Ecology-based approaches to pest management

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April 26, 2016

Project 1:
Winter cover crops influence pest and natural enemy communities

Project 2:
Multiple tactics to manage a pest complex

Dynamics of plant-insect interactions:

Consequences of beneficial/detrimental insects

Adult moth pollinates

Larvae feed on seeds

+ -

Plant fitness

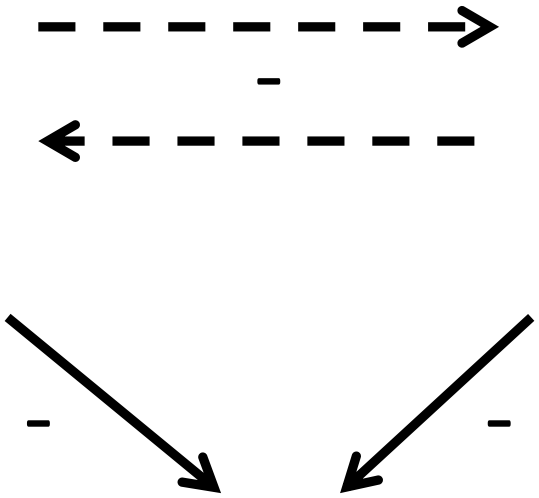
Field technician, University of Arizona

Holland, Buchanan, and Loubeau 2004. Oviposition choice and larval survival in an obligately pollinating granivorous moth. *Evolutionary Ecology Research* 6: 607-618

Multiple insects on shared host plants

Feedbacks among plant traits, pollinators, and herbivores

Pollination reduced allocation to size



Herbivory reduced allocation to flowering

Plant size / flowering

Graduate student, Florida State University

Buchanan and Underwood 2013. Attracting pollinators and avoiding herbivores: insects influence plant traits within and across years. *Oecologia* 173: 473-482

Effects of biocontrol of invasive plants

Damage alters plant traits in invasive aquatic ornamental

+

Meristem damage increased clone and leaf production

Graduate student, Florida State University

Buchanan 2013. Damage by *Neochetina* weevils (Coleoptera: Curculionidae) induces resistance in *Eichhornia crassipes* (Commelinales: Pontederiaceae). *Florida Entomologist* 96 (2): 458-462

Buchanan 2015. Effects of damage and pollination on sexual and asexual reproduction in a flowering clonal plant. *Plant Ecology* 216: 273-282

Effects of biocontrol of invasive plants

Damage alters plant traits in invasive aquatic ornamental

Adult weevil damage
reduced subsequent feeding

Graduate student, Florida State University

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Effects of biocontrol of invasive plants

Damage alters plant traits in invasive aquatic ornamental

- Biocontrol may lose effectiveness over time
- Florida management program: Integrated biocontrol, herbicides, mechanical removal

Graduate student, Florida State University

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Buchanan 2015. Effects of damage and pollination on sexual and asexual reproduction in a flowering clonal plant. *Plant Ecology* 216: 273-282

Ecology in IPM:
Manipulating biotic and abiotic environments to manage pest-host plant interactions

<u>Postdoctoral researcher, University of Maryland</u>

Buchanan et al. 2015. Can row spacing influence arthropod communities in soybean? Implications for early and late planting. *Environmental Entomology* 44(3): 557-561

Buchanan, Kolb and Hooks, in review. Single-species and mixed-species cover crops for weed management and crop yield in organic vegetables.

Buchanan and Hooks, in prep. Winter cover crop mulches influence insect pests and natural enemies

<u>Postdoctoral researcher, Michigan State University</u>

Buchanan, Grieshop and Szendrei, in prep. Attract-and-kill devices for Japanese beetle control

Buchanan, Bakker and Szendrei, in prep. Broad spectrum insecticide to control specialist pests in young asparagus plantings

Buchanan, Szendrei and Grieshop, in prep. Floral borders attract natural enemies and influence parasitism rates of asparagus miners

Project 1:
Winter cover crops influence pest and natural enemy communities









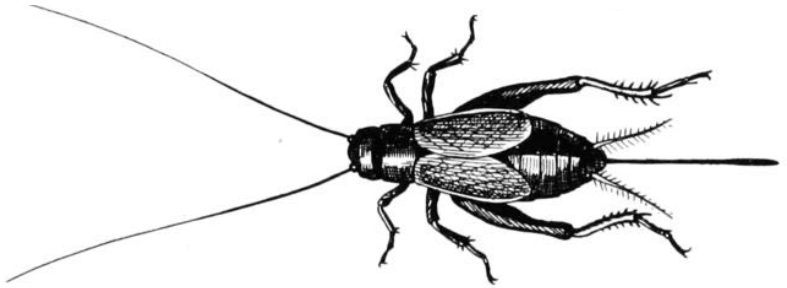

Foliar generalist pests:
Leafhoppers
Plant bugs
Aphids
Flea beetles
Scale insects
Caterpillars

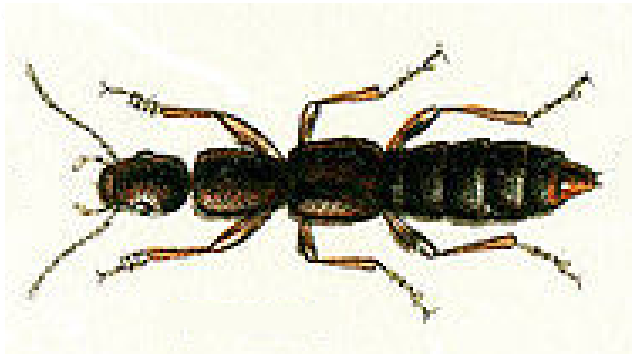


Foliar specialist pests:
Squash bugs (Hemiptera: Coreidae)
Striped & spotted cucumber beetles (Coleoptera: Chrysomelidae)

Foliar generalist natural enemies:
Spiders
Predatory pentatomids and reduviids
Ladybeetles

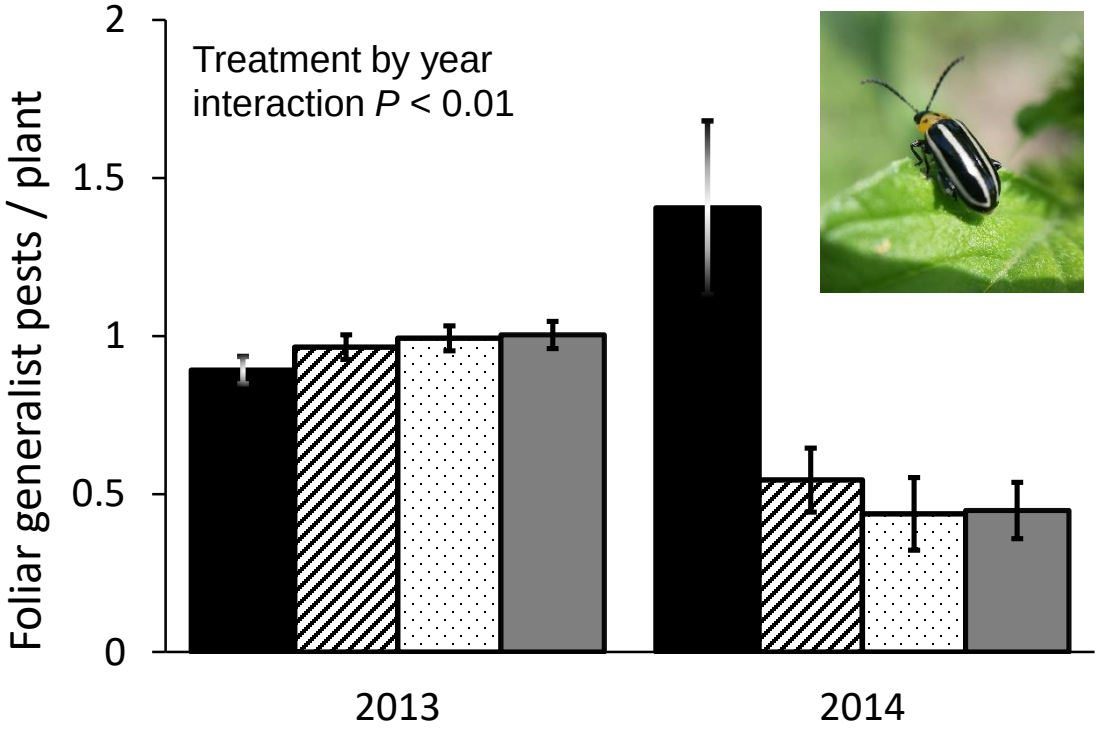
Ground-dwelling generalist natural enemies:
Ground beetles
Spiders
Crickets
Rove beetles

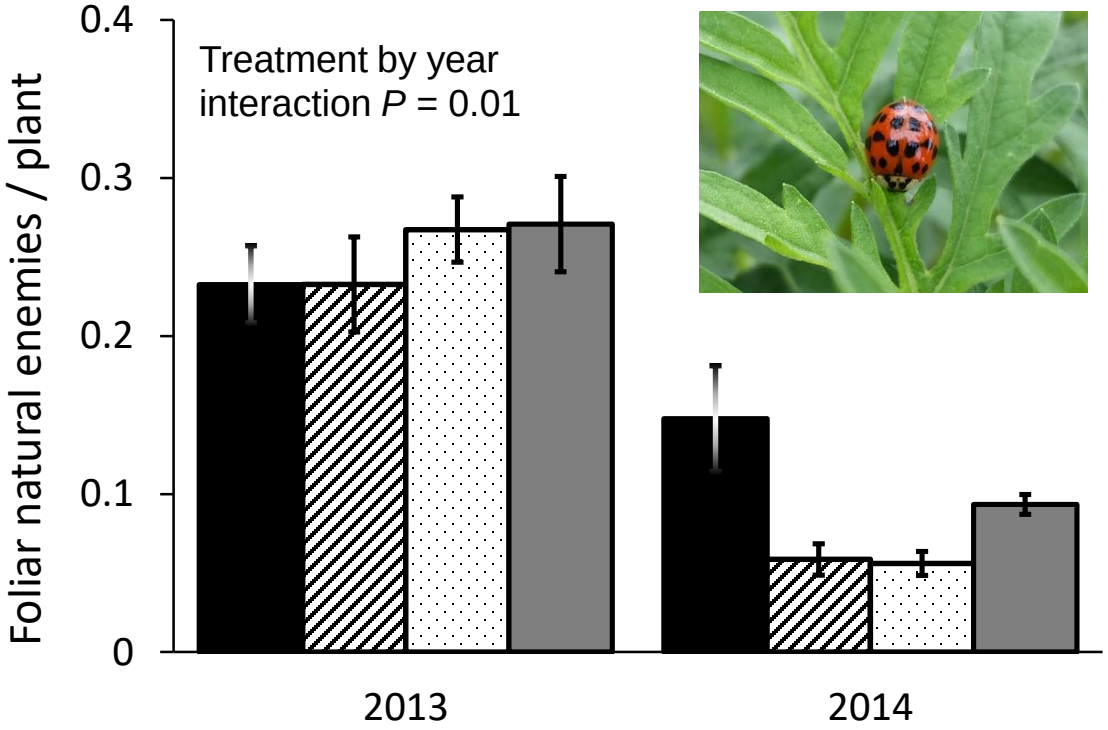




Foliar arthropods

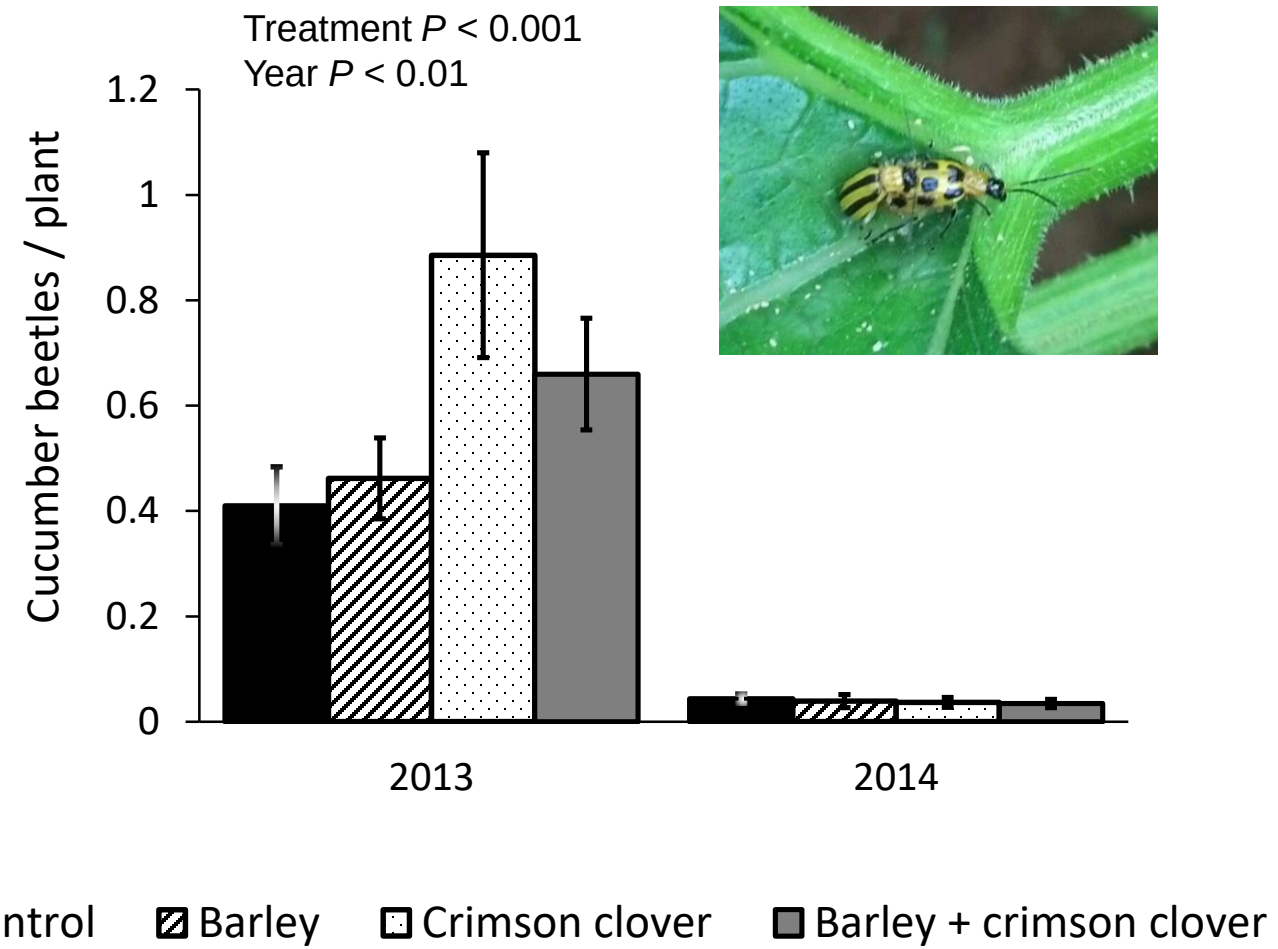
Foliar arthropods



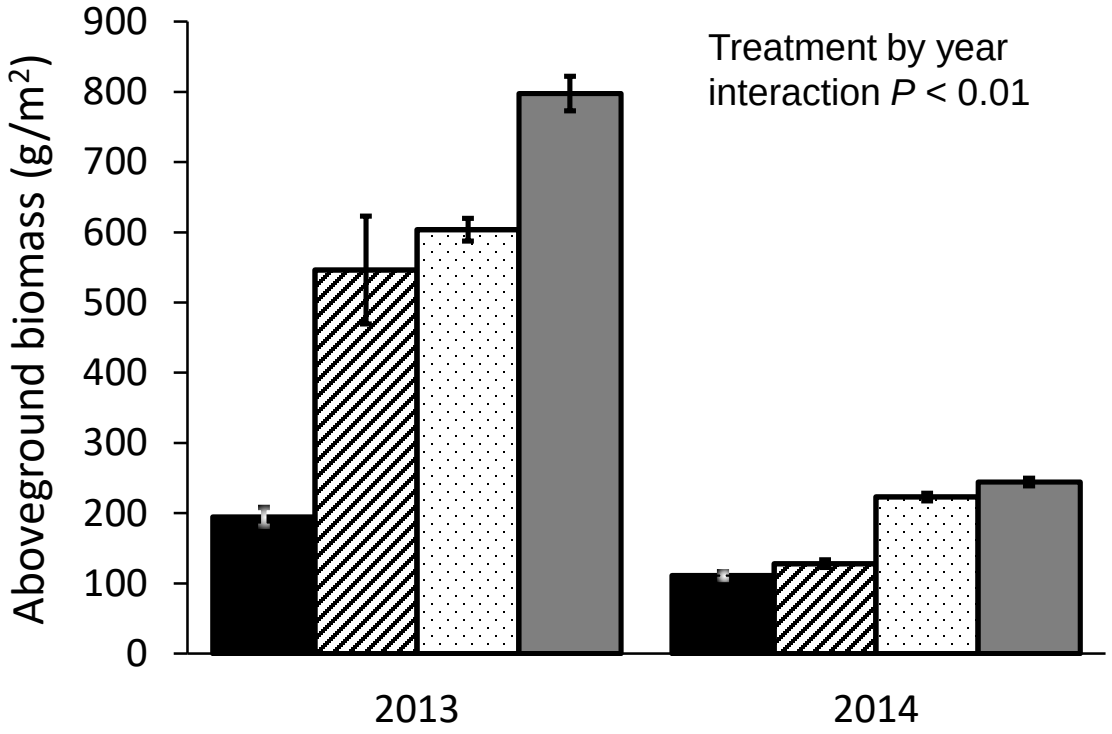


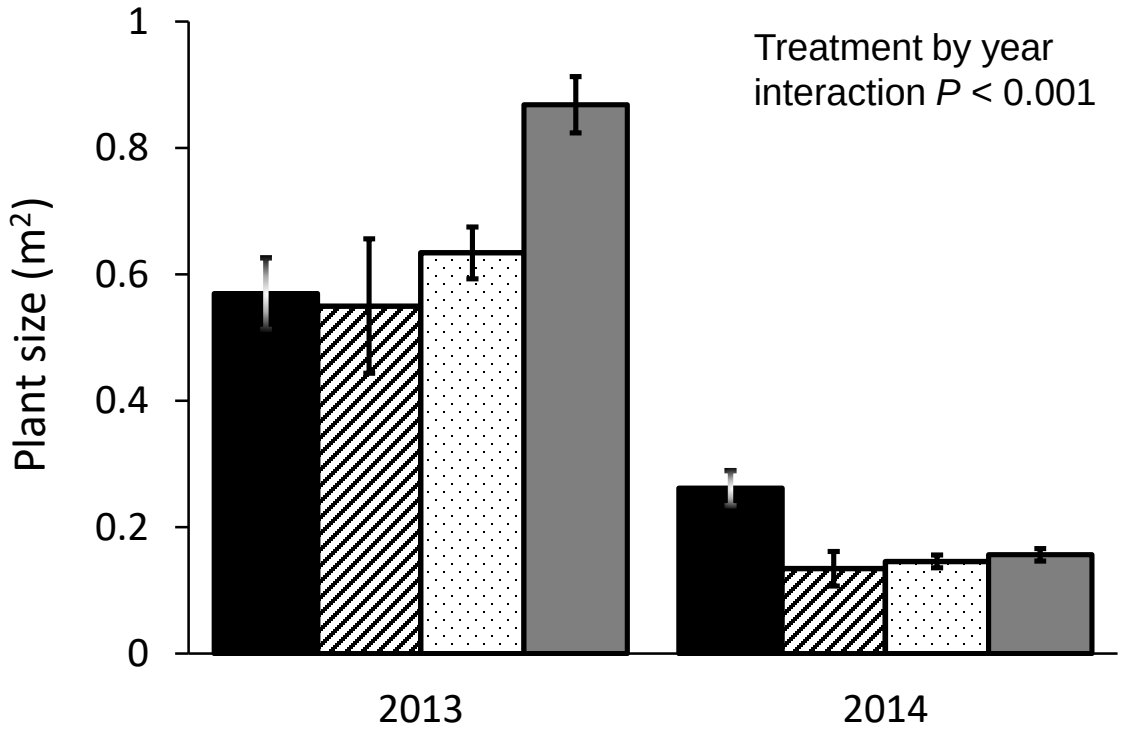
Similar responses by squash bug adults, nymphs, and egg masses

Foliar arthropods



Foliar arthropods





Control Barley Crimson clover Barley + crimson clover

Ground arthropods

Ground arthropods

Treatment $P < 0.05$
Year $P < 0.001$

Ground beetles / plot

3
2
1
0

2013 2014

Treatment by year interaction $P < 0.05$

Squash yield (kg/ha)

10000
8000
6000
4000
2000
0

2013 2014

Control Barley Crimson clover Barley + crimson clover

Evidence for species mixtures, and for species separation, for pest management

Biomass accumulation and N fixation → larger plants, more arthropods
Larger plants may be able to tolerate indirect pest pressure

Compromise between natural enemy attraction and crop performance:
Cereals in border habitats, species mixture in production habitats

Project 2:
Multiple tactics to manage a pest complex

Specialist stem miner:
Asparagus miner (Diptera: Agromyzidae)

Specialist defoliator:
Common asparagus beetle (Coleoptera: Chrysomelidae)

Generalist defoliator:
Japanese beetle (Coleoptera: Scarabaeidae)

Project GREEEN Proposal #GR16-032
2016-2018, $80,000
Buchanan, Szendrei and Grieshop

Natural enemy attraction for stem miner control

Morrison et al. 2014. The parasitoids of the asparagus miner (Diptera: Agromyzidae): field parasitism and the influence of food resources on life history. Environ. Entomol. 43 (6): 1526-1534

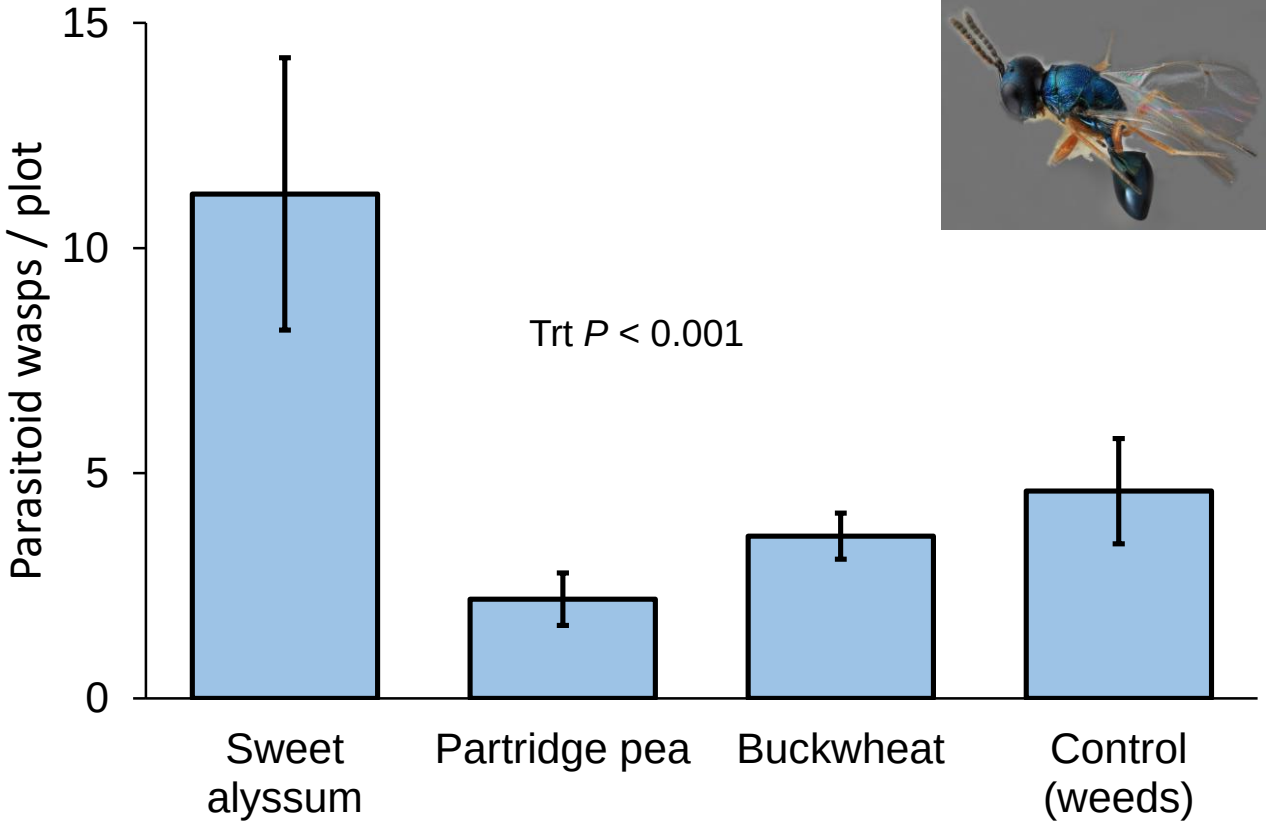
- Natural enemy attraction – 2015
  - Annual flower common garden
  - Weekly vacuum samples

Sweet alyssum

Partridge pea

Buckwheat

- Natural enemy attraction – 2015
  - Sweet alyssum most attractive



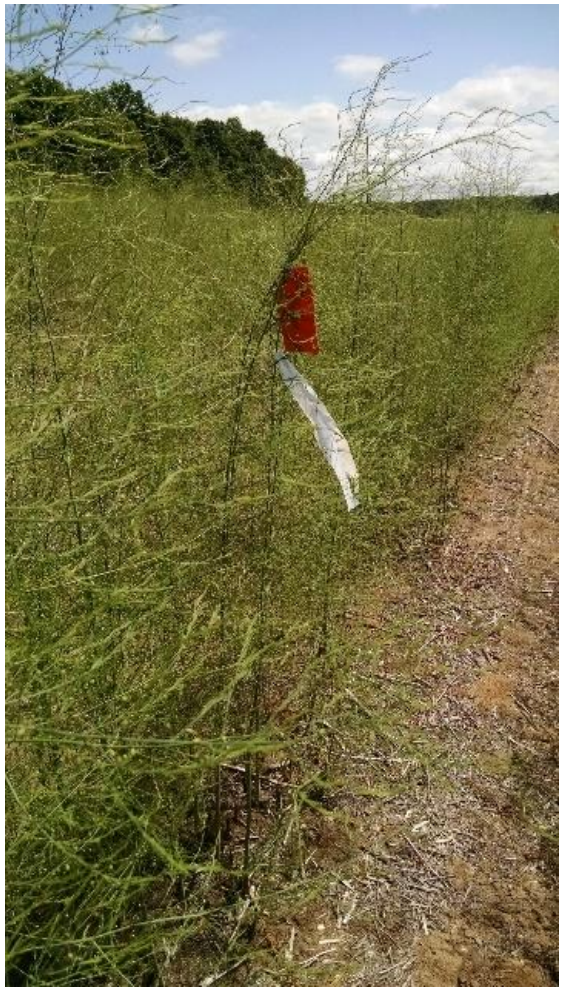
Sweet alyssum

Partridge pea

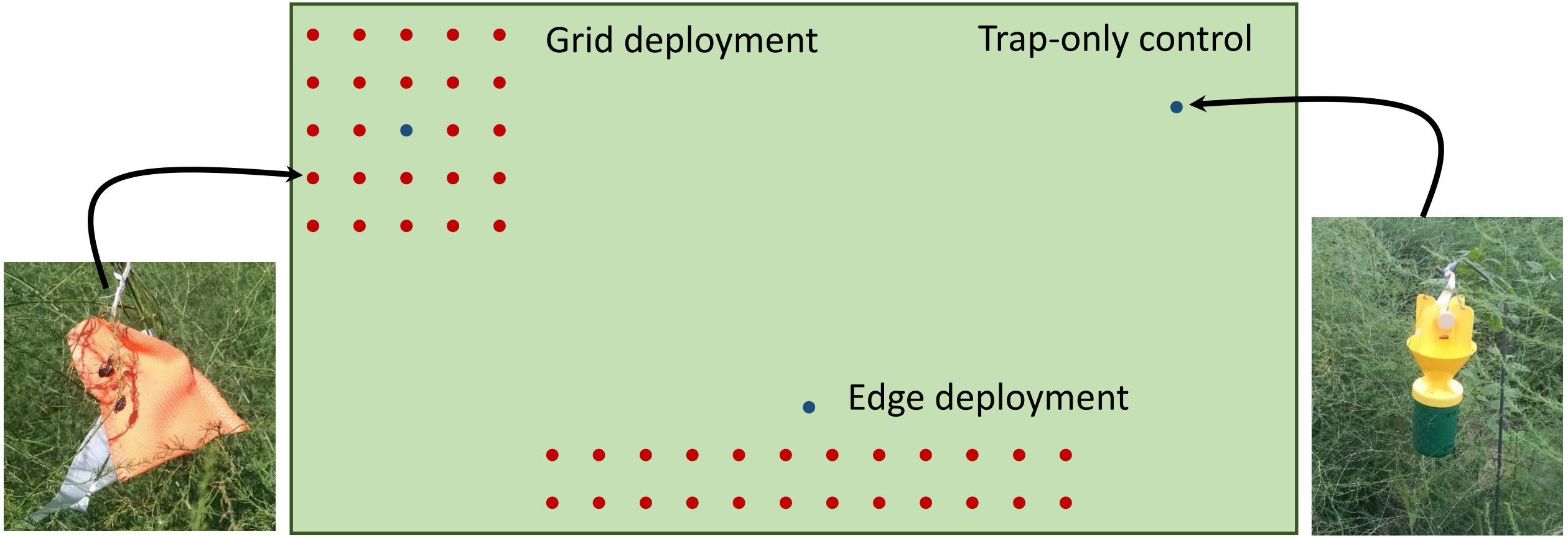
Buckwheat

- Natural enemy attraction – 2016
  - Sweet alyssum borders in production asparagus fields
  - Asparagus miner damage assessment in field
  - Pupae collection and rearing for parasitism rate

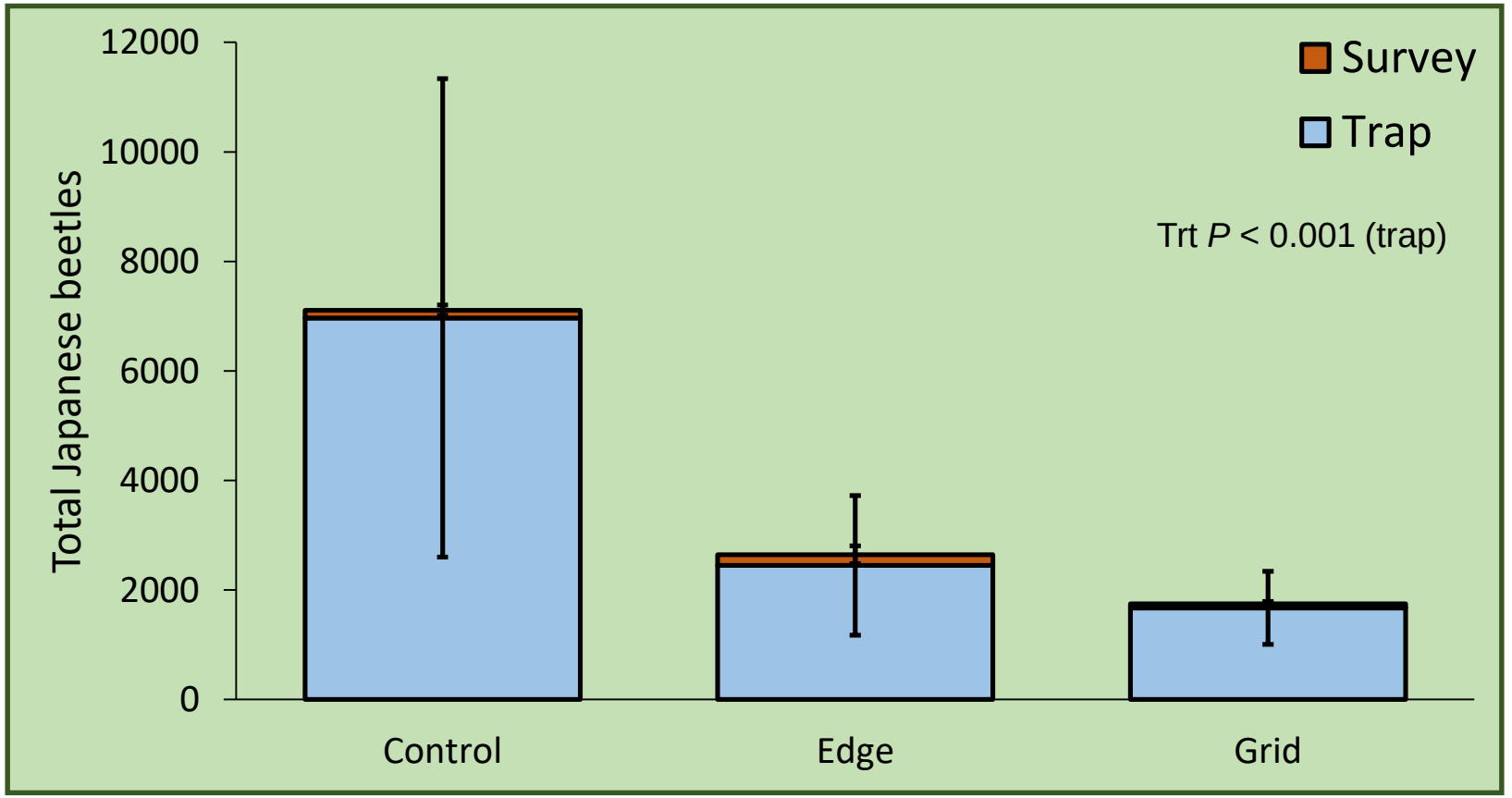
Attract and kill for Japanese beetle control



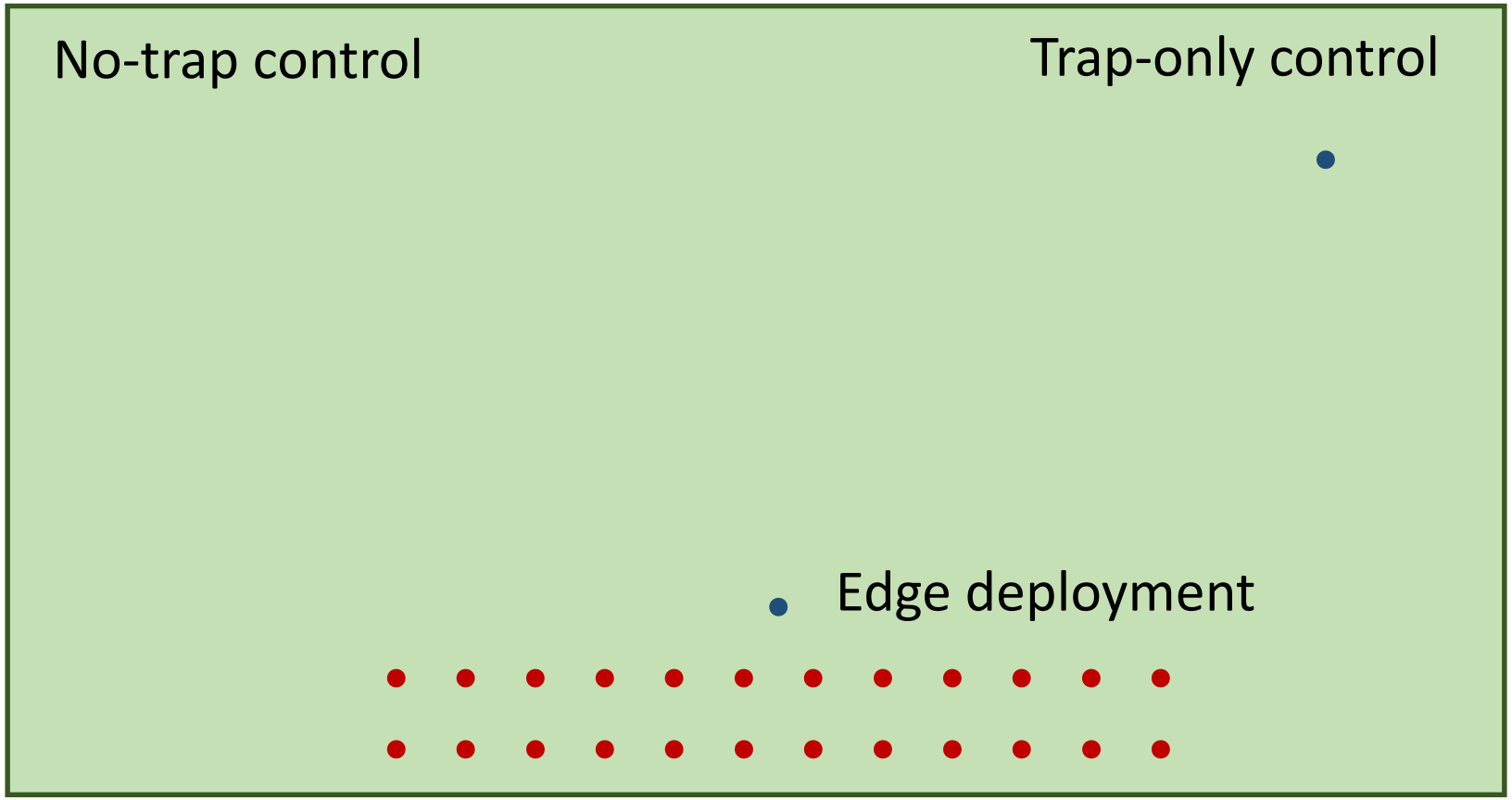
- Attract and kill – 2015
  - Devices in four production asparagus fields
  - Weekly trap count and on-plant surveys



- Attract and kill – 2015
  - Edge and grid deployments equally effective
  - No difference in survey numbers – low regional abundance of Japanese beetles



- Attract and kill – 2016
  - Focus on edge deployment
  - Expand to four asparagus production fields and four tart cherry fields
  - Estimate defoliation in cherry

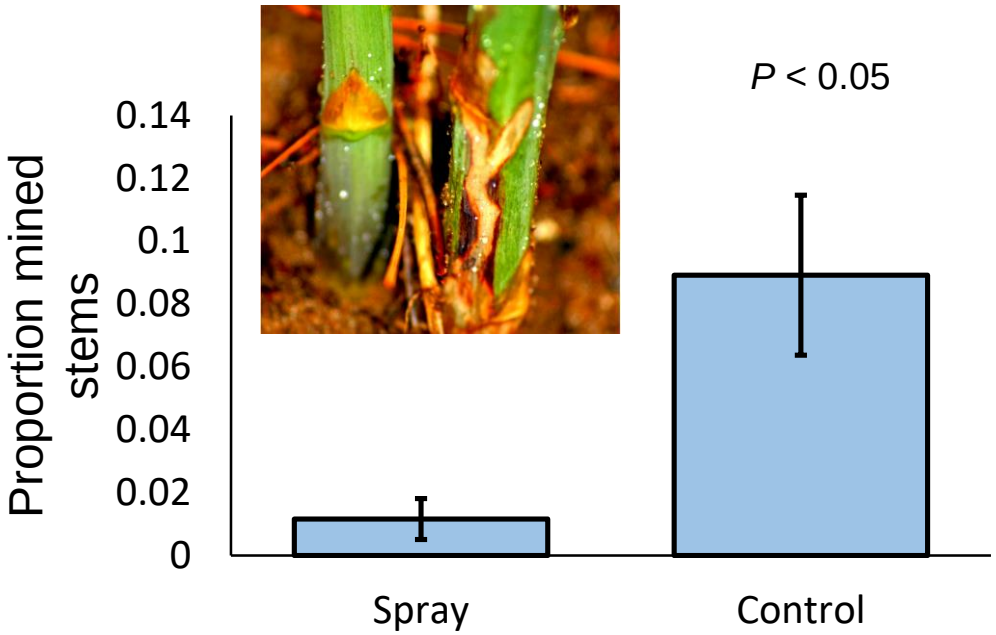


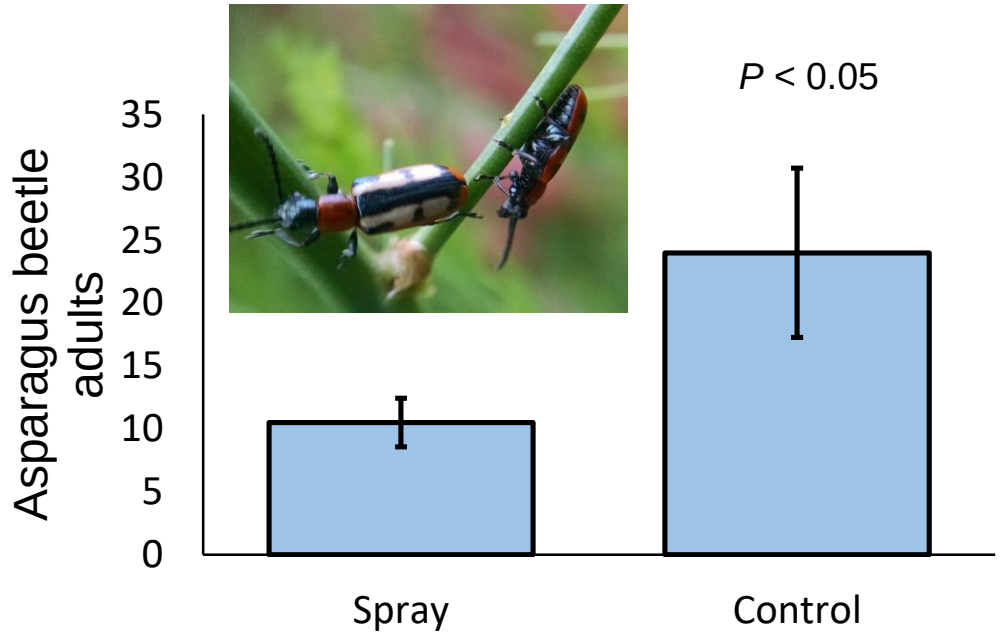
Early broad spectrum insecticide in young plantings

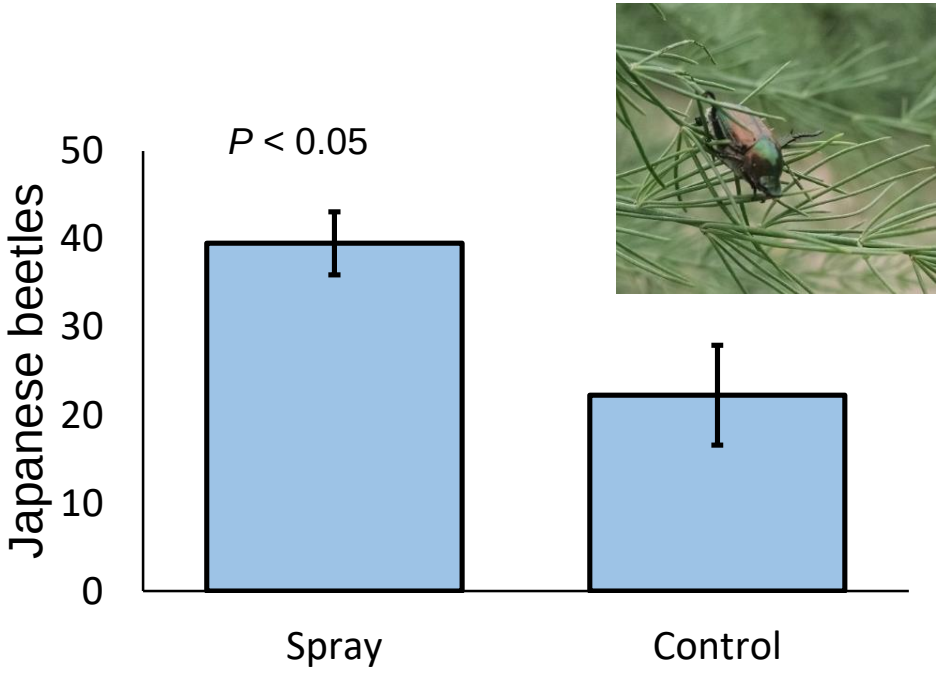




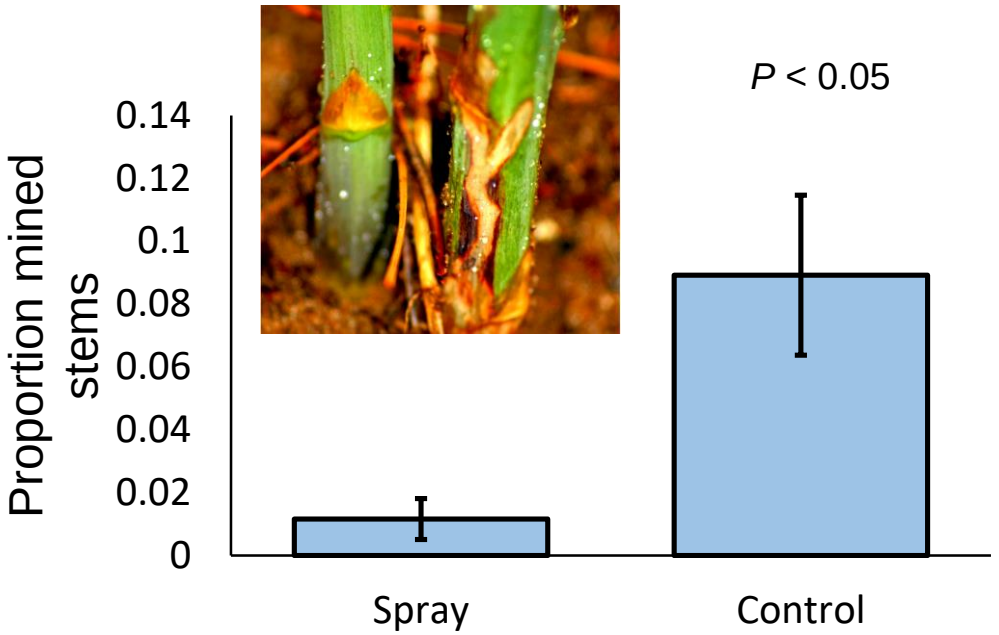
- Spray trials – 2015
  - Systemic neonicotinoid insecticide (Platinum)
  - Weekly pest surveys, post-spray plant tissue analysis

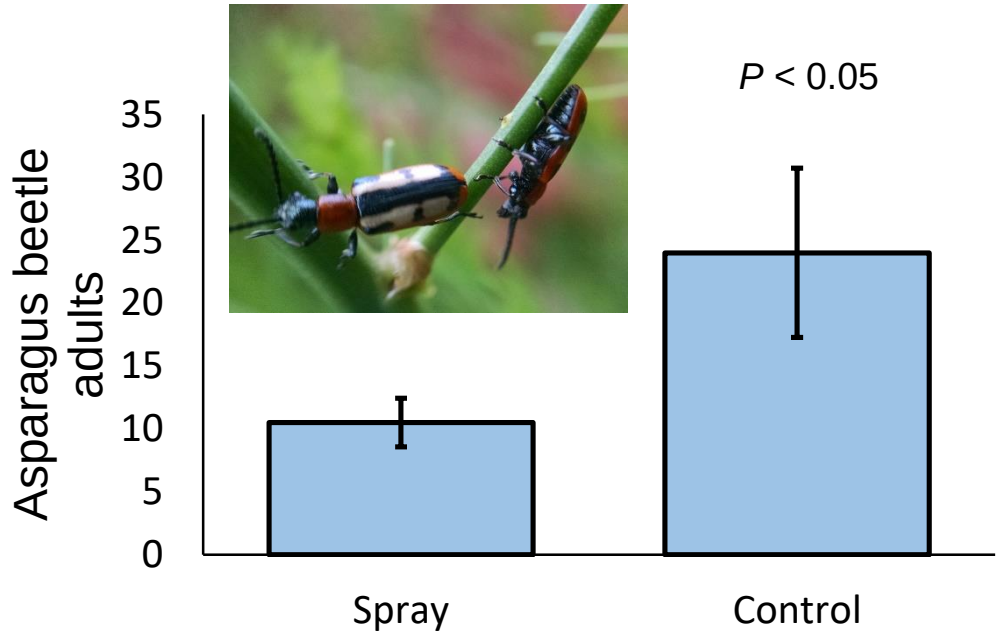


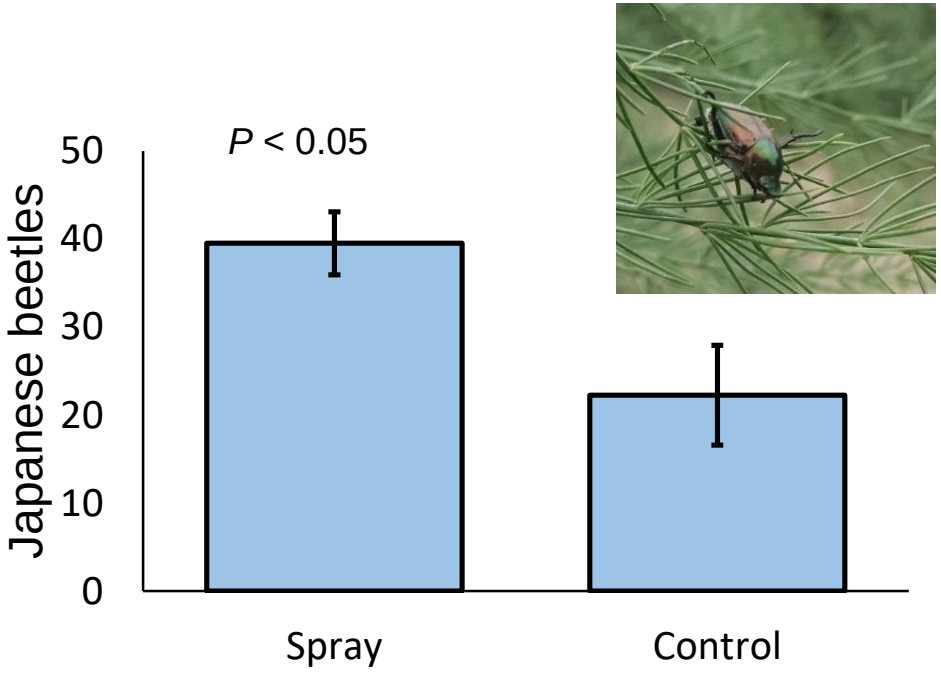




- Spray trials – 2015
  - Different responses from specialist and generalist pests







- Spray trials – 2016
  - Continued weekly pest and damage estimates
  - Plant tissue analysis
  - Plant growth estimates

Multiple tactics for a specialist/generalist pest complex

Floral resources attract natural enemies to target specialist stem miner

Specific chemical cues + low-input insecticide to target mobile generalist

Broad spectrum insecticide on young plantings for early damage control

Ecology-based approaches to pest management

(1) Combine field and lab studies with knowledge of insect ecology and host choice to understand pest-plant and pest-natural enemy relationships
(2) Manage pest complexes by integrating cultural, biological, and chemical control methods to manipulate the biotic and abiotic environment
(3) Develop multi-faceted and novel methodologies to manage pest-plant interactions in production fields, in cooperation with established growers' practices
(4) Meet growers' needs for marketable, high quality products
(5) Communicate with growers to disseminate findings and integrate grower concerns into new research

Future possibilities

New or synergistic environmental manipulations:
Cold treatments similar to aeration, cold-heat cycling, ‘pre-treatment’ treatments to encourage pest movement, refuge disturbance, or plant tolerance

Development of new chemical cues for pests and natural enemies:
Monitoring, attract and kill, plant volatiles

Pest control through host plant choice:
Chemical cues, physical barriers, plant physiology/hormones

Mahalo! Questions?

- USDA/NIFA, Organic Agriculture Research and Extension Initiative
- USDA/NIFA, Crop Protection and Pest Management
- Michigan Asparagus Advisory Board
- Trécé Inc.
- Central Maryland Research and Education Center
- Hooks Lab, University of Maryland
- Szendrei and Grieshop Labs, Michigan State University
- Ryan Walsworth, Golden Stock Farms, Mears, MI
- Ken and Ralph Oomen, Oomen Brothers Farms, Hart, MI
- Ben Werling, MSU Extension, Oceana County
- John Bakker, Michigan Asparagus Advisory Board
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National Institute of Food and Agriculture