OREGON STATE UNIVERSITY EXTENSION SERVICE

# Slug Pests in Field Crops in Western Oregon

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Slugs are a key pest in many cropping systems in western Oregon's agriculture-rich Willamette Valley. The dominant pest species in the region is the gray field slug, *Deroceras reticulatum*, which is native to Europe, North Africa, and the Atlantic Islands (Figure 1). Several exotic *Arion* species are present in the area in low numbers and can also cause crop damage.

Figure 1. Gray field slug
Photo by Amy J. Dreves, © Oregon State University

## Host Plants and Damage

Many slug species in the Willamette Valley are generalist feeders. They consume seedlings, foliage, fruits, and seeds. They scrape, streak, and shred foliage, make ragged holes in leaves, destroy growing points, hollow out seeds, and scar roots and tubers. Thus, they cause significant damage to many crops at the seedling stage and when plants are established (Figure 2, page 2).

Field crops in western Oregon that are impacted by slugs include small grains and diverse seed crops, including various grasses, clovers, cover crops (like radish), and row crops (such as broccoli, beans, and corn). Slugs also damage nursery crops, and they present a significant contamination problem for these commodities and for Christmas trees when they are transported out of Oregon.

Slug impact is particularly severe in Willamette Valley grass seed crops. In recent years, slug damage has accounted for millions of dollars of damage to the grass seed industry. Slugs can also have indirect impacts. For instance, slugs can aid in fertilization of the fungal pathogen that causes choke disease in orchardgrass.

Many factors favor slug development in the Willamette Valley and facilitate buildup of their populations. Slugs thrive in the clay and silt soils common in the valley and the cool, humid, low-light conditions that prevail in the region from fall through spring. In the early 2000s, the practice of burning straw residue after seed harvest was gradually phased out in the Willamette Valley, and the straw residue left in the fields now provides an ideal habitat for slugs. Also, many farmers in the region adopted no-till production for soil conservation and improved weed management, and this switch in cultivation practice also benefitted slug population growth. Improved field drainage (for example, tiling) allowed for a greater diversity of rotational crops, many of which encourage slug population growth. The reduction in field flooding (due to tiling or drier winters) also increases slug survival.

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Figure 2. Damage caused by slugs
Photos by Amy J. Dreves, © Oregon State University

## Life Cycle and Biology

Information about the biology of the gray field slug is incomplete. Based on field observations, they appear to undergo two overlapping generations under western Oregon conditions.

**Egg:** The eggs of the gray field slug are small, round, and pearl-like. They are typically laid in batches of a dozen or more in sheltered cavities near the soil surface or under plant residue on the soil surface when the soil is moist. They are clear when first laid but turn white as they mature. Eggs can hatch within 2 weeks to a month depending on environmental conditions. When laid in late fall through late winter, eggs can take 5 months to hatch.

**Immature**: Young juvenile slugs, called neonates, hatch from eggs. They feed primarily on algae and fungi but can readily feed on foliage as well. As they mature, juvenile slugs feed primarily on plant material. They feed throughout spring and summer under moist and mild temperature conditions. Under the dry, warm conditions of Willamette Valley summers, immatures and adults may travel down in soil cracks, earthworm burrows, and mouse holes, and undergo a dormant (quiescent) stage. They can survive without food for many months (Figure 3).

**Adult**: The adult gray field slug is small to medium-size and predominantly gray, cream, or brown with dark mottling or a netted appearance. It is rather stout and nearly cylindrical, with a ridge on the back. The breathing pore (pneumostome) lies below the mantle. The slime mucus is sticky and clear and turns milky when disturbed. The mature slug, when in motion, is about 1.5 to 2 inches (35 to 50 mm) long.

Slugs are hermaphrodites—both male and female sex organs are present in the same individual. Self-fertilization can occur and produce viable offspring. Mating commences in fall after the first rain and continues through spring. Eggs are laid 11 to 15 days after mating. A single slug can lay several hundred eggs in a lifetime and live from 6 to 18 months. Figure 4 (page 3) shows the body parts of a banana or spotted slug (***a beneficial, native nonpest***) used for slug identification. Not all slug species have all these body parts. Dissections of adult slugs' genitalia are required to positively confirm a slug species.

In western Oregon, adults feed under moist, mild temperature conditions. They remain dormant


Figure 3. Life cycle of the gray field slug
Photos by Amy J. Dreves, © Oregon State University

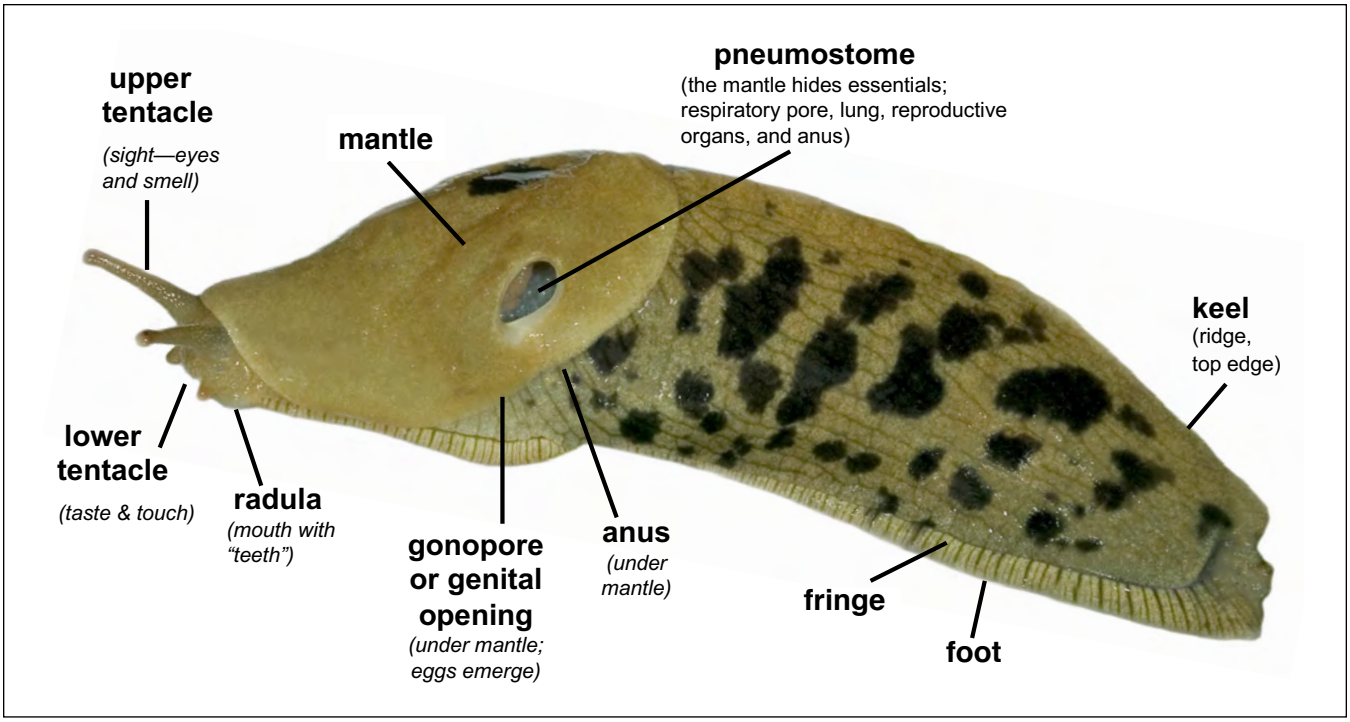


Figure 4. Parts of a slug
Photo by Jeffrey C. Miller, entomologist and professor emeritus, Oregon State University

during dry summer conditions though they can be active after a rainfall and in irrigated crops.

## Scouting for Slugs

Slugs are a challenge to monitor. They can contract in the soil and be indistinguishable from leaf litter and soil clods. They often hide within plant crowns and soil cracks. A good way to monitor slug populations is to place boards (or tiles or shingles) on the soil surface (Figure 5). These act as shelters for slugs after they feed at night. When the boards are turned over in the morning, the number of slugs on the boards' undersurface and on the ground provides an estimate of slug activity in the area.

In the spring, slugs often climb on plants and feed on young leaves, pollen, and flower parts. In field crops, examine seedlings, foliage, and the soil surface in many places every few days. Slugs often hide under soil clods, stones, and debris. When slugs are active, you can also monitor them at night with a flashlight.

## Estimating Plant Damage

There are no proven, scientifically-established thresholds to determine when slug population numbers will become an economic threat and require control. Thresholds depend on slug species, crop

Figure 5. Board for monitoring slugs
Photo by Amy J. Dreves, © Oregon State University

type, and plant growth stage. However, most growers know the level of slug damage they can tolerate.

**Establishing plants**: To estimate the percentage of seedling loss (and impact), count the number of plants per linear foot of row in at least four locations in the field and calculate the average reduction in plant stand during these three seedling early growth stages: (1) cotyledon; (2) 2-true leaf; and (3) 4-true leaf.

**Established plants**: Score the percentage of established plants or crowns (or seedlings) with slug damage using the following 5-point scale based on number of plants gone or damage done to existing plants.

**Suggested damage rating scale:**

0 = 0–5% damage
1 = 6–25% damage
2 = 26–50% damage
3 = 51–75% damage
4 = greater than 75% damage

## Slug Pest Management

In western Oregon, in the fall once the rains commence, slugs emerge after summer dormancy over a 4- to 6-week period and feed until the onset of near-freezing conditions. Damage to seedlings in fall can be severe. Slug management is particularly challenging when populations are high. (Remember that slugs may not go dormant in irrigated crops.)

### Cultural control

Tillage can reduce slug populations by crushing and burying eggs, immatures, and adults; exposing them to predators and unsuitable environmental conditions (heat, dryness); disrupting their movement through soil to the surface; and by removal of food sources. Slug populations may also be reduced by:

(1) using plant varieties that are resistant or can tolerate slug damage
(2) planting a "trap" crop to attract slugs away from the main crop
(3) creating habitats to build populations of slugs' natural enemies.

### Biological control

Natural enemies of slugs can reduce slug populations, but they may not be present in numbers high enough to prevent economic damage to field crops. Natural enemies of slugs in western Oregon include invertebrate predators such as ground beetles, rove beetles, spiders, mites, daddy-longlegs, marsh flies, and centipedes (Figure 6). Vertebrate predators include reptiles (snakes and lizards), amphibians (frogs, salamanders, and toads), and birds (starlings, killdeer, crows, geese).

Parasites of slugs in western Oregon include the immature larvae of the marsh fly, which follow the slime of slugs and kill them by penetrating the body through an entry point (glands in the foot, eye tentacles, or breathing pore). A parasitic nematode has been developed as a biological control agent for slug pests in Europe. The nematode is currently not commercially available within the U.S. It has recently been detected in California and may be available commercially in the future.

Sheep sometimes accidentally feed on slugs and tread on them while grazing. Limited research suggests that heavily grazing a clover field with sheep in summer prior to replanting can reduce slug populations.

### Chemical control

There are many commercial products available for slug control (Table 1, page 5). The success of bait use varies among fields, years, seasons, bait types, active ingredients, and slug age. Biological and nonbiological factors can affect levels of slug control achieved from bait products. A single bait application can provide 10 to 60 percent control for a single slug species, but it often does not suppress slugs below damaging levels, especially when populations are high.

#### Slug bait application guidelines

- Monitor slug abundance before and after placement of baits to assess efficacy.
- Apply baits in fall ***after*** rains commence (September and October) and in spring (March through May), if necessary. During warm winter periods (late November through February), slugs may be active and feeding, but note that rainfall and low temperatures reduce bait efficacy.

Figure 6. Ground beetle predator of slugs
Photo by Amy J. Dreves, © Oregon State University

Table 1. Some examples of commercial slug control products. Read the label closely before application, as some of these products can be toxic to humans, birds, dogs, cats, and beneficial insects.

| Brand name | Active ingredient | Formulation | Notes |
|---|---|---|---|
| Deadline® M-Ps™ | metaldehyde | Baited mini-pellets | In wet or damp conditions, in late fall, early winter, and spring |
| Durham® | metaldehyde | Sand coated with active ingredient | Requires a few days of dry weather after application for best results. Best applied close to crop emergence |
| Metarex® | metaldehyde | Baited pellet | Provides better control in late fall, early winter and spring, and on wetter soil. |
| Slug-Fest® | metaldehyde | Liquid formulation | Kills slugs through both oral ingestion and transdermal absorption. Best applied in early fall (before heavy rains) or in spring after canopy closure, when slugs climb on plants and cannot easily find baits. Most effective on young, small slugs, and on dry soils. |
| Sluggo® | iron phosphate | Food-based pellet | Approved for organic production. A "softer" bait that is more effective when applied early in the fall before soils become saturated with rain |
| Sluggo Plus® | iron phosphate with spinosad | Baited pellet | Best applied in early fall |
| Slugkill®<br>Ferroxx®<br>IronFist® | sodium ferric EDTA (FeEDTA-iron chelate) | Baited pellet | Best applied in early fall, dry to moist soil |
| Mesurol® | methiocarb | Baited pellet | Best applied in late fall, in cooler, damp conditions.<br>This product was once commonly used.<br>**Note**: Restricted use product |

- Several bait applications about 7 to 10 days apart may be necessary to control slugs of various ages. However, when slug populations are high, even many applications may not suppress slugs below damaging levels.
- Optimum conditions for baiting when slugs are most active:
  - Temperature: 50°F to 70°F
  - Wind: Little to no wind, less than 5 mph
  - Humidity: High ***after*** a rain, morning condensation, or heavy dew
  - Time: Dusk to nighttime

  Slug control increases when weather is dry and sunny following baiting: the dry warmth causes slug dessication, reduces their recovery, and minimizes bait control failure from spoilage and mold.
- The active field life of bait products is short (4 to 5 days); in some cases, their half-life is less than half a day. Slug mortality from some metaldehyde baits can drop sharply after 48 hours. The greatest impact (60 percent) occurs on the first day of application.

The following factors affect the efficacy of commercial bait products for slug control:

- Newly hatched slugs are not killed easily with granule baits because they do not have the mouthparts to feed on them. Liquid contact baits are suggested for this slug stage. As immature slugs develop, they become more susceptible to granular baits.
- Slugs can recover from metaldehyde poisoning if ingestion of bait is followed by 4 days of cool temperatures (lower than 50°F), with moist soil and/or access to water.
- Baits are made to attract slugs from short distances, so the density of bait spread on a field is

critical to increase the chances that slugs will find and consume them.

- Slugs have difficulty finding baits when plant biomass is high. At these times, consider using the liquid formulation of metaldehyde.
- Slugs that survive bait poisoning tend to avoid feeding on similar baits. This behavior is related to their aversion to eating baits that have previously poisoned them.
- In fields with good soil tilth and high earthworm populations, 90 percent of the bait can be depleted by earthworm scavenging within 4 to 5 days of application.
- After a freezing event, it can take 4 to 5 days for slugs to resume feeding, even when the freeze is followed by warm, wet conditions that favor slug activity.

### New approaches

Slug population models are currently being developed for targeting bait applications by predicting the areas within fields that will have high slug populations. Nonchemical control strategies such as trap cropping, underseeding crops, tillage, and biological control are being examined for slug suppression. Other new approaches, such as the use of RNAi (for molecular disruption of a slug's life cycle physiology), attract and kill technology, and nematodes, are also being studied for slug control as they have shown promise for other crop pests.

## For more information

Slug Control. Pacific Northwest Insect Management Handbook. 2016 edition.
http://insect.pnwhandbooks.org/ipm/slug-control

OSU College of Agricultural Sciences Slug Portal.
http://agsci.oregonstate.edu/slug-portal

**Use pesticides safely!**

- Wear protective clothing and safety devices as recommended on the label. Bathe or shower after each use.
- Read the pesticide label—even if you've used the pesticide before. Follow closely the instructions on the label (and any other directions you have).
- Be cautious when you apply pesticides. Know your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.

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