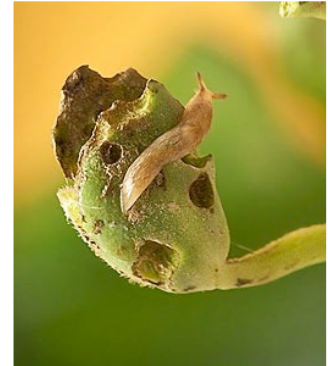




THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES



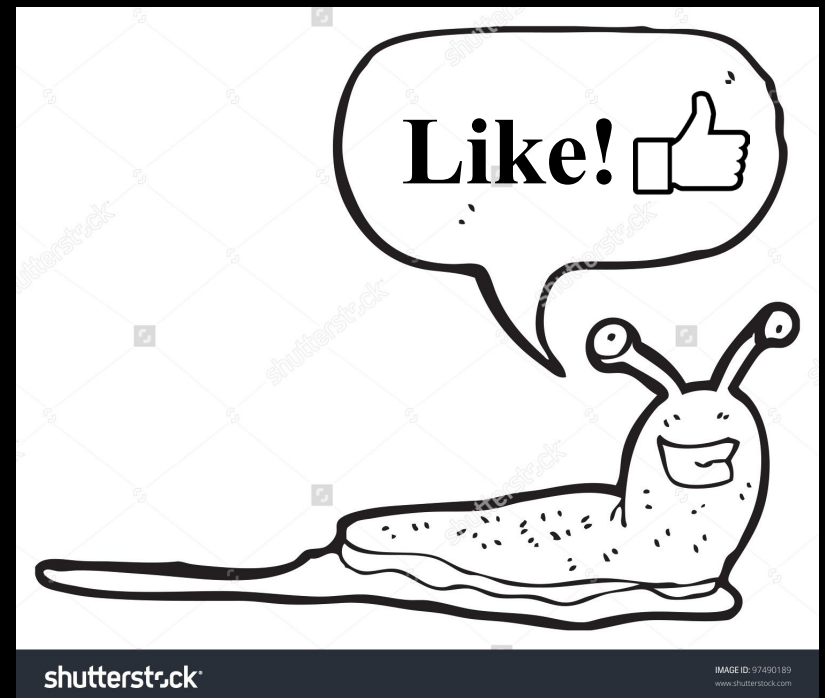
Dr. Kelley Tilmon
Department of Entomology
Ohio State University

How to describe a slug?

Slimy! Need moist habitats



- Slugs thrive in habitats that are
 - Moist
 - Protected
 - Un-disturbed
 - Moderated temperature



No-Till and Cover Crop Agriculture



- Weed control
- Erosion control
- Conserves soil moisture
- Builds soil structure and health

- Weed control
- Erosion control
- Conserves soil moisture
- Builds soil structure and health

- Slugs!
- Most slug problems are in no-till and CC fields



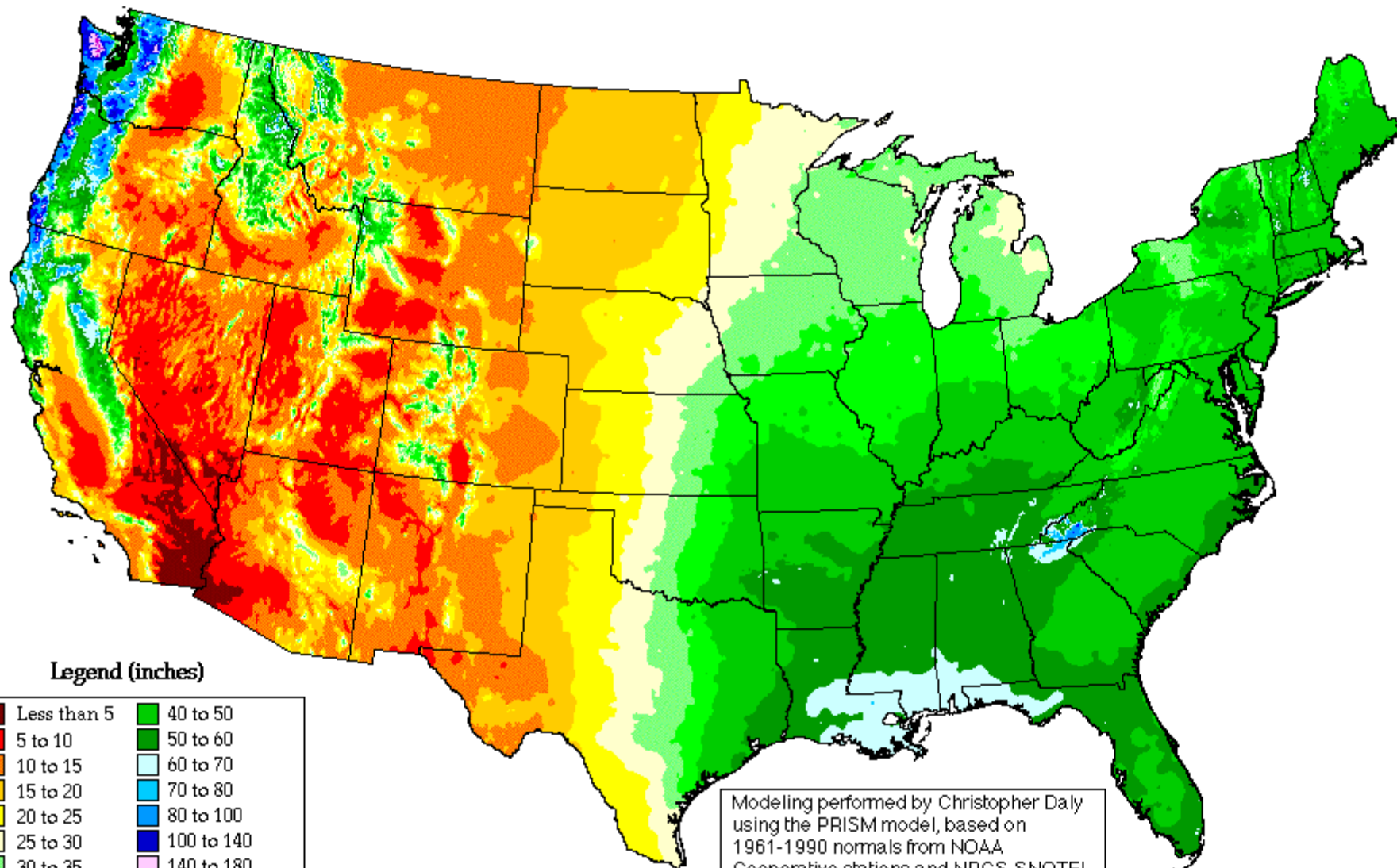
A bigger problem in some parts of the country

- Eastern corn belt
- Middle Atlantic
- Places with high no-till/CC adoption AND moisture



Annual Average Precipitation

United States of America



Legend (inches)

Less than 5	40 to 50
5 to 10	50 to 60
10 to 15	60 to 70
15 to 20	70 to 80
20 to 25	80 to 100
25 to 30	100 to 140
30 to 35	140 to 180
35 to 40	More than 180

Period: 1961-1990

Modeling performed by Christopher Daly using the PRISM model, based on 1961-1990 normals from NOAA Cooperative stations and NRCS SNOTEL sites. Sponsored by USDA-NRCS Water and Climate Center, Portland, Oregon.

Oregon Climate Service
George Taylor, State Climatologist
(541) 737-5705

Slugs an increasing problem in recent memory

- Cool, wet springs
- More no-till/CC fields
- Fields in no-till/CC for longer periods
 - Allows greater accumulation of slug populations

Lack of research on slugs in field crops

- Slugs less of a historic problem
- Only a problem in certain places
 - Lack of chemical company R&D
 - Lack of USDA and other non-profit research investment
- But...more Land Grant research in recent years due to increasing problem in no-till

Slug Biology and Damage

Slug species in eastern corn belt



Gray garden slug
Deroceras reticulatum



Marsh slug
Deroceras laeve



Banded slug
Arion fasciatus group



Dusky slug
Arion subfuscus
group



Most important
in field crops

Slugs can damage virtually all crops

Canola



Corn



Soybean



Alfalfa &
Sm. grains



Slug Damage in Corn



Slide courtesy of John Tooker, Penn State

Slug Damage in Soybean







Hay mower in mixed-grass hay field, Franklin Co. PA, 9 PM, May 2012

Photo courtesy of John Tooker, Penn State



Same night, different grower

Photo courtesy of John Tooker, Penn State

- Yield loss in no-till estimated at ~20% in Mid-Atlantic
- Final damage can be worse in soybean
 - Exposed growing point
 - if eaten, seedling won't recover
 - Greater chance of stand loss
- Can also feed on weeds and organic matter



Slug Food Chain



Predators



Gray garden slug
Deroceras
reticulatum



Marsh slug
Deroceras laeve



Banded slug
Arion fasciatus
group



Dusky slug
Arion
subfuscus
group



Other foods...



Crops



Alternative food plants

Slug Life Cycle

Adults can
live more
than one
year



Egg

Gray
garden slug
can lay 500
eggs/year



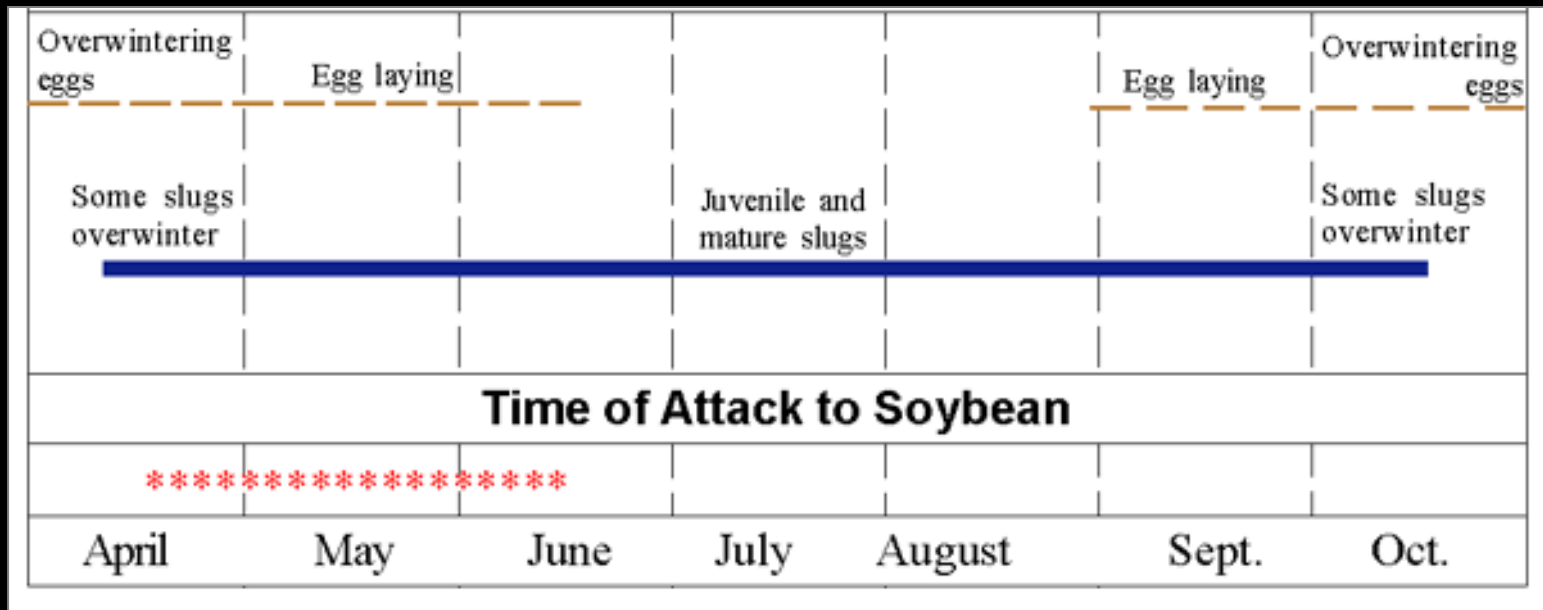
Adult



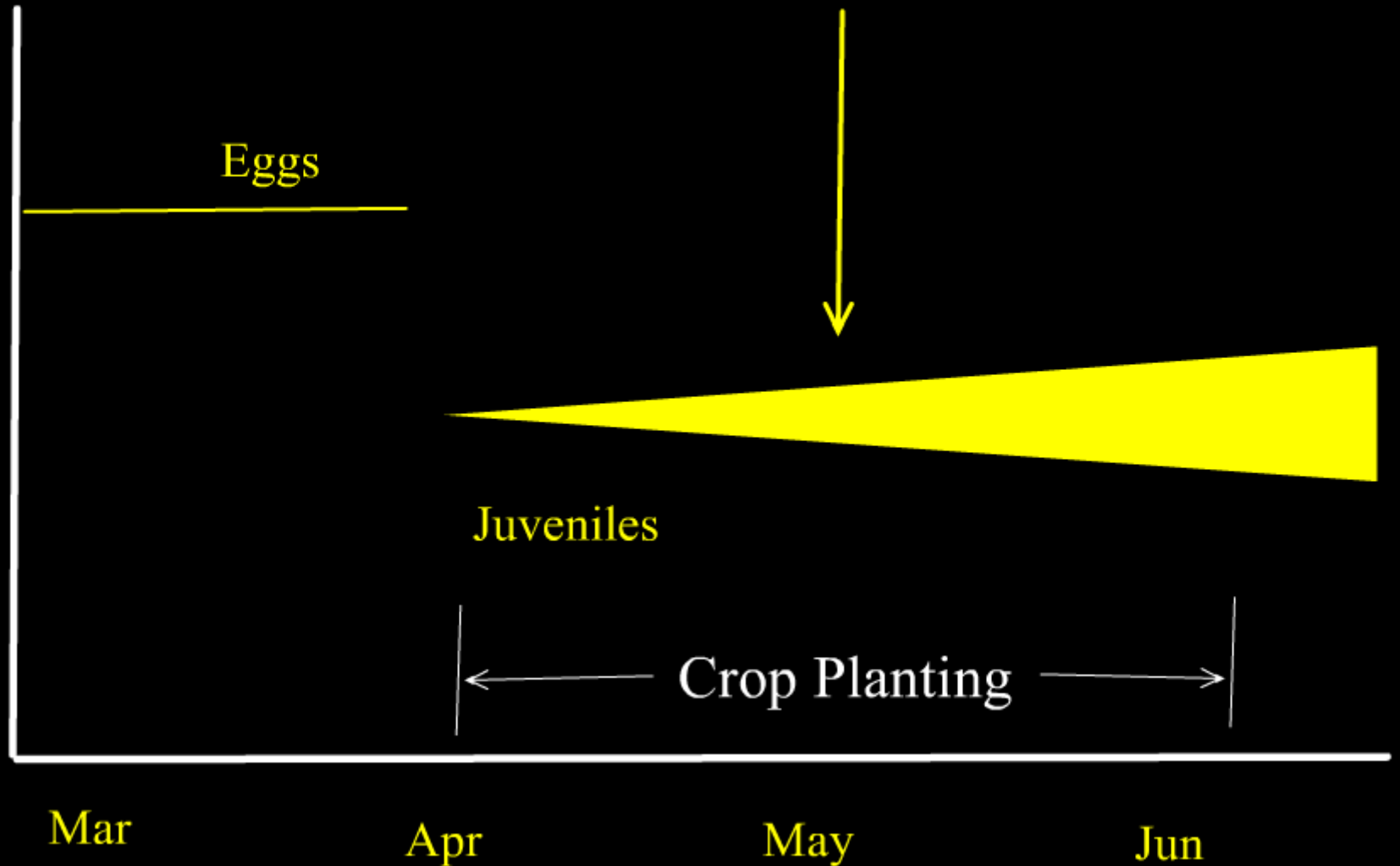
Juvenile

Slug Life Cycle

- Life cycles are not well synchronized – various life stages occur at the same time
- The bigger the slug, the greater the feeding



Slug Problems



Slug Management

- Scouting
- Tillage
- Plant early
- Molluscicide baits
- Other approaches

- Slugs are nocturnal – scouting after sundown is best way to find them and assess populations



Scouting

- Look for slugs after sundown

Scouting

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- Monitor fall slug populations to identify problem fields for next year

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- Monitor spring slug populations and injury

Scouting

- Look for slugs after sundown
- Monitor fall slug populations to identify problem fields for next year
- Monitor spring slug populations and injury
- Rescue treatments (molluscicide baits)
 - No good thresholds – go with your gut
 - Younger plants combined with heavier feeding
→ greatest damage potential

Slug Management

- Scouting
- Tillage
- Plant early
- Molluscicide baits
- Other approaches

Slug damage in heavy-residue field



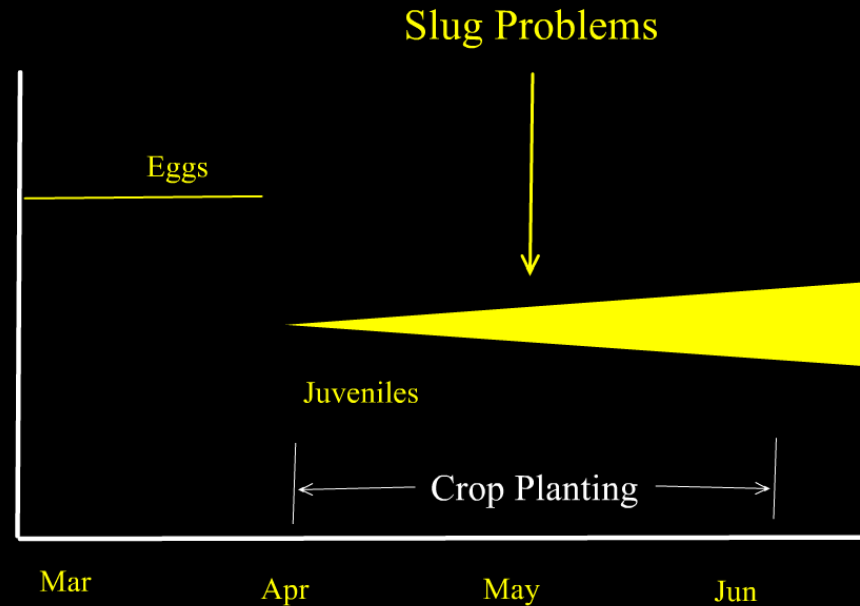
Light tillage and residue removal (same field,
same time)



Slug Management

- Scouting
- Tillage
- Plant early
- Molluscicide baits
- Other approaches

- Plant early and adopt practices to accelerate growth
- Help plants to get ahead of the slug life stages



Slug Management

- Scouting
- Tillage
- Plant early
- Molluscicide baits
- Other approaches

- Insecticides are ineffective against slugs
- Other chemical options are very limited
 - Metaldehyde (e.g., Deadline, Metarex, etc.)
 - Iron phosphate products (e.g., Sluggo, Ferroxx)
- Both are formulated as feeding baits
 - Not contact poisons; must be ingested
 - Can be expensive



Metaldehyde

- Swiss manufacturer (Lonza) recommends 5% active ingredient
- Most U.S. formulations range from 3.5 – 4%
 - Some garden products even less
 - Older slug baits were as low as 2%
 - Sub-toxic doses, slugs can recover
 - Look for higher % of active ingredient

Metaldehyde

- Approved for broadcast application in corn and soybean
- Rates (Deadline MP)
 - Corn, 25 lbs/acre
 - Soybean, 10 lbs/acre

Deadline MP label 2016

Crop	Growth Stage ¹	Maximum Single Application Rate (lbs/Product/A)	Total number of applications per season ³	Re-application Interval (days)	Preharvest Interval	Application Information
Corn (field)	Up to V8	25	3	7	0	Broadcast or Ground directed
Corn (field)	V-8 - VT	25	3	7	0	Ground directed only
Soybean ²	Up to V4	10	3	7	0	Broadcast or Ground directed
Soybean ²	V4-R1	10	3	7	0	Ground directed only

¹Growth stages are according to the Iowa State University Crop Guides:

Corn - <http://www.agronext.iastate.edu/corn/docs/corn-field-guide.pdf>.

Soybeans - http://extension.agron.iastate.edu/soybean/production_growthstages.html

²Only for use in the following states: Alabama, Arkansas, Connecticut, Delaware, Georgia, Louisiana, Maine, Maryland, Massachusetts, Mississippi, North Carolina, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia. Livestock may not graze in the treated fields. Applications must be completed prior to pod formation.

³The maximum number of application per crop per season is 3.

- Good coverage is important, but tricky



- Does it work? It can...

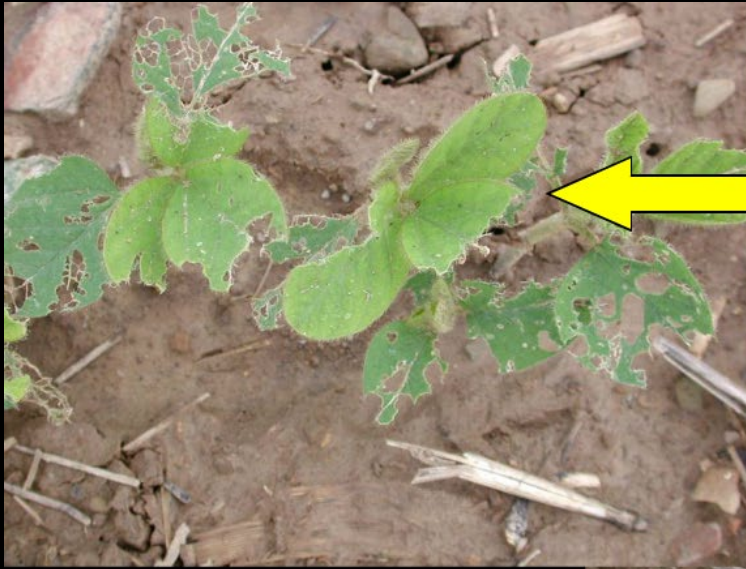


← with Bait

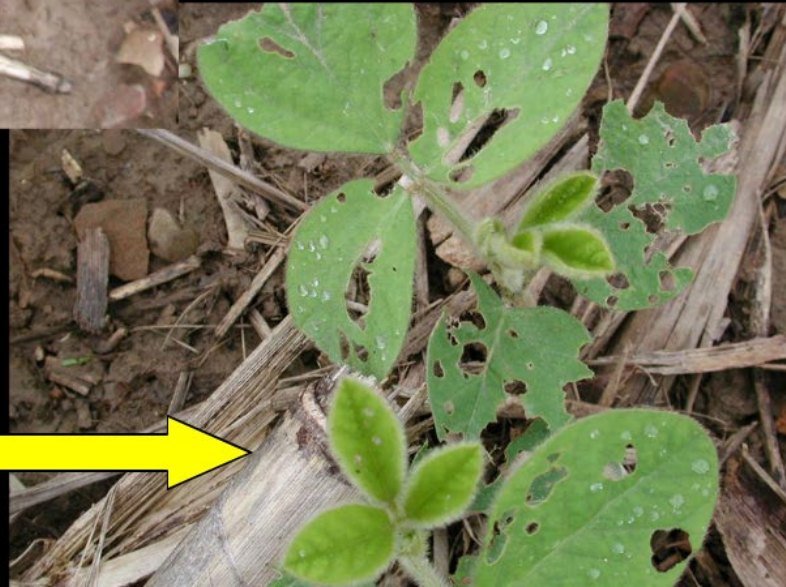


No Bait →

- Did it work? Go back and check...
 - Check after dusk, look for slugs
 - Look for new plant growth without damage



**Continued
Feeding**



**No Further
Feeding**

Iron Phosphate Bait

- Some approved for organic farming
- Not as effective as metaldehyde
 - Typically requires higher rate
 - Usually more expensive
- Sluggo (by Deudorf) = older formulation
 - Ferroxx = newer formulation (a chelated iron) – may be more effective; research needed

Slug Management

- Scouting
- Tillage
- Plant early
- Molluscicide baits
- Other approaches

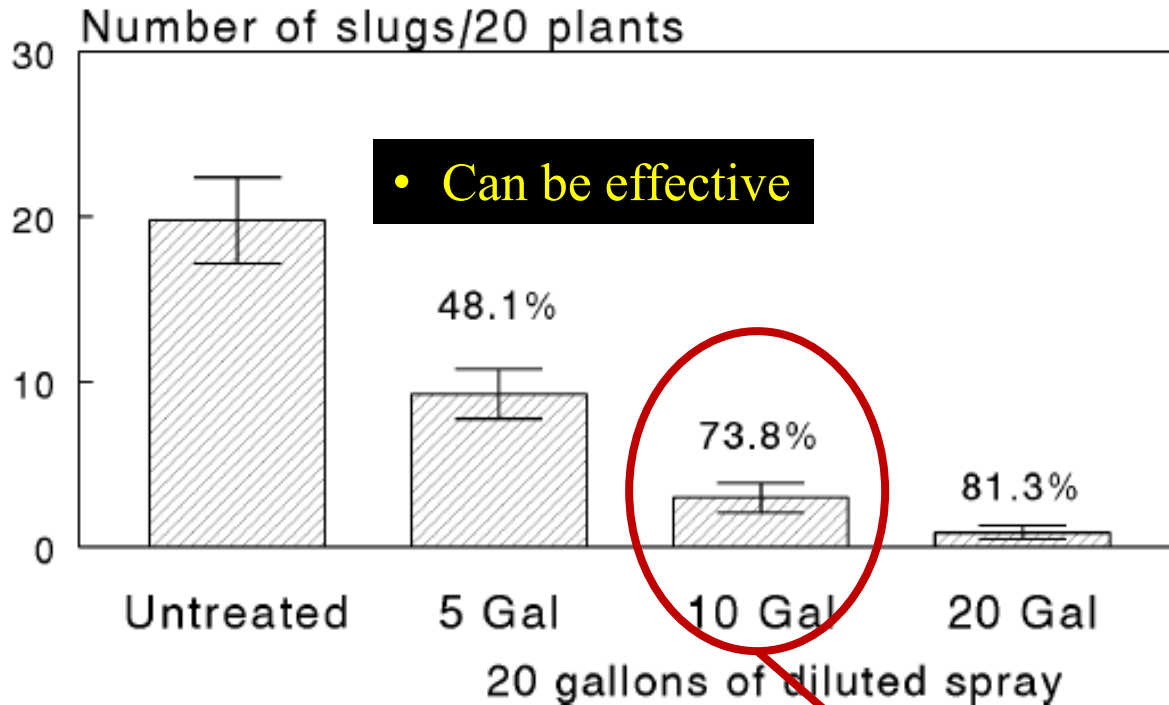
Nitrogen solutions

- “Rule of 3” (30% N [1:1 in water], 3 am, 3 nights in a row)
 - Night application --
N must contact slugs directly
 - This rate can cause toxicity to soybean (better for corn)
 - Efficacy? Only one study

Nitrogen solutions

- “Rule of 3” (30% N [1:1 in water], 3 am, 3 nights in a row)

Figure 4. Effect of 30% urea-based nitrogen applied as a broadcast spray at night on slug activity. Means \pm one standard error. Number over bar indicates % control. 1994.



- Night application -- N must contact slugs directly
- This rate can cause toxicity to soybean (better for corn)
- Efficacy? Only one study

10 gal of urea in 10 gal water

Galen Dively, U. MD

Lannate spray

- An insecticide, but labeled for use on slugs in corn and soybean in certain states
- Also a nighttime, direct-contact application
- One study in state of Delaware: at 5 days after treatment, no significant difference in damage or slug counts between treated and check



DUPONT™ LANNATE ® LV INSECTICIDE

EPA Reg. No. 352-384

**FOR USE ON FIELD CORN AND SOYBEANS FOR THE
CONTROL OF SLUGS IN THE STATES OF DELAWARE,
ILLINOIS, INDIANA, KENTUCKY, MARYLAND,
MICHIGAN, NEW JERSEY, OHIO, PENNSYLVANIA,
VIRGINIA, AND WEST VIRGINIA**

Some Interesting New Research

- Dr. John Tooker and lab, at Penn State University
- Looking at relationship between ground beetles, slugs, and neonicotinoid seed treatments

Slug Food Chain



Predators



Gray garden slug
Deroceras
reticulatum



Marsh slug
Deroceras laeve



Banded slug
Arion fasciatus
group



Dusky slug
Arion
subfuscus
group



Other foods...



Crops



Alternative food plants

Ground beetles: The lions of no till fields



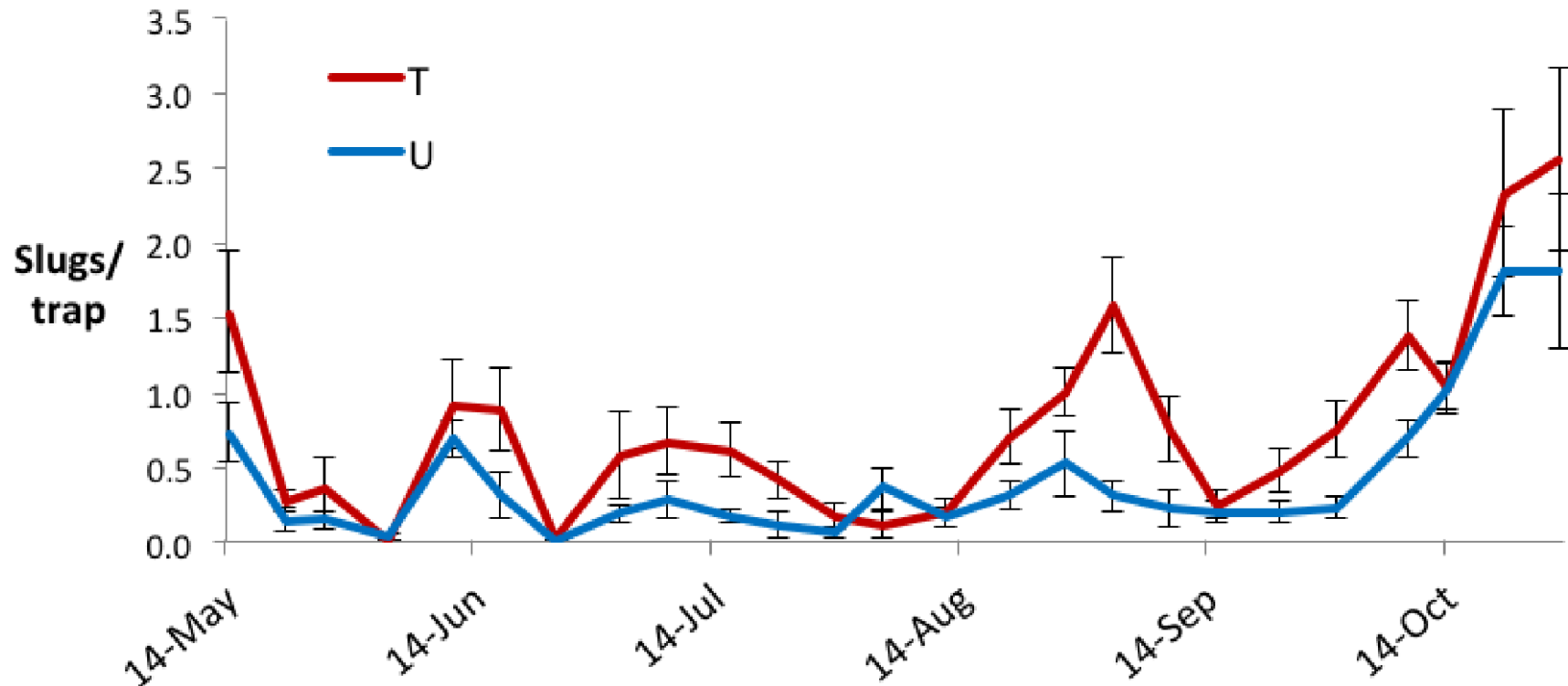
©MARLIN E. RICE

- Ground beetles are good for slug biological control
- Pesticides can interfere with them

- Neonicotinoid seed treatments (e.g., Cruiser) are increasingly common in corn and soy
- A systemic insecticide applied to seed coat, taken up into plant tissue at germination



- Neonic seed treatments worsen slug problems!
- What's going on?



- What happens to a beetle that eats a slug with thiamethoxam in its slime?

Neonicotinoid seed treatments create “toxic slugs”



Slug Management

- Scouting
- Tillage
- Plant early
- Molluscicide baits
- Other approaches
 - Avoid neonicotinoid seed treatments if you don't need them for specific pests

- Seed treatment are effective for early-season bean leaf beetle in soybean (a very rare problem)
- Soil pests (wireworms etc.), especially after CRP



Can the right cover crop approach help with slugs?

- Slugs have feeding preferences
- Like to eat some plant species; dislike others
 - They like rye and soybeans
 - Seem to dislike crimson clover (?? research needed)



Lucas Criswell (Union County, PA): Slides from John Tooker



Lucas Criswell (Union County, PA)

Observation: clean fields provide one slug food source – the crop. Also not much habitat for natural enemies

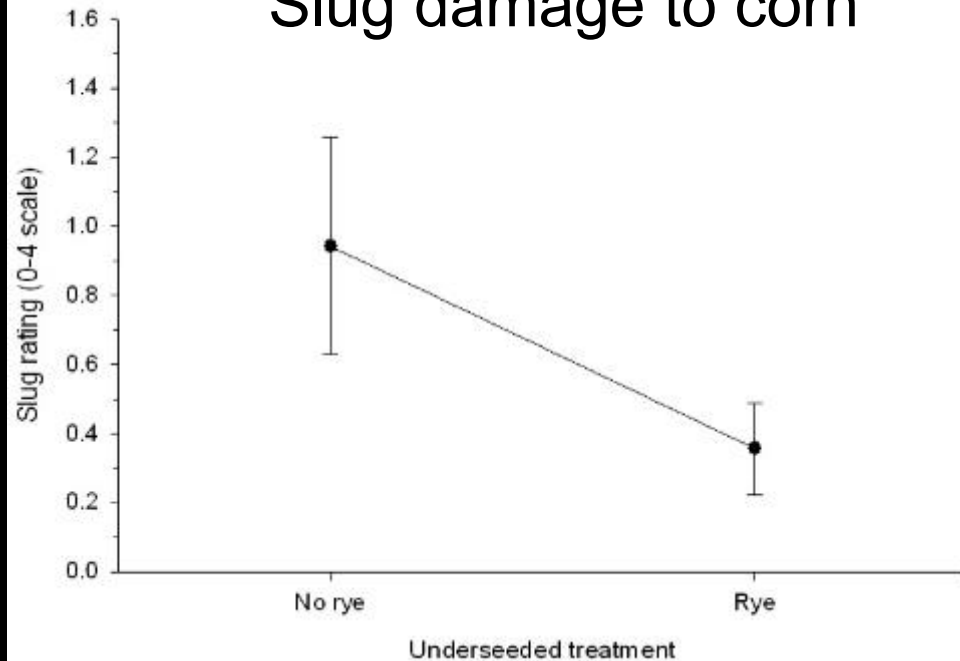




Rye intercrop with corn

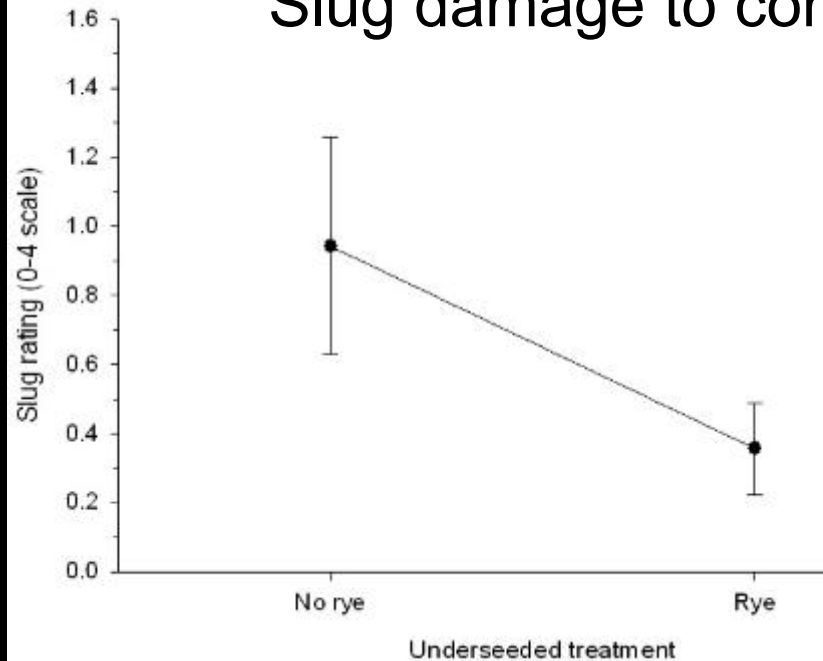
Intercropping decreases slug damage, increases predators

Slug damage to corn

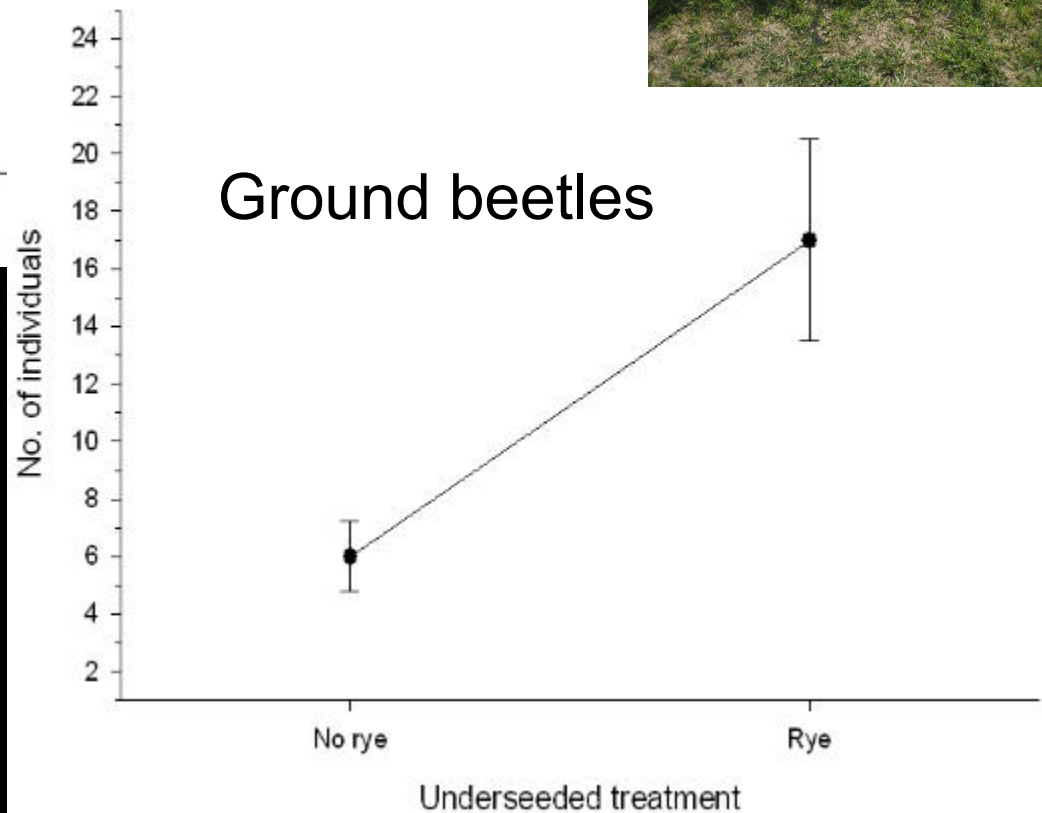


Intercropping decreases slug damage, increases predators

Slug damage to corn



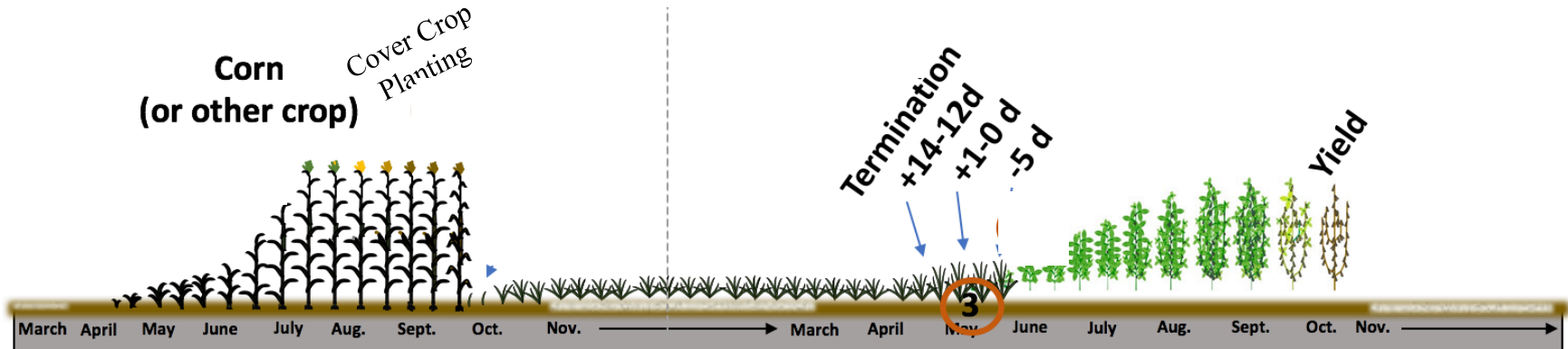
Ground beetles



Slug Management

- Scouting
- Tillage
- Plant early
- Molluscicide baits
- Other approaches
 - Avoid neonicotinoid seed treatments if you don't need them for specific pests
 - Cover crops may help: more research needed

Slug/Pest Cover Crop Research



Participating States

- Nebraska
- Iowa
- Illinois
- Ohio
- South Dakota
- Minnesota
- Wisconsin
- Missouri



Cover Crop

- ② Rye following corn
- ③ Termination: Glyphosate

Measurements

- ④ Cover crop biomass
- ⑤ Extended leaf height
- ⑥ Plant damage assessment, slug and insect levels
- ⑦ Soybean yield

Questions?

