Comparison of Neonicotinoid Concentrations in Target and Non-Target Members of the Soil Invertebrate Community of Pennsylvania Soybean Fields

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Sometimes Mass Specs Break and a Millipede Walks into Your Life

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We Know what IPM Should Look Like

All Benefits $\geq$ All Costs

Avoid:

Pesticide resistance

Secondary outbreaks

Toxic residues

Harming people/wildlife

*Interfering with ecosystem functioning

Stern, Smith, Bosch, Hagen 1959

But corn production violates IPM goals, soy increasingly so

Prophylactic Pesticides

- Bt
- Seed Treatments

Limited Rotation

Tank Mixes

Pesticide resistance

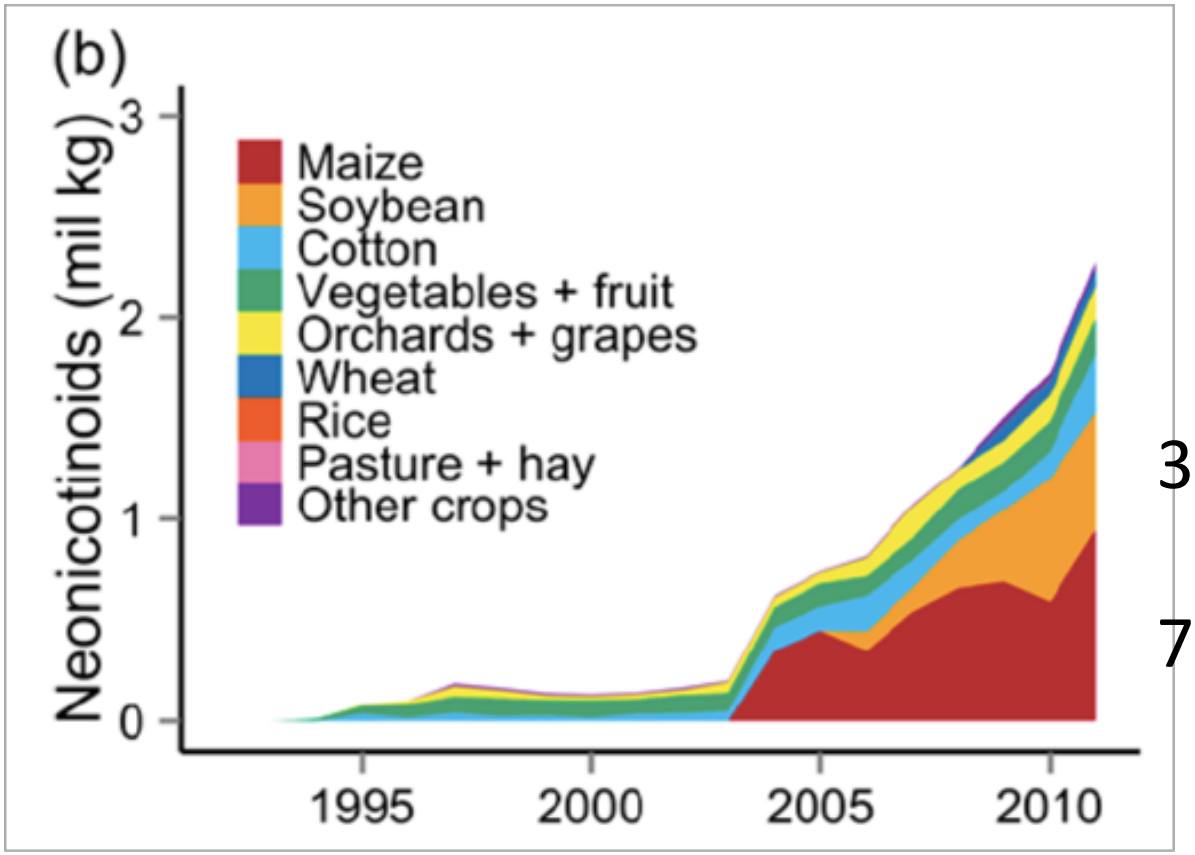
Secondary outbreaks

Toxic residues

Harming people/wildlife

*Interfering with ecosystem functioning

Neonicotinoid seed treatments (NSTs) have been adopted rapidly



34 - 44% of Soy

79% - 100% of Maize

Douglas & Tooker , 2015

But the costs > benefits

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 15 2014

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

MEMORANDUM

SUBJECT: Benefits of Neonicotinoid Seed Treatments to Soybean Production

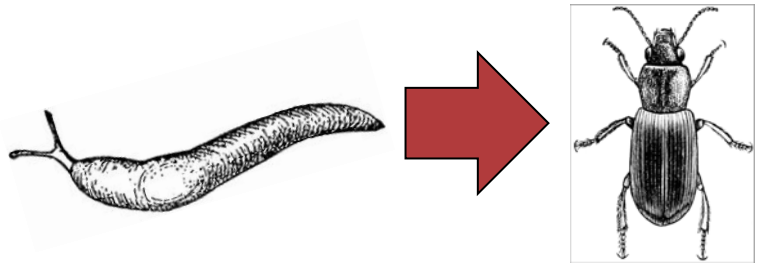
FROM: Clayton Myers, Ph.D., Entomologist
Biological Analysis Branch

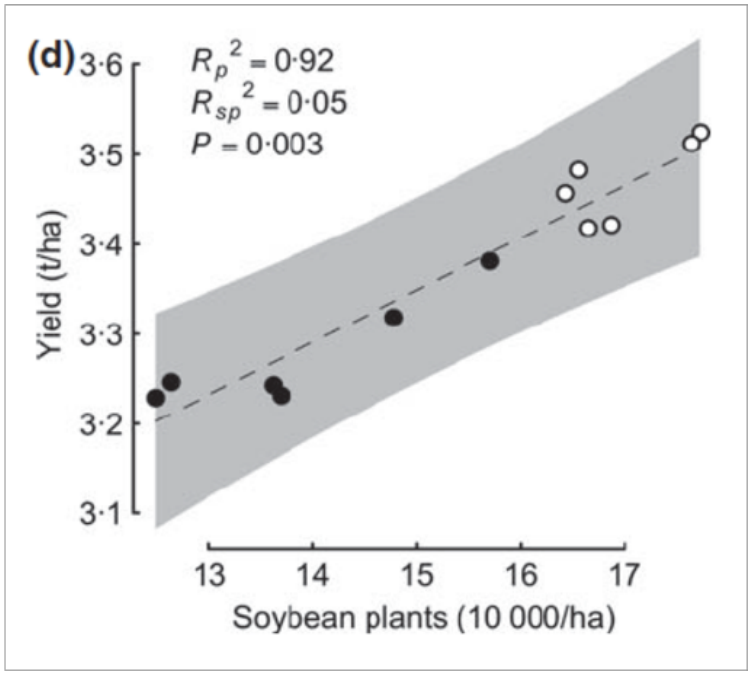
Elizabeth Hill, Economist
Economic Analysis Branch
Biological and Economic Analysis Division (7503P)

Especially in Agroecosystems like those in PA

Photo: Tom Butzler

NSTs affect top-down biocontrol of critical PA pests





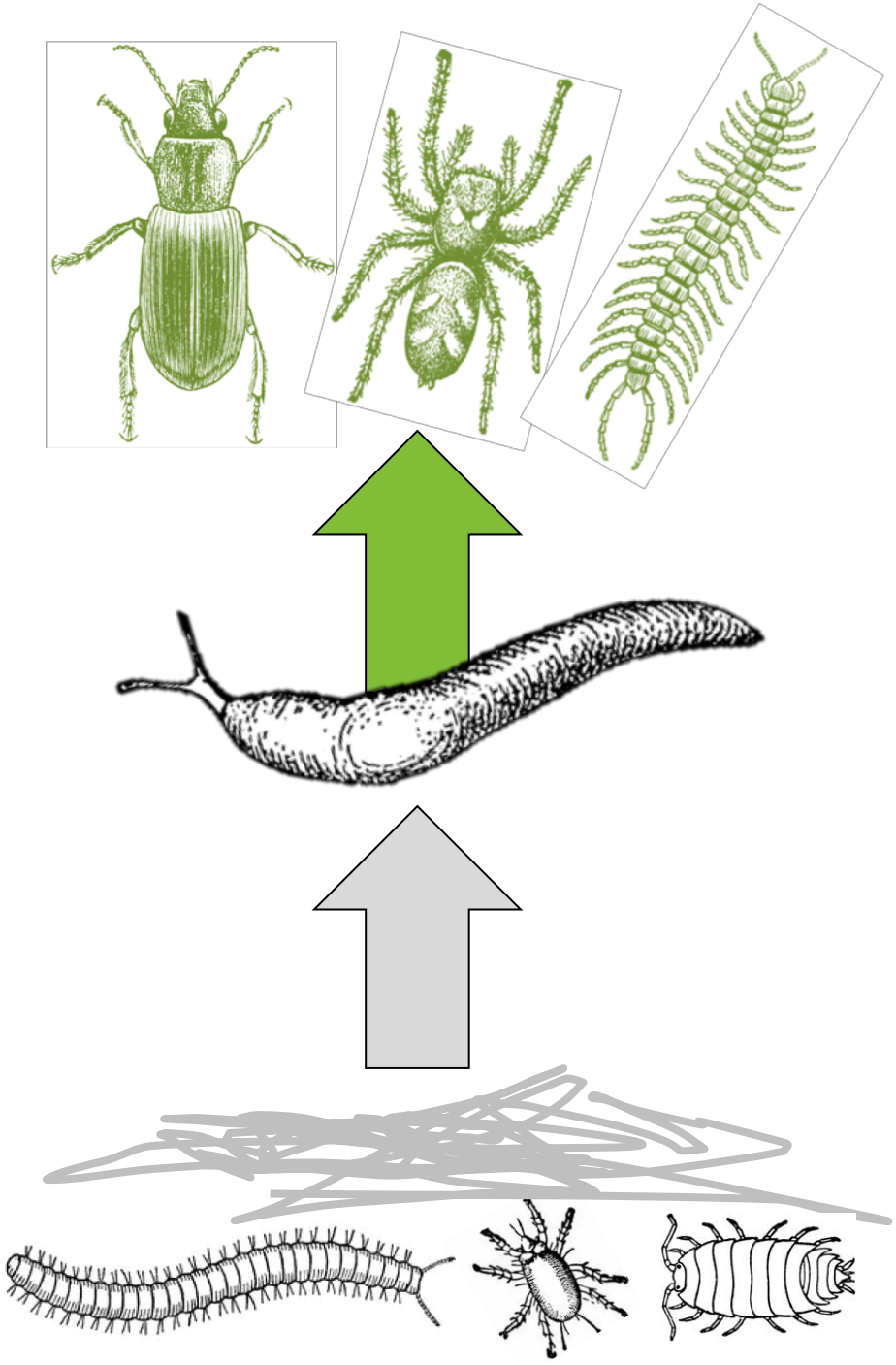
And not actually a softer method than pyrethroid s

Douglas, Rohr, Tooker , 2015

Could there be some bottom-up facilitation as well?

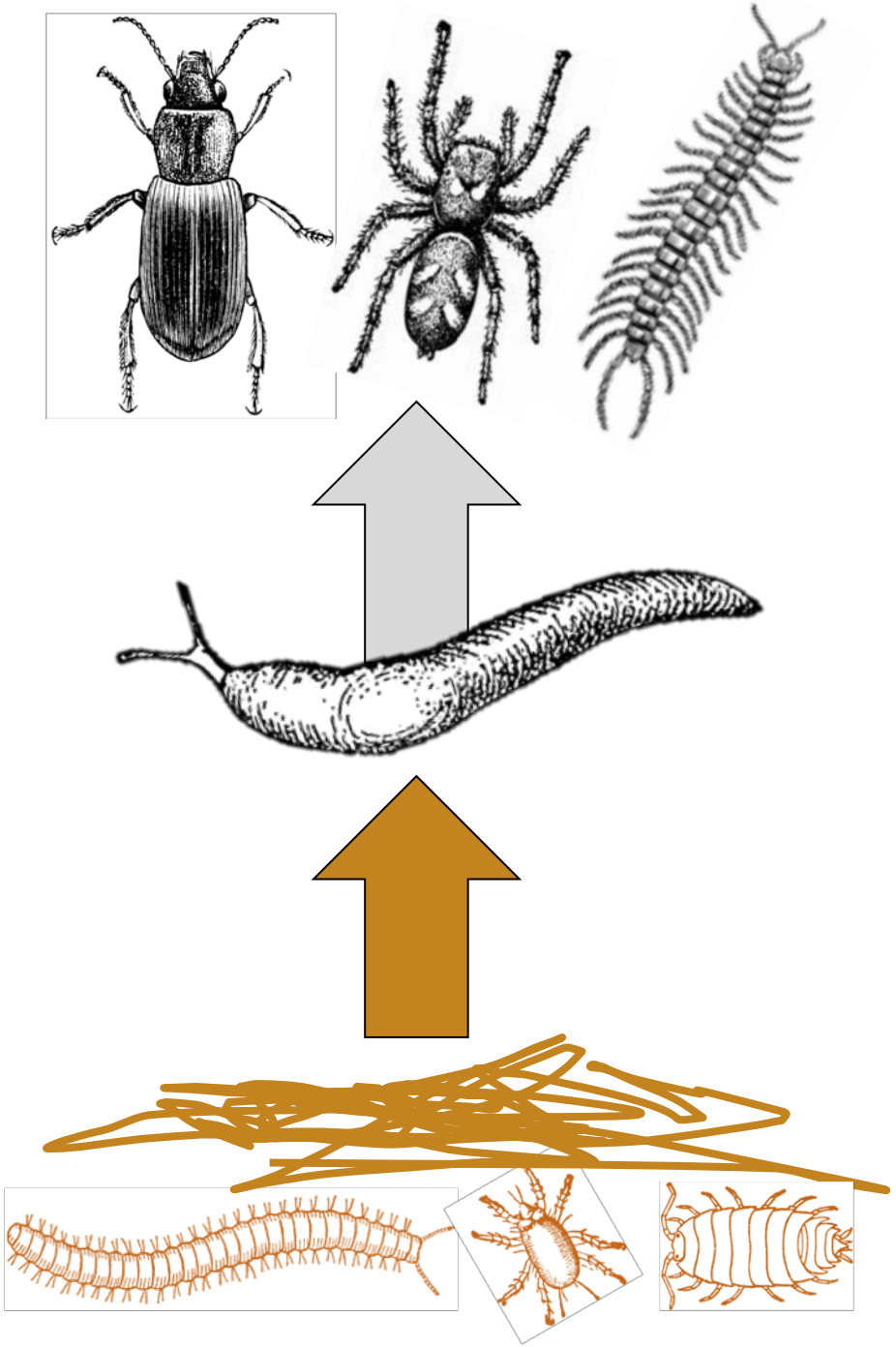
Papers on pesticide effects on decomp/neonics earthworm toxicity????

Photo: Aaron Lee Daigh



Objective 1.
Further assess NST impact on predators

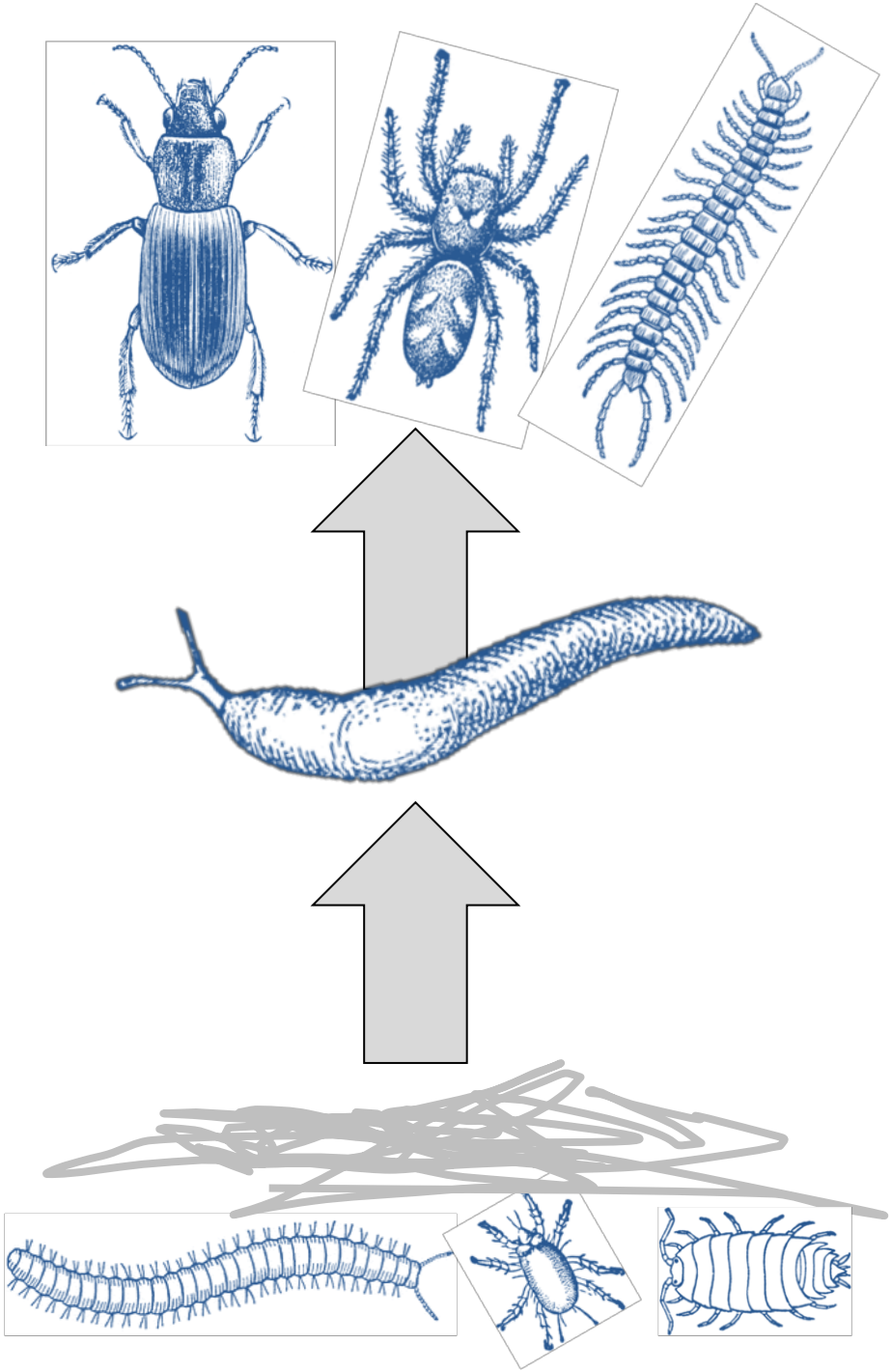
Images from http://etc.usf.edu/



Objective 1.
Further assess NST impact on predators

Objective 2. Investigate NST effects on residue breakdown

Images from http://etc.usf.edu/

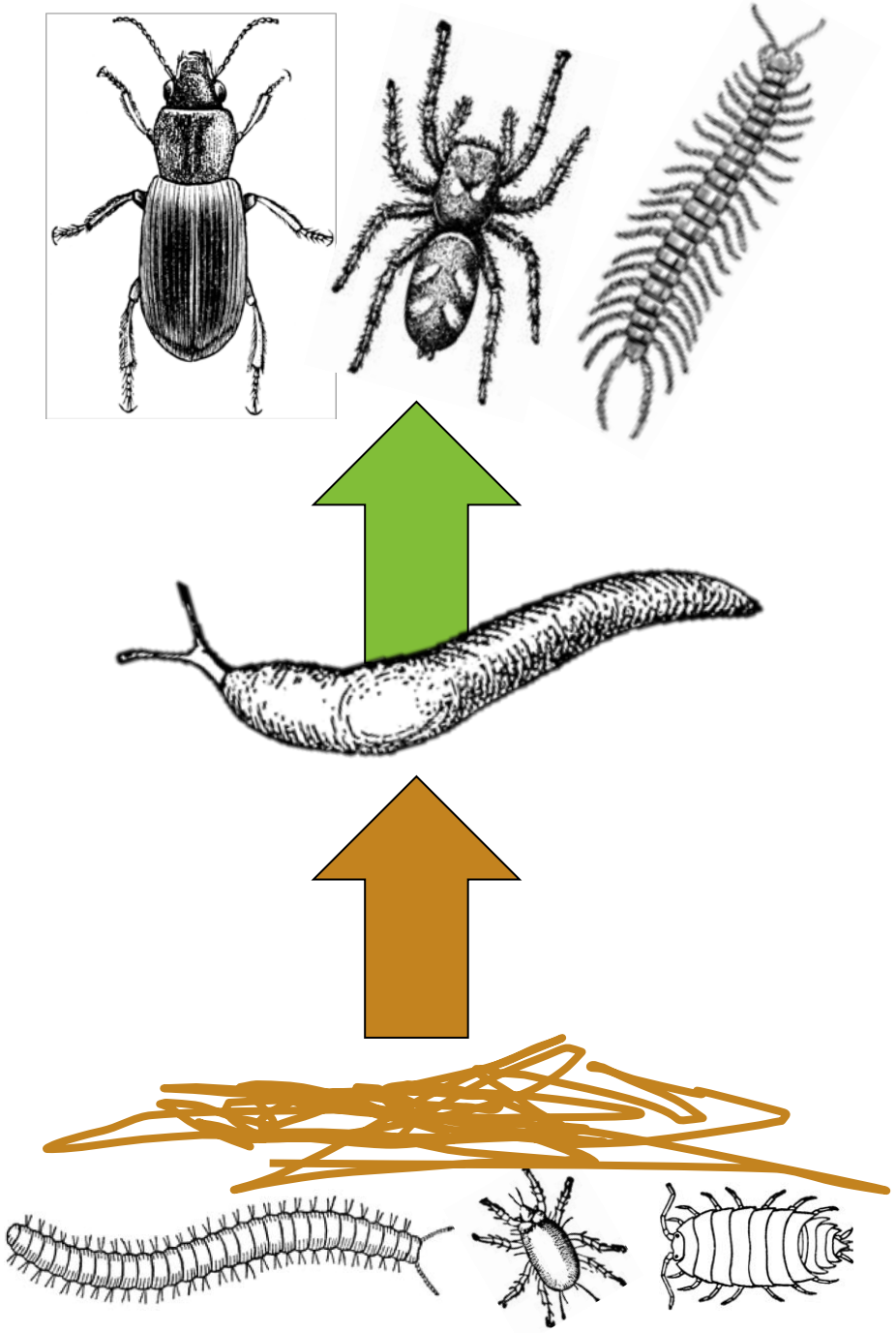


Objective 1.
Further assess NST impact on predators

Objective 2.
Investigate NST effects on residue breakdown

Objective 3.
Quantify neonicotinoid concentrations in soil invertebrates

Images from http://etc.usf.edu/



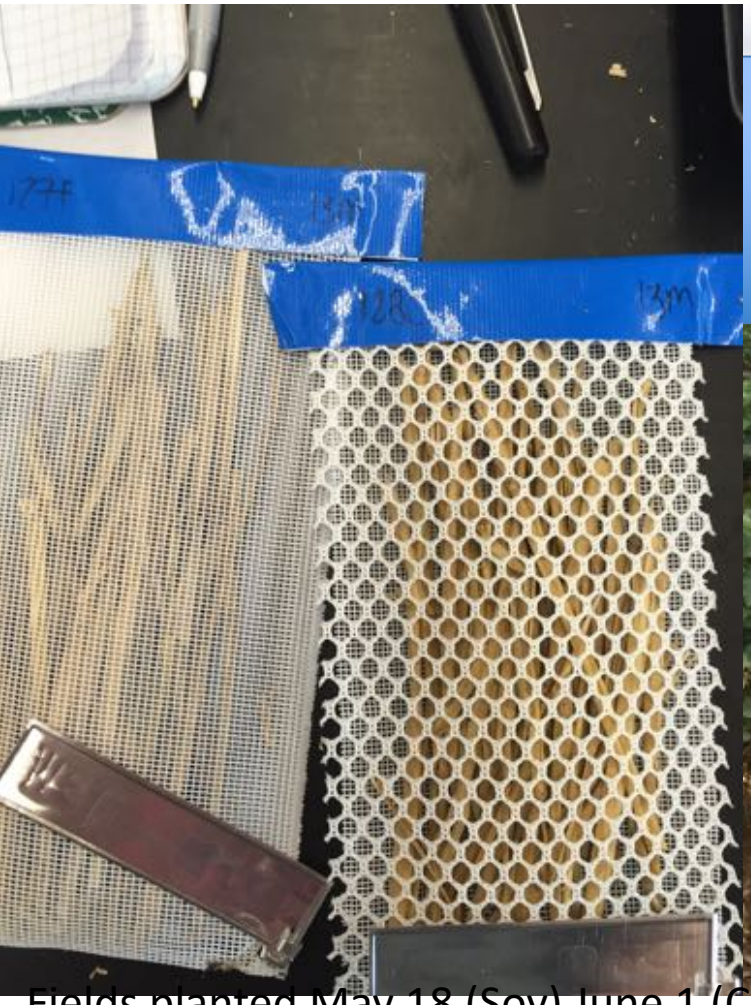
Hypothesis 1.
NSTs have negative impact on predator populations

Hypothesis 2.
NST will slow residue breakdown

Hypothesis 3.
Neonic concentrations will be at biologically relevant levels

Images from http://etc.usf.edu/

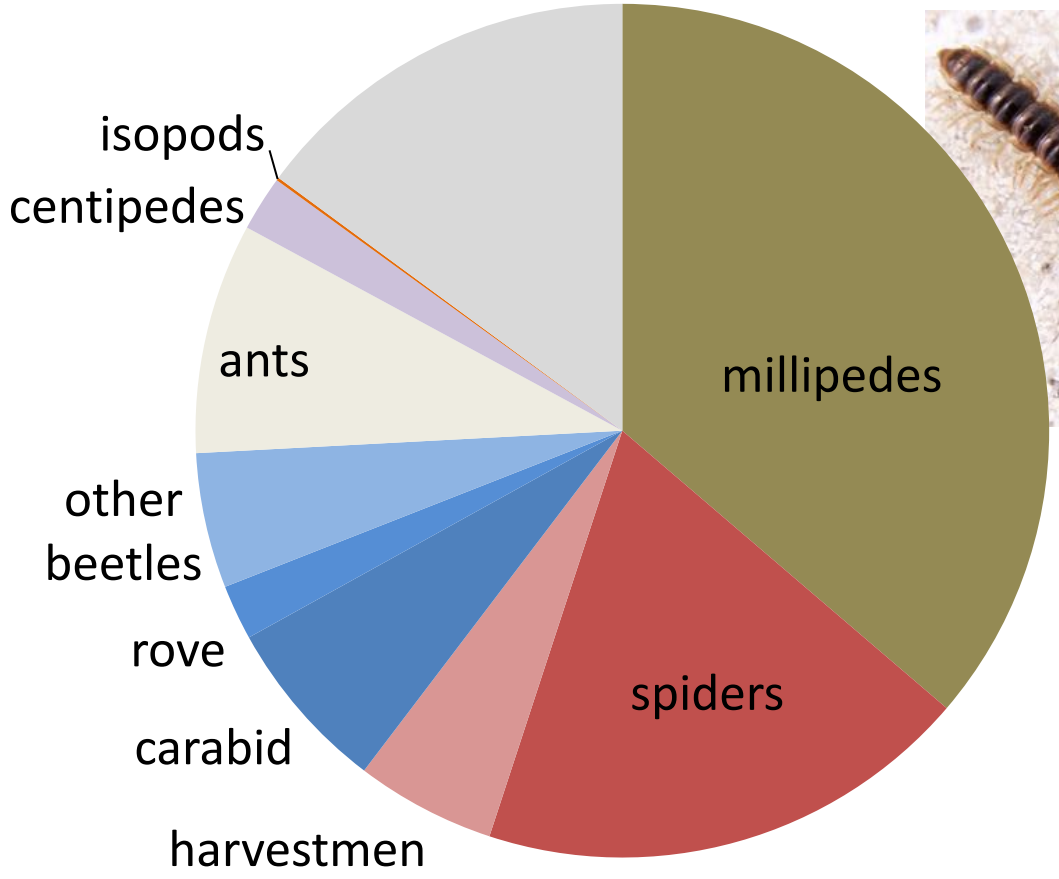
Characterizing soil invertebrate communities



Picture of Pitfall trap

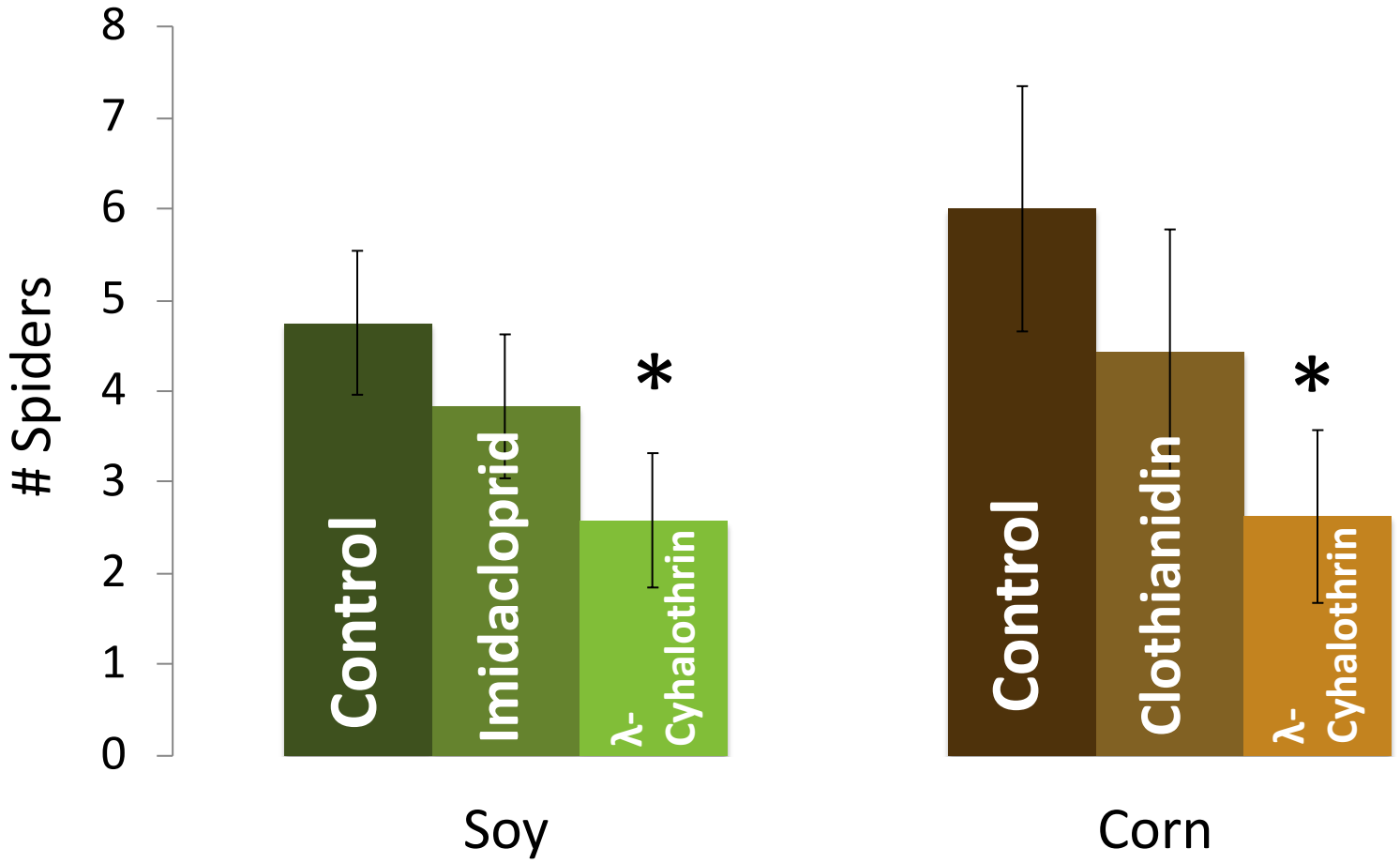
Fields planted May 18 (Soy) June 1 (Corn)
Lambda-cyhalothrin sprayed June 22

Surface-active predators dominated by spiders, macrodecomposers dominated by Oxidus gracilis



5507 specimens, 1995 = Oxidus gracilis

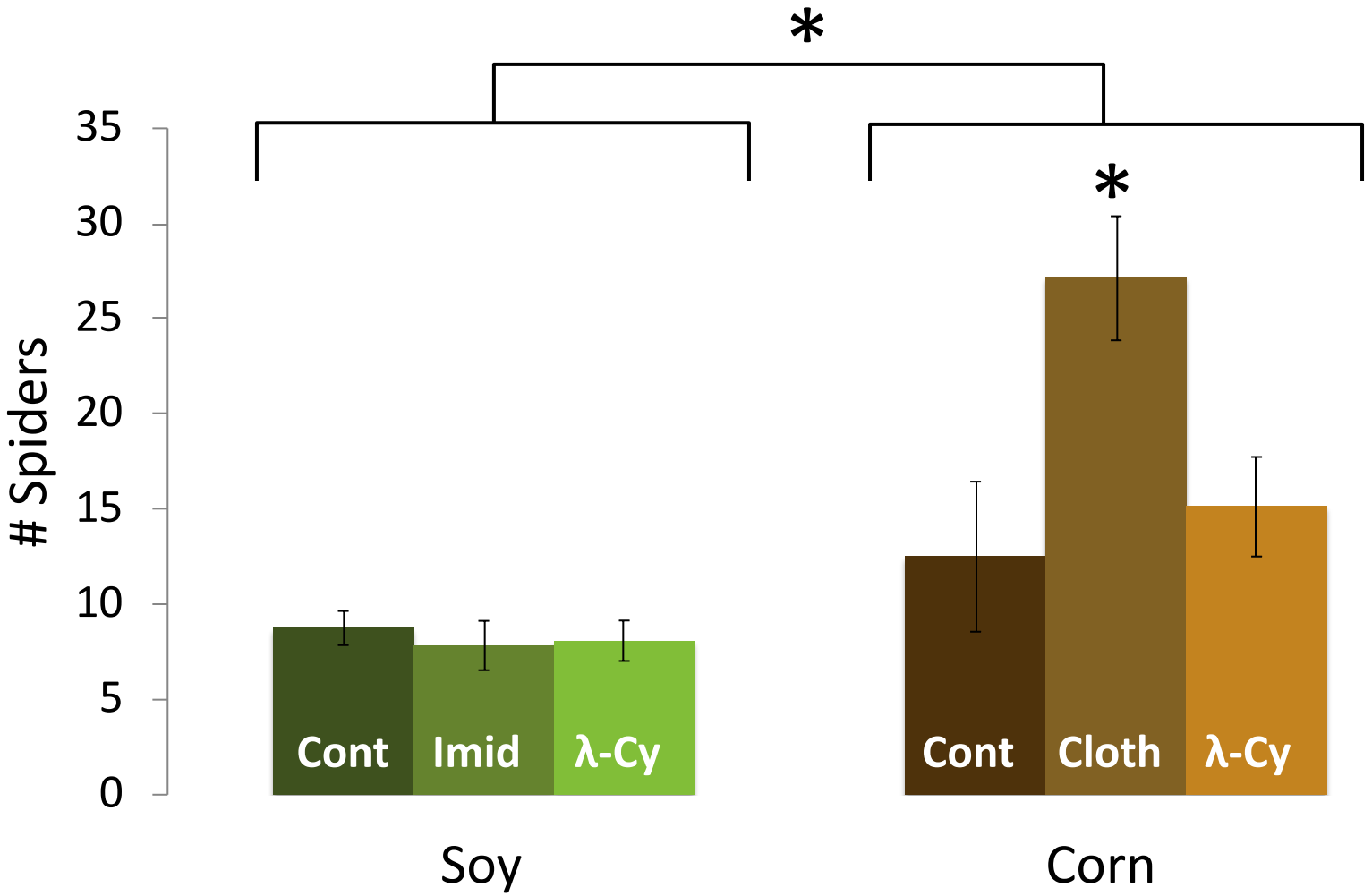
Spider population initially reduced by λ-cyhalothrin spray



glm.nb; λ-cyhalothrin, $p < 0.000518$

228 spiders

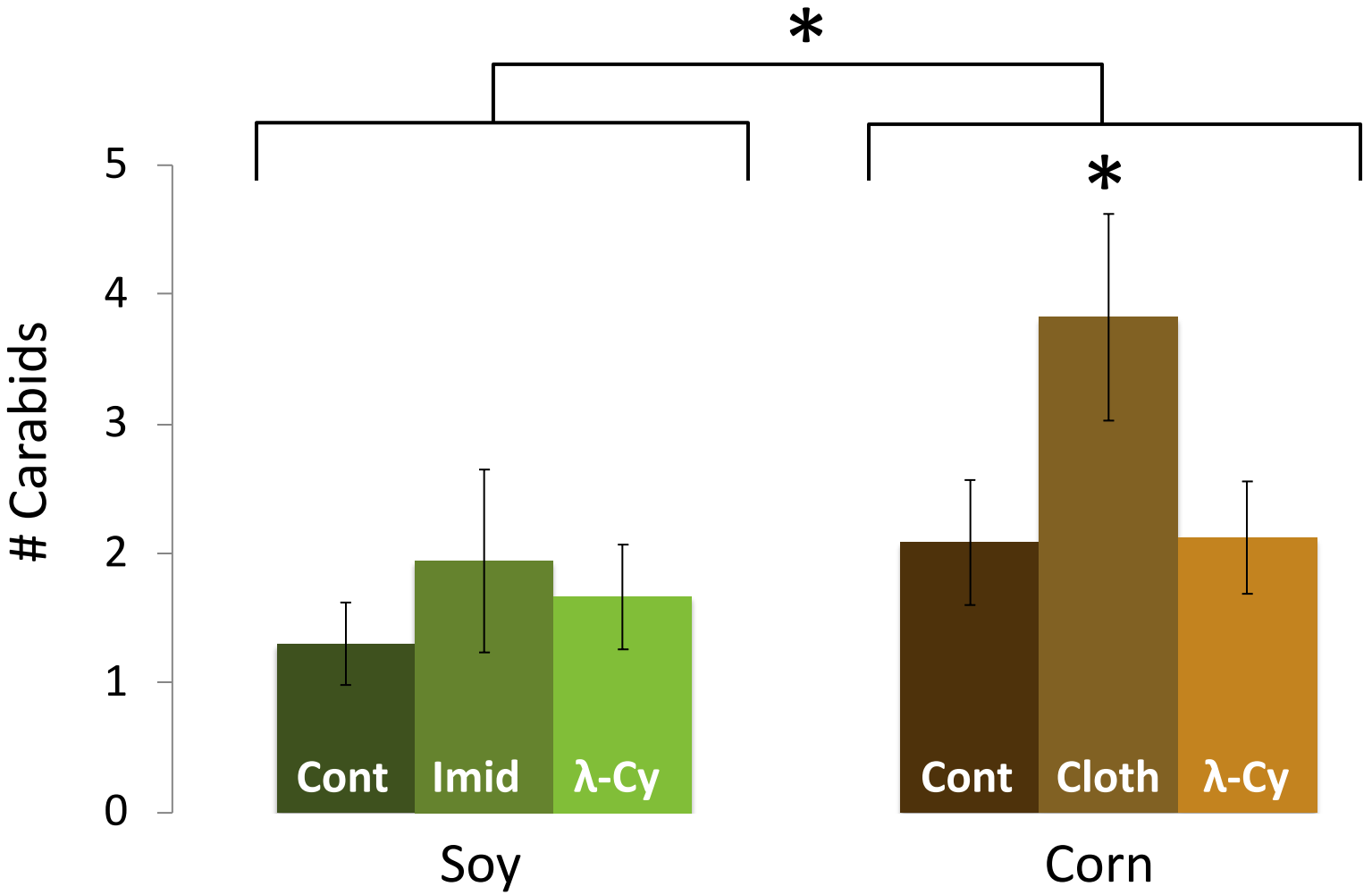
Spiders rebound with NST in corn



glm.nb; neonic, $p < 0.0884$; crop, $p < 1.21e-07$

734 spiders

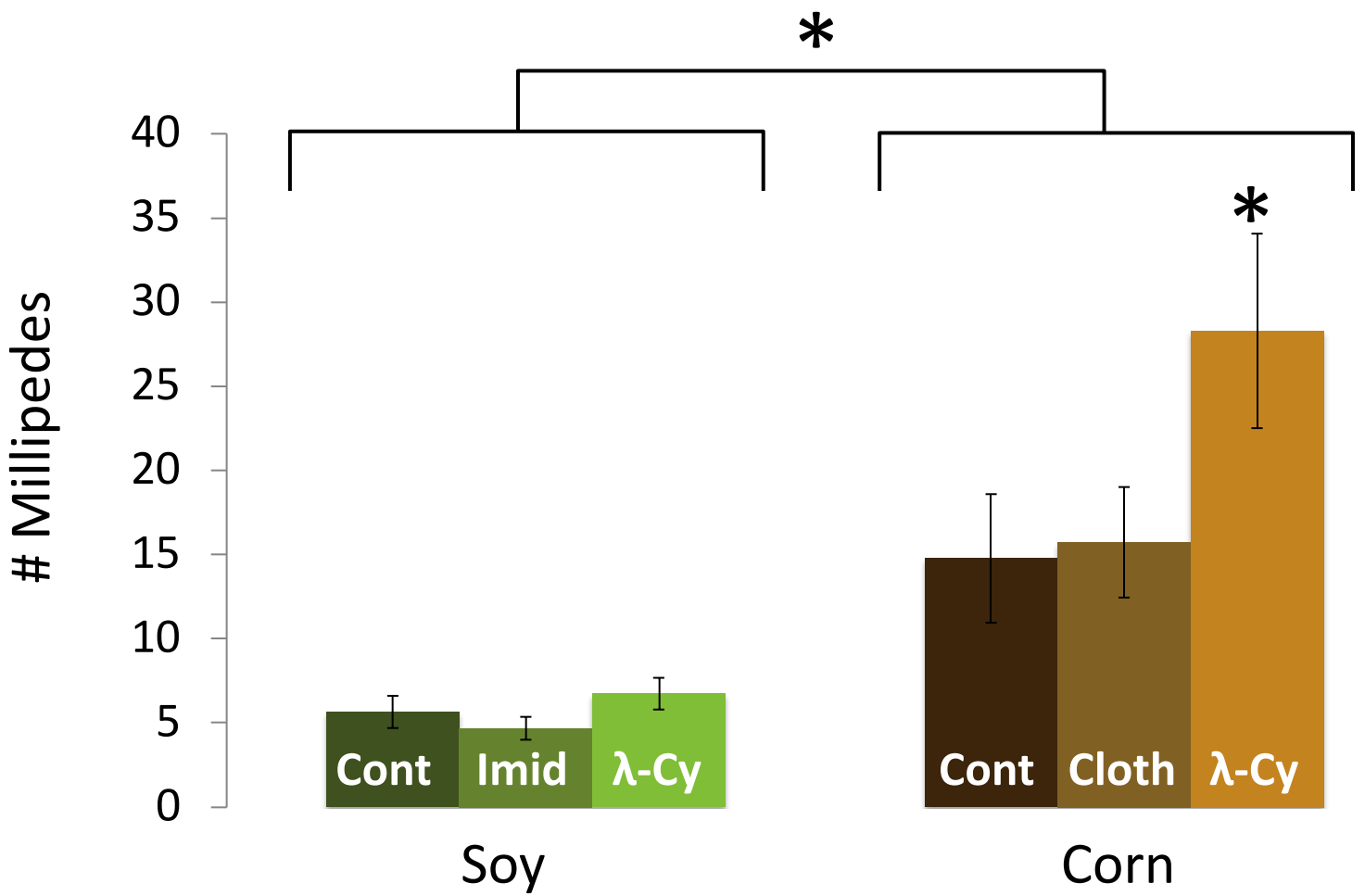
Carabids show similar trend as spiders



glm.nb; neonic, $p < 0.0567$; crop, $p < 0.0269$

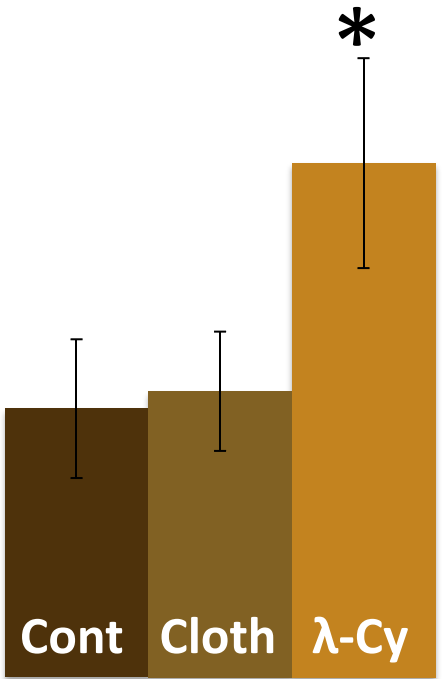
364 carabids

Fewer millipedes in soy and more in pyrethroid treatment



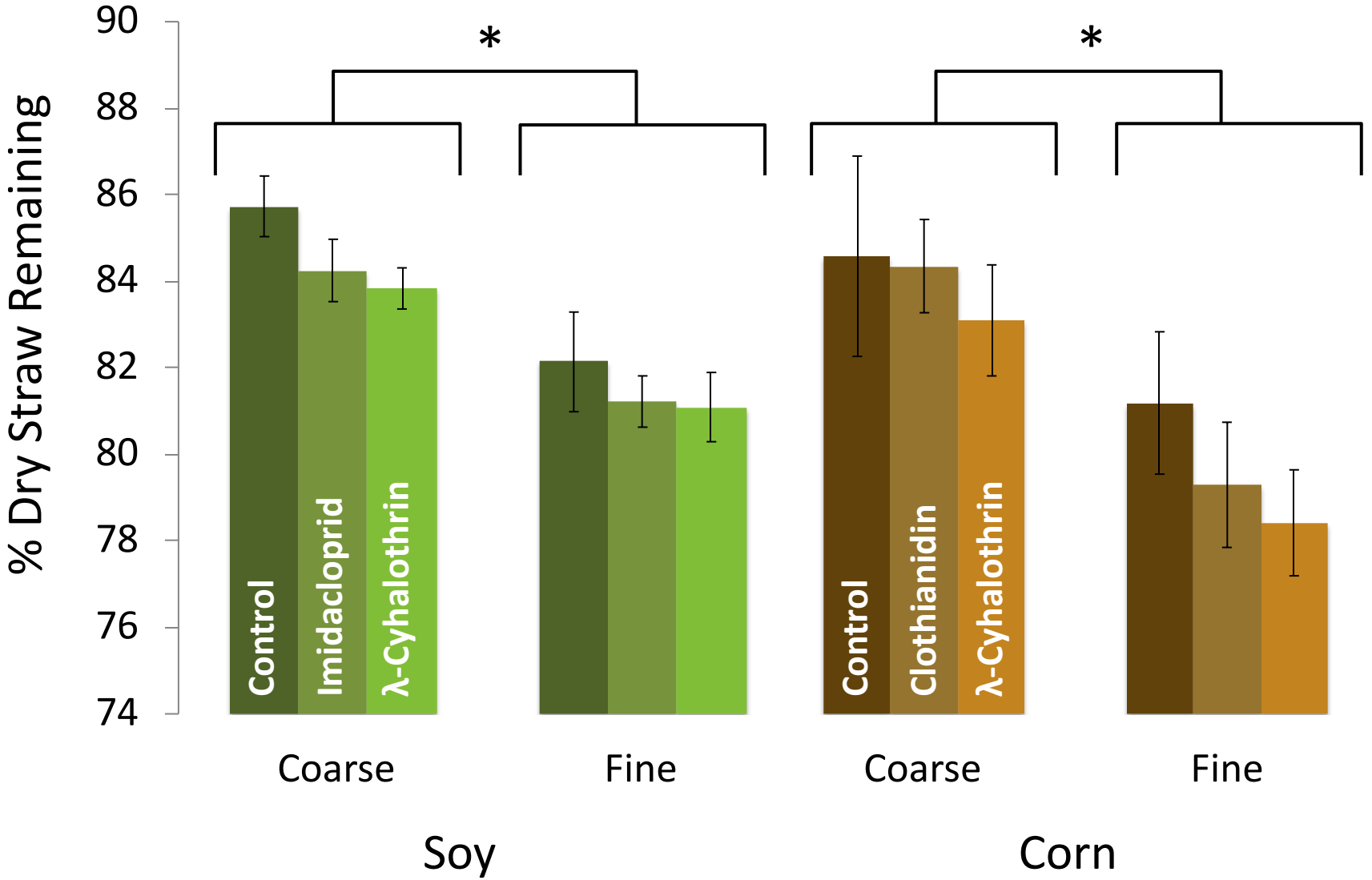
glm.nb; λ-cyhalothrin, $p < 0.0211$; crop, <2e-16

1997 millipedes



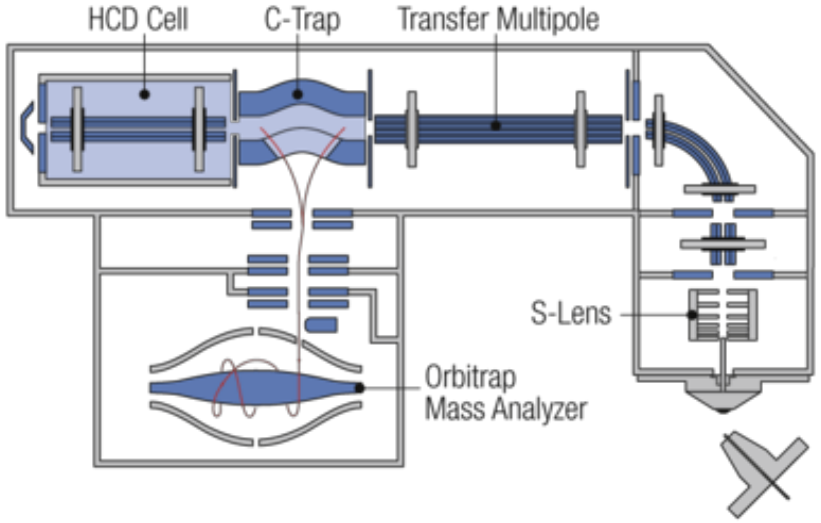
Corn

Greater loss in fine mesh bags; No correlation with millipedes



Greenhouse: Neonic concentrations in soy plants, slugs, and cutworms; control efficacy

QuEChERS Pesticide Residue Extraction Followed by Detection and Quantification with HPLC-Q Exactive MS



http://planetorbitrap.com/

Detection success! more data to come

Conclusions

- More evidence that NSTs aren't soft on biocontrol
- Some evidence that macrodecomposers, and decomposition rates may not be significantly affected by NSTs

Future Directions

Rotation next season to tease apart field vs crop effects

Ecosystem Function

litterbag decomposition study (3 years)

+ Mesofauna survey

Expanding field samples for pesticide analysis

What's up with these invasive millip

Thank You

- Northeast SARE
- Kyle Elkin, USDA-ARS
- Research Farm
- Tooker Lab
  - Summer help
- Sahakian Family

PennState
College of
Agricultural Sciences

NORTHEAST
SARE
Sustainable Agriculture
Research & Education

USDA ars

Lab Peeps

Neonicotinoid seed treatments target 2° pests:

Corn	Soybeans
Aphids	Aphids
(Black cutworm)	Bean leaf beetle
Corn flea beetle	Leafhoppers
Seed corn maggot	Seedcorn maggot
White grub	White grubs
Wireworm	Wireworm