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Slugs on Field Crops

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Slugs are a problem associated with conservation practices, such as reduced tillage, no-tillage, and the use of cover crops. Fields with reduced tillage and/or cover crops generally have cash crop and other plant residues on the soil surface. The advantages of these practices include reduced soil erosion, reduced labor requirements, increased soil moisture, and improved soil tilth. However, these practices also provide a cooler, moister, and therefore more favorable habitat for slugs, a common pest of field crops.

Figure 1. Gray garden slug adult. Photo by Ron Hammond.

Slugs belong to the phylum Mollusca, class Gastropoda, which also contain snails. Slugs, unlike snails, do not have an external shell, though they have a remnant of the shell inside their body. Slugs are hermaphrodites, containing both male and female reproductive organs, but most mating occurs with another slug. Slugs produce copious amounts of slime, either to assist in movement or as a defensive measure to rid their body of unwanted materials or toxins. Slugs are nocturnal and can often go unnoticed during the day as they shelter under residue.

Figure 2. Slug eggs. Photo by Amy Raudenbush.

Three slug species are often associated with field crops in Ohio, with the most common being the gray garden slug (fig. 1), *Deroceras reticulatum*, a species introduced from Europe in the late 1800s. This medium-sized slug is grayish brown in color. Its defensive slime is white, which is characteristic and used in identification. Eggs (fig. 2) that have overwintered or been laid in the spring hatch beginning in late April in central Ohio and mid-May to late May in northern Ohio. Juvenile slugs begin noticeable feeding about 1–2 weeks after hatching, with significant feeding occurring as the slugs mature (fig. 3). Juvenile slugs become full-sized adults sometime during the summer. By the fall, most gray garden slugs have completed development and are capable of laying eggs.

Figure 3. Juvenile slugs on corn. Photo by Ron Hammond.

The other two slugs often found in crop fields are the marsh slug (fig. 4), *Deroceras leavae*, a slug endemic to the United States, and dusky slugs (fig. 5), *Arion subfuscus*, a

slug that was introduced to the United States. While common in some fields, they are not usually observed to cause economic damage.

Symptoms

Slug feeding symptoms vary depending on the size of the slug and the species, size, and growth stage of the crop. Because the growing point of corn is below ground when the plant emerges, corn will continue to put out new leaves, even if defoliated. This growth habit limits slug feeding to defoliation of young leaves rather than causing complete stand loss (fig. 6). If corn is planted later and emergence occurs when the slugs are actively feeding, damage can occur to the flag leave within the whorl and continue to appear on all emerging leaves (fig. 7).

Figure 4. Marsh slugs. Photo by Ron Hammond.

Figure 5. Dusky slug. Photo by Amy Raudenbush.

Figure 6. Slug injury to emerging corn.
Photo by Ron Hammond.

Figure 7. Slug injury to five-leaf (V5) stage corn.
Photo by Ron Hammond.

Figure 8. Slug injury to soybean within the seed furrow. Photo by

Ron Hammond.

Slug feeding on soybean affects the plant differently because the growing point is within the emerging cotyledons. If planted relatively early, emergence can occur while slug feeding is minimal, resulting in unharmed unifoliate leaves. However, if soybean is planted late and germination occurs when slugs are actively feeding, they can feed on the cotyledons, which can damage the growing point, kill the plant, and result in significant stand loss. Feeding can occur in open seed furrows (fig. 8)—an ideal, protected "buffet line" for the slug—and beneath crop residue immediately following plant emergence. Severe defoliation can then continue on emerging leaves (fig. 9).

Because of the differences in how slugs feed on and damage corn and soybean crops, slug management is often considered more difficult on soybean. Emerged leaves make it much easier to see slug feeding and activity and take corrective actions. With soybeans, the injury to the crop often results in stand loss before a grower realizes the problem.

Figure 9. Slug injury to young soybeans. Photo by Ron Hammond.

Scouting

Although no thresholds are available on corn or soybean, knowing the crop stage and the relative number of slugs present in a field can assist with slug management. The following guidelines help scout for slug eggs, juvenile slugs, or adults in spring and early summer. Warm April and early May days are the time to determine if slugs are present. Sift through crop residue and examine the soil surface. At this time, the most common stages to be found will be eggs or adults. Small, clear eggs are often found in clusters that are half the size of BBs (fig. 2). Although no definitive threshold of eggs can be considered a problem, discovering large numbers of eggs can be a warning sign of a potential problem. Locate adult slugs by carefully examining the soil surface. A square foot of plywood placed on the soil surface at a few locations (marked with flags) can also be used for monitoring—check underneath the plywood in the morning periodically to track slug populations. As with slug eggs, no threshold number of juvenile and/or adult slugs definitively indicates an economic problem.

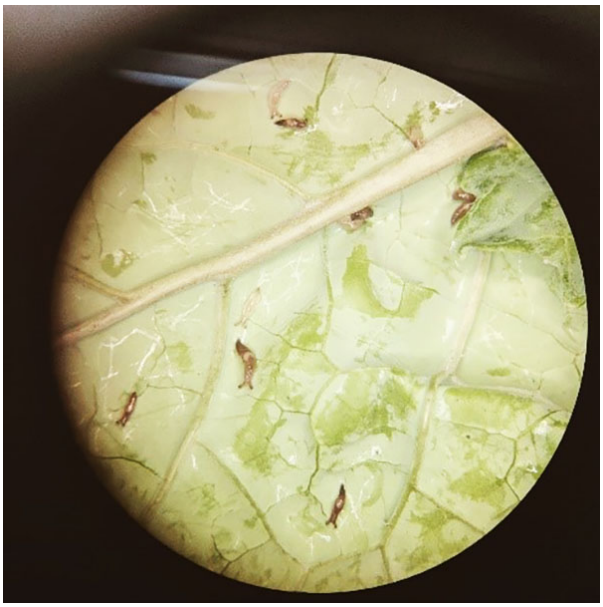

Figure 10. Newly hatched slugs on a leaf. Photo by Amy Raudenbush.

Egg and adult sampling should occur until late May or early June. At this time, newly hatched juveniles (fig. 10) can be found. Juvenile slugs are quite small, and care should be taken so they are not overlooked.

The most important time to sample for the small juvenile slugs is when defoliation is occurring. The best time to sample juvenile slugs is at dusk or immediately after dark. Juvenile slugs can be found feeding on the plants or crawling over the crop residue. Because corn is usually planted in wider rows, it is easy to count the number of slugs per

individual plant. It is recommended that the number of slugs in a unit area, such as 1 ft², are counted for soybean, which are usually planted in narrower rows. Although there are various sampling procedures involving soil traps with or without beer, these traps do not measure the presence of eggs or juvenile slugs. They are more appropriate for measuring adult slugs only.

Management

Though there is no widely recognized economic injury level (EIL) for slug damage, a study conducted in the late 1980s–early 1990s in Pennsylvania tried to define the EIL for no-till corn. The EIL is the point where the cost of the damage begins to outweigh the cost of treatment (the break-even point for treatment). The study found that in warm, wet seasons, the EIL ranged anywhere from 2% to 20% defoliation. However, in the drier years of the study, a higher level of defoliation could be tolerated, and the EIL ranged from 39% to 59% (Byers & Calvin, 1994). This demonstrates that there is a wide spectrum of damage to corn that can be tolerated under different conditions, adding to the difficulty in determining an action threshold.

An Ohio soybean study looked at slugs' impacts on yield. It was found that that 50% defoliation of the first unifoliate leaves (stage VC) resulted in minor yield losses, but the same 50% defoliation at V1 (when the first trifoliate leaves are present) caused almost no yield loss (Hammond, 2000). This is consistent with the observation that vegetative soybeans can sustain considerable defoliation and compensate for it later in the season. This study demonstrates that the chief injury from slugs to soybeans is from very early feeding just after emergence, when only the cotyledons are present. Quick control is essential for preventing soybean stand loss between VE and VC.

Molluscicides

There are few rescue treatments for slug damage, and they tend to be expensive. Slugs are not insects, and insecticides do not kill them. Molluscicides—slug-killing compounds—are formulated as baited pellets, which the slug must consume. Avoid spreading these pellets before rain— if they dissolve, they are not available for the slug to eat. The two common active ingredients are metaldehyde and iron phosphate. Regardless of the product chosen, early intervention when the slugs are smaller is more successful than later intervention with larger slugs (a reason why scouting is important).

Metaldehyde is a molluscicide used worldwide. This product causes the mucus-producing cells in slugs to burst, effectively killing them. To be effective, a product with a

high concentration (3.25%– 4%) of metaldehyde should be used. The current rate of application for most metaldehyde-containing molluscicides is 10 pounds per acre for soybeans and 25 pounds per acre for corn. Both uses are labeled in Ohio but are not labeled for both crops in all states. Spread pellets at a rate of 5–12 pieces per square foot. The other alternative active ingredient, iron phosphate, has lower effectiveness, but the advantage of being organic-approved.

After applying a molluscicide, growers should evaluate its effectiveness. First, walk the field to ensure sufficient and even coverage. Problems with uneven application are often a major reason for poor slug control. Evaluate the bait's efficacy through slug counts at dusk and, more importantly, by examining regrowth of the plants. While old plant tissue shows injury, the new plant tissue will not. In corn, the whorl of newer leaves should be examined. In soybeans, growers should look at the newest and expanding trifoliate. Adequate control is obtained when the newest leaf tissue is relatively free of slug feeding.

Cultural Practices

High slug populations do not crop up in one season but tend to build over time until they are noticed. Certain practices, over time, can help reduce slug populations. The primary management tactic against slugs is tillage, which is at odds with the production practices of reduced or no-till (where slug problems tend to be the worst). Even light tillage and residue removal can help mitigate slug populations over time. Another useful cultural practice is to plant early before slug eggs hatch or prior to when juvenile slugs begin their heavier feeding. Although adjusting the planting date doesn't prevent slug injury to the plant, it allows the crop to get a head start and grow larger before heavy slug feeding occurs, making the plants less susceptible to feeding damage. Manipulating the planting date might not be possible in all areas of the state, especially in southern Ohio. If slugs are actively feeding, later plantings when the soil has warmed enough to discourage slug activity might be considered. However, the risk of significant feeding damage to small plants is possible if weather conditions become cooler and plant growth slows.

An associated tactic is to provide conditions that aid in quicker germination and plant growth, which gives the plant a head start to outpace slug feeding. More leaf area on the plant will lower the potential for economic losses. Row cleaners or sweepers that remove crop residue from the crop rows at planting have been suggested for slug management. Row cleaners may not have much of an impact on the size of the slug population, but

they allow for drier, warmer soils that encourage quicker plant germination and growth. In effect, any practice allowing for more vigorous plant growth will aid in reducing the impact of slugs.

In addition to tillage and manipulating planting dates, practices to encourage the natural enemies of slugs can help reduce populations. Carabid beetles (ground beetles) are one of the main slug predators in field crops. In a well-studied case in Pennsylvania, researchers found that reducing ground beetle populations resulted in higher slug populations (Douglas & Tooker, 2016). The source of this ground beetle reduction was neonicotinoid seed treatments (the most common class of insecticide applied to seed coats). Slugs consume young plants containing this insecticide, which does not kill them but is instead excreted in their slime. Ground beetles that eat these "toxic slugs" die, reducing their populations and allowing slug populations to increase. Avoiding the use of insecticidal seed treatments is an approach that, over time, can help promote ground beetle populations in field crops.

Other natural enemies of slugs include parasitoid flies and parasitic nematodes. Within the family of marsh flies (Sciomyzidae) are six species known to feed on slugs, either by predation or parasitism. However, it is not possible to manipulate populations of these beneficial flies. On the other hand, the parasitic nematode *Phasmarhabditis hermaphrodita* is sold commercially by at least two companies. Parasitic nematodes are very different from the species of nematodes that damage plants—they are not capable of feeding on or infecting plants. This species of parasitic nematode lives in the soil and enters a slug via natural openings to complete its life cycle. These nematodes are very effective against the gray garden slug. Because of high production costs, this control method isn't feasible for large-scale agricultural production, but can offer control in smaller areas, such as gardens. There has also been some small-scale success in utilizing essential oils, such as myrrhs and birch tar oil, to repel slugs. Again, because of difficulties with large-scale application, using essential oils is unpractical for large-scale agricultural production.

Management of slugs therefore is more difficult than controlling most insects and weeds. Slug populations often must be decreased over time through consistent use of cultural practices, avoidance of insecticidal seed treatments, and, if warranted, the use of molluscicides at the appropriate time.

Steps for managing slugs:

1. identify the problem—species and stage of slug
2. know the biology and slug/plant injury interaction
3. determine slug presence and relative numbers
4. use preventive tactics
5. use therapeutic tactics
6. evaluate efficacy and control

See the Michigan State University and Ohio State University Extension joint publication Field Crops Insect Pest Management Guide for information on molluscicides, slug life stages, and information about where slugs feed on crop plants.

For More Information

More information is available about the symptoms, scouting, and management of slugs on field crops in the following resources:

Barua A., Williams C. D., & Ross J. L. (2021). A literature review of biological and bio-rational control strategies for slugs: current research and future prospects. *Insects*, *12*(6), 541.
doi: 10.3390/insects12060541

Deadline MPs, Mini-Pellets! One Last Meal for Slugs & Snails. (2019). American Vanguard Businesses.
s3-us-west-1.amazonaws.com/agrian-cg-fs1-production/pdfs/Deadline_M-PS_Mini_Pellets1c_Label.pdf

References

Byers, R. A. & Calvin, D. D. (1994). Economic injury levels to field corn from slug (Stylommatophora: Agrolimacidae) feeding. *Journal of Economic Entomology, 87*(5), 1345–1350.
doi.org/10.1093/jee/87.5.1345

Douglas, M. R., & Tooker, J. F. (2016). Meta-analysis reveals that seed-applied neonicotinoid and pyrethroids have similar negative effects on abundance of arthropod natural enemies. *PeerJ, 4*, e2776.
doi:10.7717/peerj.2776

Hammond, R. B. (2000). Simulation of moderate levels of slug injury to soybean. *Crop Protection, 19*(2), 113–120.
doi.org/10.1016/S0261-2194(99)00087-3

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This publication refers to pesticide recommendations in Bulletin 545 that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this writing may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, the recommendation must be disregarded. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. The authors, Ohio State University Extension, and the Ohio Agricultural Research and Development Center assume no liability resulting from the use of these recommendations.

Additional information is available from your local OSU Extension office or The Ohio State University Entomology Agronomic Crops Insects website (entomology.osu.edu/ag/).
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