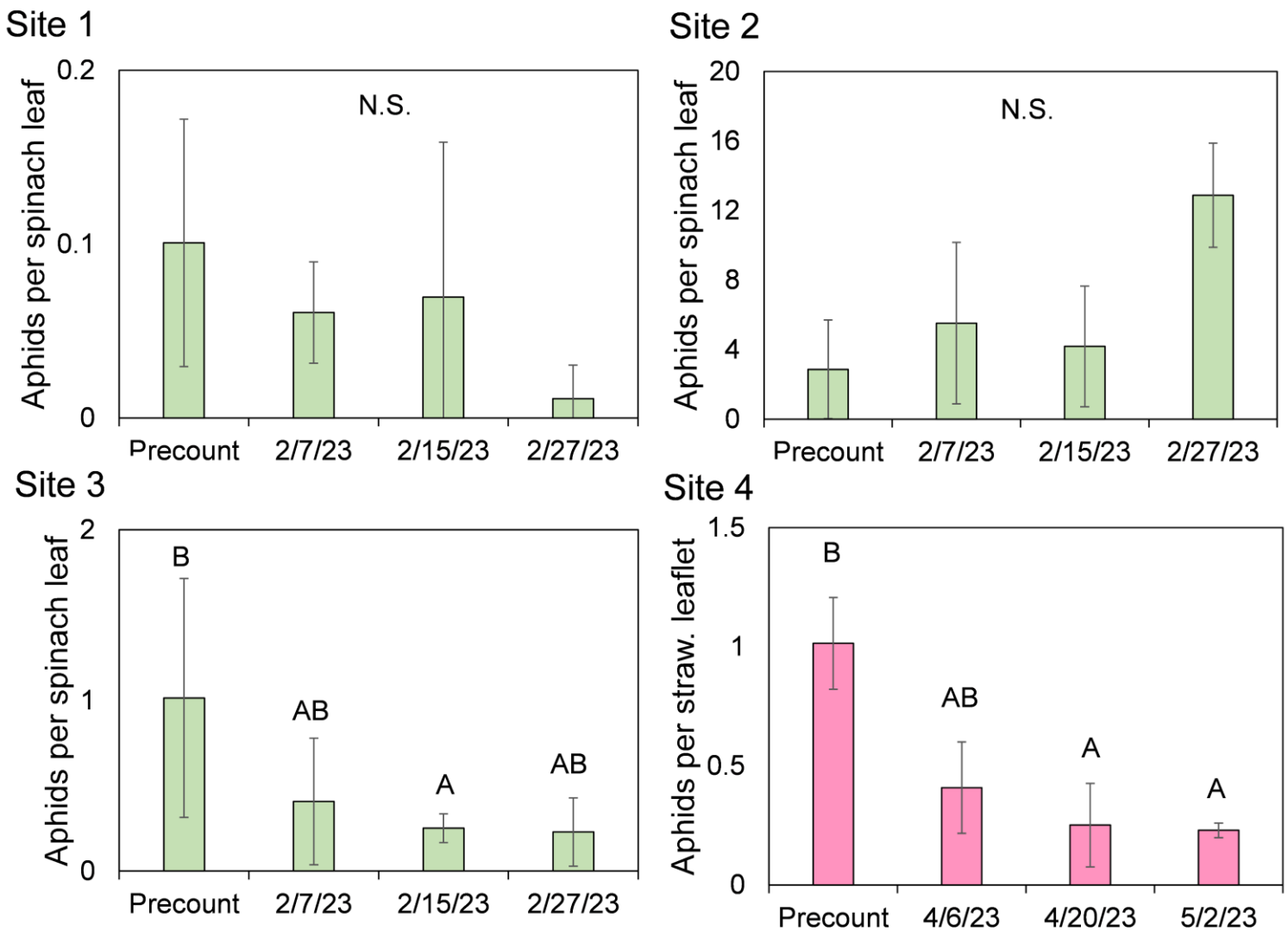
1. Early season prevention

Chrysoperla carnea

Recommendation for winter aphid mgmt:

1. Early season prevention

Chrysoperla carnea



Recommendation for winter aphid mgmt:

1. Early season prevention

Chrysoperla carnea

2. When aphids are increasing (< 5 aphids per leaf, Feb – March)

Sil-MATRIX® LC
FUNGICIDE/MITICIDE/INSECTICIDE

Neemix® 4.5
INSECT GROWTH REGULATOR

PyGanic®
Check water pH!

THANK YOU!

swillden@purdue.edu

lingwell@purdue.edu

@hightunnelipm

High tunnel production website

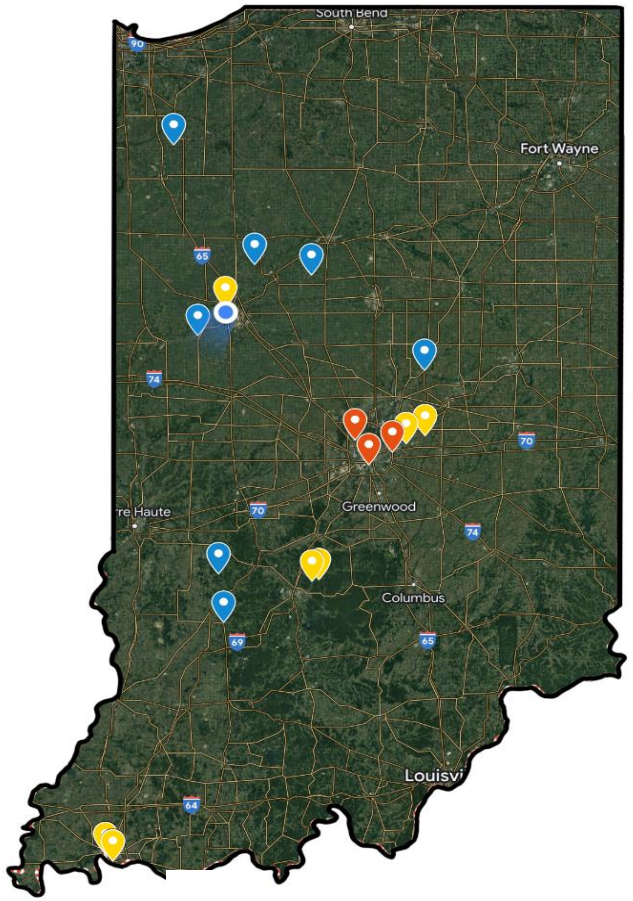
USDA National Institute of Food and Agriculture
U.S. DEPARTMENT OF AGRICULTURE

This work is supported by the Specialty Crop Research Initiative (SCRI) [grant no. 2021-51181-35858/project accession no. 1027430] from the USDA National Institute of Food and Agriculture.

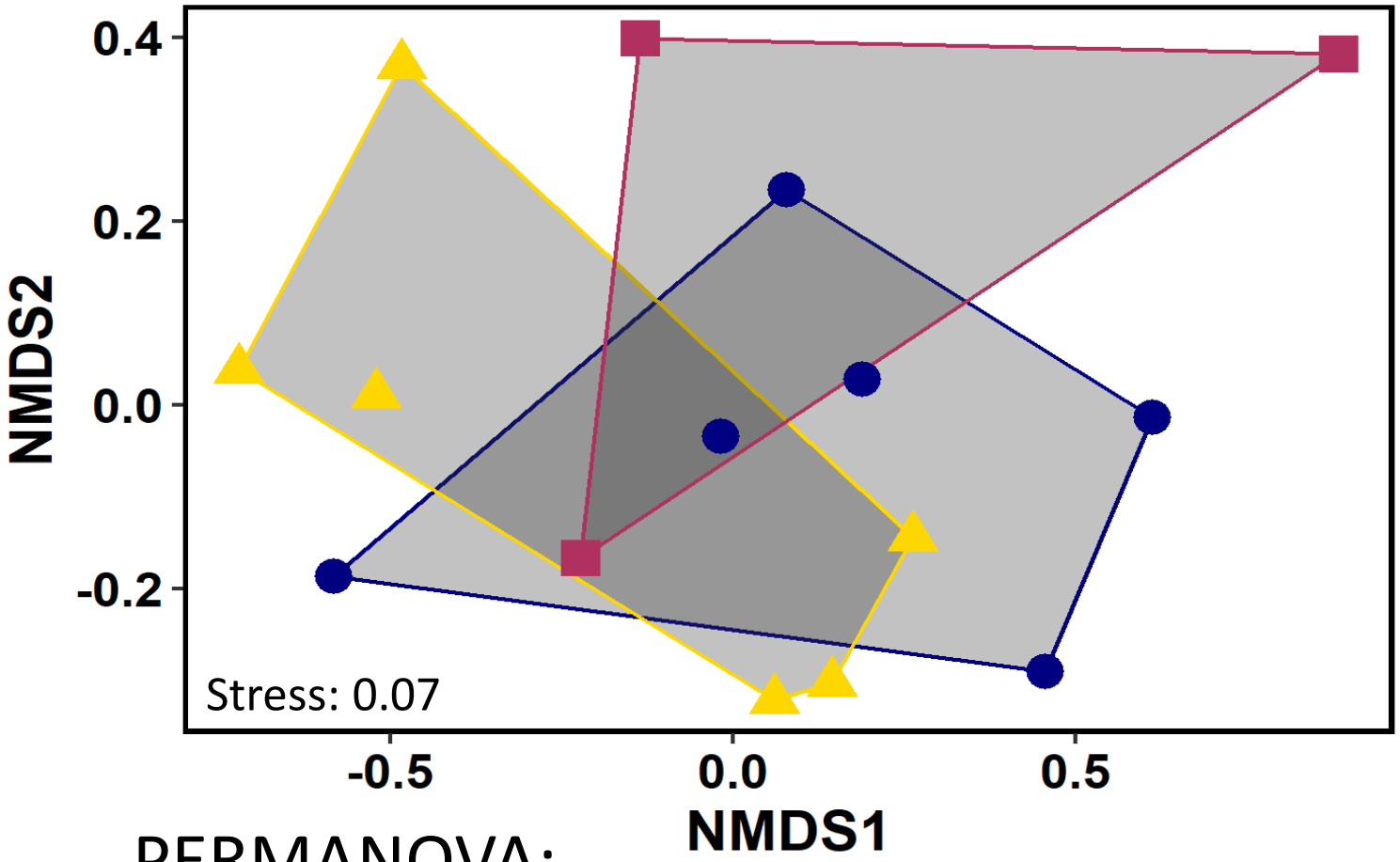
PURDUE UNIVERSITY | Extension

Arthropod functional groups:

Proportion that were phytophagous, predators, parasitoids, oligophores, detritivores



Urban Suburban Rural



PERMANOVA:

$F_{2,14} = 0.12$, $R^2 = 0.02$, $p = 0.96$