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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University Park, PA
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
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
NSTs affect top-down biocontrol of critical PA pests

And not actually a softer method than pyrethroid sprays

Douglas, Rohr, Tooker, 2015
Could there be some bottom-up facilitation as well?

Papers on pesticide effects on decomp/neonic earthworm toxicity???
Objective 1.
Further assess NST impact on predators
Objective 1. Further assess NST impact on predators

Objective 2. Investigate NST effects on residue breakdown
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Objective 2. Investigate NST effects on residue breakdown

Objective 3. Quantify neonicotinoid concentrations in soil invertebrates
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
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
Spider population initially reduced by \( \lambda \)-cyhalothrin spray

\[
\begin{align*}
\text{Soy} & \quad \text{Control} & \quad \text{Imidacloprid} & \quad * & \lambda- \text{Cyhalothrin} \\
\text{Corn} & \quad \text{Control} & \quad \text{Clothianidin} & \quad * & \lambda- \text{Cyhalothrin}
\end{align*}
\]

glm.nb; \( \lambda \)-cyhalothrin, \( p < 0.000518 \)

228 spiders
Spiders rebound with NST in corn

Soy

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.

Soy:
- Cont
- Imid
- λ-Cy

Corn:
- Cont
- Cloth
- λ-Cy

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

1997 millipedes
# Millipedes

- Soy
- Corn

**λ**

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<thead>
<tr>
<th>Cont</th>
<th>Cloth</th>
<th>λ-Cy</th>
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* 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 millipedes?
Thank You

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

Lab Peeps
Neonicotinoid seed treatments target 2° pests:

<table>
<thead>
<tr>
<th>Corn</th>
<th>Soybeans</th>
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<tbody>
<tr>
<td>Aphids</td>
<td>Aphids</td>
</tr>
<tr>
<td>(Black cutworm)</td>
<td>Bean leaf beetle</td>
</tr>
<tr>
<td>Corn flea beetle</td>
<td>Leafhoppers</td>
</tr>
<tr>
<td>Seed corn maggot</td>
<td>Seedcorn maggot</td>
</tr>
<tr>
<td>White grub</td>
<td>White grubs</td>
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<tr>
<td>Wireworm</td>
<td>Wireworm</td>
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