Slugs and IPM—Healthier soil decreases troubles from menacing molluscs?

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Take home messages

Predators can help protect crops from slug/insect pests

Value knowing what pests are active in your fields

Healthy soil is alive, IPM can help protect it

Soil health: No-till, diverse rotations, cover crops, IPM
No-till in Mid-Atlantic Fields

PA: 75% of soy, 65% of corn (1.5 million acres)

Decreases labor, conserves fuel, soil & water
Corn field being eaten by slugs
~20% Mid-Atlantic no-till has yield loss from slugs (~600,000 acres)

Limited cost-effective management options

Some producers are returning to tillage to control slugs
Slugs can damage virtually all crops

- Canola
- Soybean
- Corn
- Alfalfa & Sm. grains

~20% of no-till acreage loses yield (~600,000 acres)
Gray garden slug - Most problematic species

Each individual can lay 500 eggs/year
Can feed on organic matter & weeds

eggs
Life cycles are not well synchronized (even within a species)

- Various life stages can be found at many times of year
- Mild winters or thick snow pack: increase survival
- Individuals can live more than one year

### Life cycle of Gray garden slug (*Deroceras reticulatum*)

<table>
<thead>
<tr>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
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</thead>
<tbody>
<tr>
<td>Eggs</td>
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<td>Junveniles</td>
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<td>Crop damage</td>
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<td>Eggs</td>
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<td>Adults</td>
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<tr>
<td>Crop damage</td>
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Slug management

Limited control options:

- Tillage
- Metaldehyde
- Nitrogen solutions
- Predators
  
  (Beer / salt)
No-till makes conservation possible

Stability provides a good habitat for beneficial organisms

Cover crops enhance good populations further
“Soil health” values life in soil
Soil is a home to many; it breathes.
Soil arthropods, what do they do?

Shred organic material
Stimulate microbial activity (feeding, feces)
Mineralize plant nutrients
Enhance soil aggregation
Burrow
Stimulate succession of species
Control pests
Integrated Pest Management is key for soil health

Uses a combo of biological, cultural, chemical tactics

Introduced in 1959 by entomologists to:

Ensure profitability:
- Only use insecticides when it will pay
- Protect natural enemies

Will help avoid:
- Resistance
- Pollution
- Reducing natural-enemy populations

Do natural enemies matter?
Deer strongly influence forest regrowth
Exclusion experiments reveal the impact of deer

Plumb et al., National Park Service
Natural experiment revealed the influence of predators
Natural experiment revealed the influence of predators

Predators can protect plant growth

Can we take advantage of this in agriculture?
Ground beetles = lions of no till fields

Black cutworm
True armyworm
Stalk borer
Wireworm
Slugs
Ground beetles = lions of no till fields
Strong predator populations can protect plants from pests
Insecticides are valuable tools

 Foliar, soil, seed treatments – tend to be overused

• Use via Integrated Pest Management

• Unintended consequences
  • Decrease good insects, can make pest problems worse
  • Environmental concerns
Soil function is highest with no insecticides

- High: 8-12 oz
- Med: 4-5 oz
- Low: 1-2 oz
- None: 0 oz

Insecticide use:
- Low: 1-2 oz
- Med: 4-5 oz
- High: 8-12 oz
- None: 0 oz

Wickings, Cornell
Neonic seed treatments exacerbate slug problems
Neonicotinoid seed treatments

May protect yield

Targeted application

Systemic activity

Low dose

• Very toxic to insects

• Low mammalian toxicity
Neonicotinoid seed treatments target 2° pests:

<table>
<thead>
<tr>
<th>Corn</th>
<th>Soybeans</th>
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</thead>
<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><strong>Seed corn maggot</strong></td>
<td><strong>Seedcorn maggot</strong></td>
</tr>
<tr>
<td>White grub</td>
<td>White grubs</td>
</tr>
<tr>
<td><strong>Wireworm</strong></td>
<td><strong>Wireworm</strong></td>
</tr>
</tbody>
</table>
Do neonics exacerbate slug populations in the field?

**Treated**
Thiamethoxam (0.152 mg/seed) + fungicides (CruiserMaxx)

- N = 6
- 0.25-acre plots
- No-till planted in 30” rows

**Untreated**
Slugs decrease soybean yield

(d) $R_p^2 = 0.92$
$R_{sp}^2 = 0.05$
$P = 0.003$

(c) $R_p^2 = 0.81$
$R_{sp}^2 = 0.66$
$P = 0.014$

Soybean plants (10000/ha)

Slugs (#/trap)
Predators control slug populations

Insecticides disrupt biological control
Neonic seed treatments generate toxic slugs
Bottom line:

- Manage for the pests you have
  - Insecticide use can make pest populations worse
What do insecticides in the soil do to arthropod populations?

Insecticides exacerbate slug populations by killing predators.

Another example:

Slugs in Australia
Penn State Diversified Dairy Cropping Systems project

One two-year corn-soy rotation
   Bt, seed treatments, broadcast pyrethroid

Two six-year rotations (cover crops, alfalfa, corn, small grains)
   IPM (no Bt or seed treatments, insecticides as necessary)

Pests have been worse
No-till, diversity (crop rotation + cover crops) builds predator pops
Insecticides can disrupt natural control

Scrutinize, optimize insecticide usage

• Soil insecticide, broadcast, seed treatments, etc.

Use Integrated Pest Management to protect allies

• Scout
• Apply economic thresholds
• Use insecticides only when it makes economic sense
  • Avoid disrupting natural control
Lucas Criswell (Union County, PA): IPM and soil health
Lucas Criswell (Union County, PA)

Observation: clean fields provide one food source – the crop
Can intercropping improve slug control?

Rye planted between soybean rows
Ground beetles

Slug damage to corn

Intercropping decreases slug damage, increases predators.
Planting green to combat slugs, version 1…
Soil is covered always, increasing organic content, biodiversity
Need to commit to IPM (Scouting)
Planting green, all in, version 3...
Benefits to rolling:
- Uniform cover
- Better planting
- Biomass persists longer

Rolled rye, side by side:
203 bu/ac - treated Acremax
204 bu/ac – untreated untraited

Saving ~$9000 in pesticides
Benefits to keeping soil covered:
• Less soil erosion, weed suppression, natural enemy habitat
Building soil health:

1. Build resilience
   - Farm with diversity and conservation in mind
     - No-till
     - Crop rotation
     - Cover crops

Protect soil health: IPM

2. Know what’s happening in your fields
   - Scout to know what pests are present
     - Use insecticides if populations exceed econ. threshold
     - Protects natural enemies
Take home messages

Predators can help protect crops from pests

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Soil health: No-till, diverse rotations, cover crops, IPM