Slug working group presentation

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Sustainable Dairy Cropping Systems

- **Goal**: Evaluate strategies to improve profitability and sustainability of Northeast dairies
  - Mostly no-till management
  - Incorporates cover crops into rotations
  - Testing manure, weed, and insect management strategies
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• Three crop rotations:
  – Two diverse, 6-yr rotations with cover crops
  – One corn-soy rotation without cover crops

• How do these rotations influence slugs, insect pests, and natural enemies?
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• I will present a subset of our data
• Analysis is still in progress – this is preliminary!
Experimental design:

Year 1: Corn silage
Year 2: Winter wheat
Year 3: Corn silage
Year 4: Winter canola
Year 5: Alfalfa / grass
Year 6: Alfalfa / grass

Forage:
- Manure Inject: 60'
- Manure Broadcast: 60'

Grain:
- Alfalfa
- Winter canola cereal rye
- Soybean cereal rye
- Corn grain
- Alfalfa

Red. herb.:
- Alfalfa/grass

Manure clover vetch
- Inject 60'
- Broadcast 60'

60' canola + oats
- Red. herb. Alfalfa/grass

120' Vets, clover, alfalfa + grass

40' canola + oats

120' Vets, clover, alfalfa + grass
Experimental design:

- Year 1: Corn grain
- Year 2: Soybeans

Conventional Manure
Inject

60' 50' 90'

Manure
Broadcast

60'

120'
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Large site: ~15 acres

Variable soils & history
Adventures in slug sampling...

• Attempted soil cores + flooding
  – Recovered only 15 slugs from 160 soil cores (each 11 cm diameter)

• Also attempted counting slugs on plants at night
  – Was very time consuming on a large scale

• Finally settled on the homely shingle
Methods for slug monitoring

- 8 shingles/plot
  - 1 sq ft – white
  - Brush residue aside
- 20 plots total
  - 12 corn; 8 alfalfa
- Count slugs about once/week during active periods
Methods for assessing plant damage

• Alfalfa + forage mixes
  – Stand counts + damage measurements ~40 days after planting
  – 20 samples (40cm long) per plot
  – Record presence/absence of slug damage
Methods for assessing plant damage

• Corn
  – Stand counts + damage measurements at V2 + V5
  – 8 samples (each 10ft of row) per plot
  – Record slug damage on a scale from 0 – 4
  – Also record insect damage (cutworm, billbug, etc.)
Slug activity 2010
Slug growth & development 2010

**Dotplot of Weight (g)**
Species = Deroceras reticulatum (Gray garden)

**Dotplot of Weight (g)**
Species = Deroceras laeve (Marsh)

**Dotplot of Weight (g)**
Species = Arion fasciatus (Banded)
Gray garden slug growth X crop plant
Shingle traps & slug damage

• Can slug counts under shingle traps in spring help predict crop damage?

• Can shingle traps be a useful sampling technique for large studies?

• Challenges: variability & timing
Forages: Shingle traps & crop damage

- Slugs under shingles were positively related to crop damage
- Stands were planted 4/15 and assessed 5/26
Forages: Shingle traps & crop damage

- Slugs under shingles were negatively related to stand count
- 25 – 30 plants/ft² is the target
Corn: Shingle traps & crop damage

- Sampling before manure application + planting was not very predictive (prob. too early)
- Sampling later was a little bit more predictive
Corn: Shingle traps & crop damage

- Averaging slug counts from 3 sample dates (one pre-plant and two post-plant) improved the fit

\[ y = 0.57x + 0.32 \]
\[ R^2 = 0.59 \]
Corn: Counting slugs at night

- Slugs/plant were positively related to crop damage in June

\[ y = 2.44x + 0.40 \]
\[ R^2 = 0.77 \]
Slugs have been far less abundant this year.
Gray garden slugs X cover crop 2011

Slug activity in corn was higher after certain cover crops
Slug damage was low, but did follow a pattern similar to activity under shingles.

**Damage scale:**
- 0 = no leaf area gone
- 1 = < 25% leaf area gone
- 2 = 25-50% leaf area gone
- 3 = 50-75% leaf area gone
- 4 = 75-100% leaf area gone

* bars = 1 SE
Other early season pests – V5

• Most other early season pests were rare
• Cutworm damage was highest after a rye cover crop

[Graph showing % cut plants by previous cover crop: Vetch/Rye, Red clover, Rye, None]
Natural enemy sampling

- 8 pitfall traps per plot
- Open for 48 hours every 2 to 3 weeks
- 20 plots total
  - 12 corn
  - 8 alfalfa
- Same plots as slug sampling
- Results are still to come...
Measuring predation in the field

- Waxworm caterpillars (*Galleria mellonella*) are used as sentinel prey items
- 32 deployed per plot, half in vertebrate exclusion cages
- AM: 8:30 am – 8pm
- PM: 8:30pm – 8am
- Early (June) and mid-season (July) sample dates
At night, caterpillars were attacked more quickly in the diverse rotations with cover crops.

Major night-time predators were ground beetles, ants, wolf spiders, and harvestmen.
Lab studies on slug predation

• Does central PA host potential natural enemies of slugs?

• Do these predators discriminate between slug species?

• Do predators influence slug behavior?
Laboratory predation assays

- Microcosms with slugs, predators, + soybean seedlings
- Field-collected predators are starved for one day
- Soybeans are planted one day before trial begins
- Trial is run for 4 days in a growth chamber (21° C, 12L:12D)
Laboratory predation assays

Photos from the Canadian Biodiversity Information Facility (www.cbif.cg.ca)
Laboratory predation assays

Slugs that survived in the presence of *P. melanarius* did not gain as much weight as control slugs or slugs in the presence of other predators.
Questions?
Penn State Sustainable Dairy Cropping Systems

Forage Rotation: manure management, green manure species comparison, & standard herbicide regime

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<th>MANURE MANAGEMENT</th>
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<td>Corn Silage</td>
<td>Winter Wheat</td>
<td>Underseed Red Clover</td>
<td>Corn Silage</td>
<td>Canola</td>
<td>Alfalfa + Orchardgrass</td>
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Grain Rotation: weed management, canola mycorriza comparison, & inject manure regime

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<td>Standard Herbicide</td>
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<td>Alfalfa</td>
<td>Canola</td>
<td>Rye cover crop</td>
<td>Soybean</td>
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<td>Broadcast &amp; Post-Emergent Herbicide</td>
<td>Roll rye</td>
<td>Alfalfa</td>
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<td>Reduced Herbicide</td>
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<td>Alfalfa + Grass</td>
<td>Moidboard plow</td>
<td>X Manure</td>
<td>Rye cover crop</td>
<td>Soybean</td>
<td>Banded Herbicide &amp; High Residue Cultivator</td>
<td>Roll rye</td>
<td>Triticale + Peas</td>
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Corn Grain Conventional Rotation: manure, standard herbicides, and GM-crops

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