FACTSHEET

Integrated slug control

Latest information

- **The molluscicide metaldehyde can be detected in raw (untreated) water above the drinking water standard**
- **The deadline for the sale and distribution of metaldehyde slug pellets is 31 December 2020. The deadline for the disposal, storage and use up of stocks is 31 December 2021**
- **As the situation can change rapidly, the very latest information is published at ahdb.org.uk/slugs**

Action points

- **An integrated approach to slug control, using various techniques, is more successful than relying solely on molluscicide pellets**
- **Monitor slug activity prior to and throughout the susceptible crop growth stages**
- **Use the tool at wiyby.co.uk to find out if you farm in a Drinking Water Protected Area or Safeguard Zone**
- **Refer to the metaldehyde stewardship guidelines at getpelletwise.co.uk**

Oilseed rape

Seedlings are most vulnerable to slugs. This is because, unlike cereals, the growing point of a germinating oilseed rape shoot is above ground. Serious damage occurs up to the four true-leaf stage.

Figure 2. Slug-damaged oilseed rape

Cereals

Seeds are particularly vulnerable because slugs can hollow them out. Each slug can kill up to 50 seeds in the first week after sowing, indicating the need for immediate control. Weight-for-weight, smaller slugs destroy more seeds than larger slugs.

Shoots and leaves are also vulnerable. The crop is most sensitive up to GS14 (four leaves unfolded) and remains vulnerable up to GS21 (one main shoot and one tiller).

Potatoes

Slugs are most damaging at the early stages of tuber bulking. They enter through small holes in the skin and cause irregular-shaped holes on the tuber surface. These can extend into large cavities in the tuber (see Figure 3).

Figure 3. Slug-damaged potato

Horticulture (vegetables)

Various vegetable crops are susceptible to slugs. Celery, carrots, asparagus, long-season brassicas (e.g. Brussels sprouts and cabbage), lettuce and spinach tend to be the most susceptible. Early planted crops (e.g. lettuce and salad crops), in particular, are especially vulnerable.

Figure 4. Slug-damaged brussels sprouts

Slugs can damage crops at varying stages of their development. Direct feeding on seedlings can result in plant loss. At later stages, feeding can lead to cosmetic problems. The tolerance to feeding damage varies from zero (e.g. in salad crops) to small permitted tolerances (e.g. Brussels sprouts). Slug feeding can also contort the growing tip of some crops (e.g. asparagus) and cause rejections. Faecal and slime contamination, as well as the presence of live or dead slugs, can also make mature crops unmarketable or lead to rejections.

Key slug species

The grey field slug (*Deroceras reticulatum*) and other *Deroceras* spp.

Figure 5. Grey field slug

The grey field slug is the most widespread and troublesome species. It is usually light grey or brown, grows to 5 cm in length and produces milky white mucus. Populations tend to have a mixed age structure, so damage occurs whenever conditions are favourable for activity. It continues to be active in damp weather and even when temperatures are close to freezing. Generally, breeding peaks in April/May and September/October. However, in favourable conditions, it will breed throughout the year. In optimum conditions, it can start to lay eggs within 16 weeks of hatching.

The garden slug (*Arion hortensis* and *Arion distinctus*)

Figure 6. Garden slug

The garden slug grows to just 3 cm in length. Its body is dark and the foot (underside) ranges from yellow to orange. It produces orange or yellow mucus. Egg hatch peaks in late spring/early summer. Young slugs can develop rapidly to produce a further generation within the year. Arion species are only active at temperatures above 5°C and are less active on the soil surface than the grey field slug.

The keeled slug (*Milax*, *Tandonia* and *Boettgerilla* spp.)

Figure 7. Keeled slug

Keeled slugs are more localised in arable crops than field or garden slugs. They vary in size and generally produce a colourless mucus. Keeled slugs have annual life cycles and their eggs hatch from autumn to spring. Although keeled species are subterranean, they sometimes surface, especially during the breeding season.

The Spanish slug (*Arion vulgaris*)

Figure 8. Spanish slug

Spanish slugs can be brown, black, fawn or mustard coloured and grow up to 15 cm long. Unlike other slug species, the Spanish slug is omnivorous, eating dead animals, excrement and plant material. They produce twice as many eggs as native slug species.

Life cycle

All slug species are hermaphrodite (each individual is both male and female). While some species are self-fertile, most mate before laying eggs in batches of 10 to 50 in soil cavities, between clods, under stones or at the base of plants. Up to 500 eggs per slug may be laid over several weeks. Eggs develop slowly in the winter but will hatch within a few weeks when the temperature starts to rise.

The slug population density and the suitability of the weather for activity (activity-density) dictate the number of active slugs. Rapid reproduction and growth is enhanced by mild, moist weather conditions, sufficient food supply and ample shelter. Such conditions prevail in the spring and early autumn, making crops such as lettuce and Brassicas more vulnerable at these times of year.

Slug movement occurs most frequently at night but they will return to their resting site by dawn, if weather conditions are unfavourable. They do not travel far from where they were hatched, often taking only a circular route of a few metres in search of food.

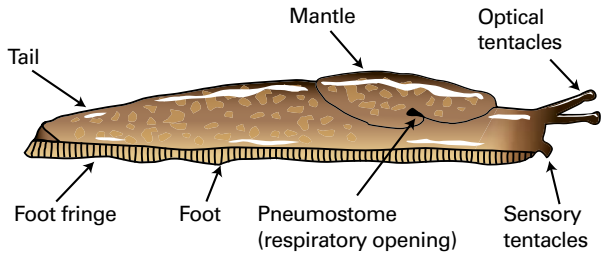

Figure 9. Defining features of a slug

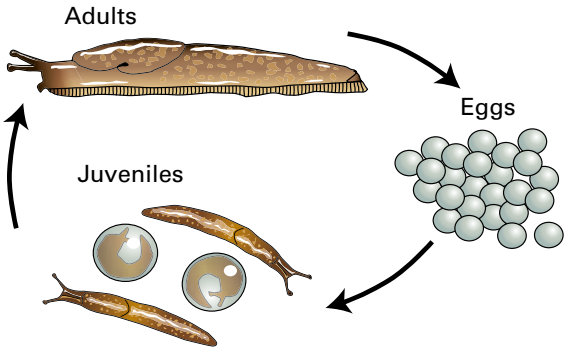

Figure 10. Basic life cycle of a slug

Risk factors

Moisture and temperature

Activity, survival and reproduction are dependent on temperature, moisture, light and soil structure. The optimum temperature for slugs is 17°C but they are active between 5°C and 20°C. The grey field slug is active even when temperatures are close to freezing.

Crops grown under fleece, nets or polythene covers provide warm, damp and, occasionally, weedy conditions favourable for slugs. Irrigating crops after planting results in a conducive environment for slug activity.

Soil type

Slugs are more abundant in heavy soils with high clay or silt content.

Previous cropping

Slug damage is greater after leafy crops that create moist soil conditions. New plantings following crops that have a long growing period are more susceptible.

Crop residues, organic matter and weeds

Crop residues or applications of manure, especially in the autumn, as well as weeds and volunteers, provide slugs with a source of food and shelter.

Slugs prefer soft, nutritious tissue provided by young ground plants. A damp environment combined with succulent food is essential for their survival, so leafier crops that offer ground cover are often preferred.

Cultivation

Direct drilling, as well as delayed drilling, increases the risk of slug damage.

Open, damp and cloddy seedbeds help slugs move easily and provide more shelter than friable, frequently cultivated soils.

Crop type

Autumn-sown crops are slow growing and more at risk than spring-sown crops. Barley and oat seeds have an extra seed coat, so are less vulnerable to attack than wheat.

There is variation in susceptibility to slug damage between potato varieties but there are no independent variety resistance ratings available.

Small fields surrounded by ditches, wasteland, hedgerows or green fallow

The risk of damage increases on the field's perimeters. Headlands are close to field boundary vegetation and are often compacted, with poor drainage. This can create a moist refuge for slugs.

Other agronomic conditions

Lack of nutrients, poor drainage and weed competition can all result in slow crop growth, prolonging the vulnerable period of establishment.

Cultural control

Cultivation

Seedbed preparation and quality are potentially more important than chemical control of slugs, particularly in combinable crops. Ploughing is an effective way to reduce slug populations. Even minimum tillage gives a considerable reduction in slug damage compared with direct drilling. The level of slug mortality depends on the soil type, as well as the machine action and timing of cultivation, depth and intensity. Firm seedbeds also reduce slug activity, as it is harder for them to move around and it reduces the availability of safe resting places. A fine, consolidated seedbed also provides good seed-to-soil contact. This helps crops germinate quickly and grow rapidly through the vulnerable establishment stage. If the seedbed is cloddy, increase sowing depth of wheat to 4–5 cm.

Minimise weeds

Minimising weed growth in preceding crops and seedbeds will reduce sources of food and shelter.

Beetle banks

The establishment and management of beetle banks in field margins as habitats for carabid beetles has been shown to reduce slug numbers by predation, mainly from June to September.

Figure 11. Carabid beetles

Monitoring for slugs

To assess the risk of crop damage, it is important to estimate the size of slug populations present. Sampling in the field is best done using refuge traps. Put slug traps out before cultivation, when the soil surface is visibly moist and the weather is mild (5–25°C). When soil conditions are dry and slugs are not actively seeking food, trapping has little value.

Figure 12. Refuge trap using chicken layers' mash bait

Traps consist of a cover about 25 cm across, such as a plant pot saucer, with a small heap of bait underneath. Two heaped spoonfuls of chicken layers' mash or a cereal grain-based food (not slug pellets) are suitable baits. Leave a small gap between the trap and the soil to allow slugs to enter. It may be necessary to put a weight on the trap in windy conditions.

In each field, nine traps (13 in fields larger than 20 ha) should be set out in a 'W' pattern, spread over the entire area of the field. Place extra traps in areas known to suffer damage. In standing crops, place the traps just to the side of tramlines and mark with canes to allow them to be located.

Leave traps overnight and examine early the following morning while the soil surface is still moist. Count the number of slugs and note slime trails. On warm days, check traps early while the temperature is still cool, as slugs will leave as it gets warmer. Continue to trap, until crops have passed their vulnerable stage.

Table 1 indicates the slug numbers associated with a risk to various crops, when soil and weather conditions favour slug activity.

Table 1. Slug numbers associated with a risk to various crops

Crop	Threshold
Winter cereal	4
Oilseed rape (standing cereals)	4
Oilseed rape (cereal stubble)	1
Potatoes	1
Field vegetables	1

Monitoring slug damage

Oilseed rape: Monitor for slug damage regularly, from sowing to the four true-leaf stage.

Winter cereal crops: Monitor from sowing to first tillering (GS21). Damage after this stage is less likely to result in further plant loss. However, monitoring should continue through winter.

Potatoes: Monitor crops during the two critical control periods (Figure 13), at 50–75% canopy closure and at the early stages of tuber bulking. Continue to monitor the crop until burn-down.

Horticulture: Monitor lettuce crops in January/February and Brussels sprout crops in March/April.

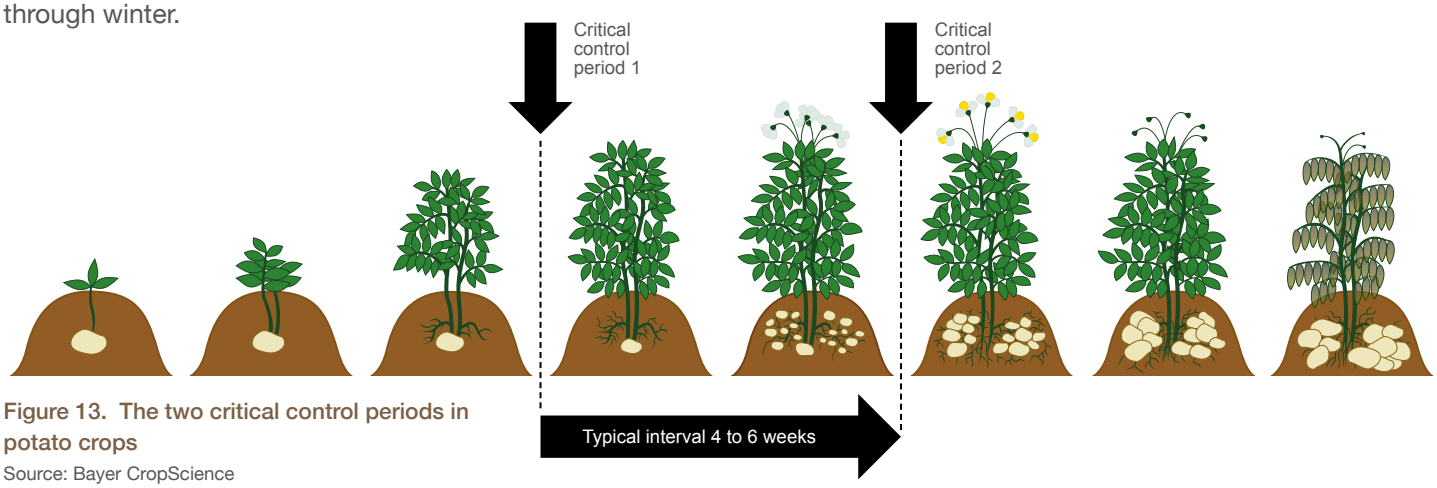

Figure 13. The two critical control periods in potato crops

Source: Bayer CropScience

Biological control

A biological molluscicide, based on a nematode parasite of slugs *(Phasmarhabditis hermaphrodita)*, is available. Unlike pellets, nematodes can target soil-dwelling slugs, as well as surface-active slugs. However, slugs may not feed or rest on substrates treated with nematodes.

The nematodes enter the slug's shell sack (mantle), where bacteria from the nematode's gut are released and start to multiply. The nematodes feed on the bacteria. Eventually, the slug's mantle swells and bursts. Although it usually takes 7 to 21 days for an infected slug to die, it stops feeding soon after the nematode enters the body. When the slug dies, the nematodes feed on it until the food source is depleted. They then leave in search of more slugs.

The grey field slug is highly vulnerable to the nematode but larger species are only susceptible when they are young and small.

Nematodes can be applied in advance of expected damage, at sowing or any time during the crop's lifetime. However, they are best applied in dull weather, in the evening and before rain. Success is dependent on wet conditions after application.

In ideal conditions, nematodes provide a reduction in damage for about six weeks after application. To get the best out of the product, it may need to be used soon after purchase (always follow the instructions carefully).

Biological control of slugs is particularly suited to organic systems and high-value crops. It is also extremely useful in situations where it is difficult to target the slugs effectively with molluscicide pellets, such as in mature lettuce crops.

Chemical control

The effectiveness of pellets depends on their chemical content, as this affects their attractiveness to slugs and their durability under field conditions. Large slugs need to ingest more of the active substance than smaller ones, to cause death, so it is critical that the pellet is palatable to slugs, to ensure enough bait is eaten. If there is too much active substance in a pellet, slugs may detect it and stop feeding before a lethal dose is consumed.

Figure 14. Slug infected with nematodes

Ferric phosphate

Ferric phosphate is particularly suitable for organic systems. Slugs quickly stop feeding, become less mobile and die within 3–6 days. As slugs often die underground, effectiveness of the treatment should be measured by the decrease of feeding damage in the crop.

Metaldehyde

Metaldehyde is a selective molluscicide and principally acts on slugs by inducing excessive secretion of mucus, leading to subsequent dehydration and death. At high temperatures of around 20°C, the activity of metaldehyde is optimised. At low temperatures, its toxic effect may be diminished. Metaldehyde does not harm predatory ground beetles, which can help to restrict slug populations.

Figure 15. A slug consuming foliage

Application method and timing

Cereals and oilseed rape

Broadcasting pellets is the best method of application in cereals and oilseed rape. It usually kills slugs more quickly than pellets drilled with seeds, and can facilitate stewardship. It also often gives more consistent slug control, particularly in combination with fine, firm seedbeds.

Broadcast slug pellets as soon as possible after drilling. Application is most effective up until the four true-leaf stage in oilseed rape and GS14 in wheat. Admixed slug pellets (pellets mixed with seed at drilling) are ineffective in fine seedbeds because both seeds and pellets are unavailable to slugs. However, when direct drilling or in open cloddy seedbed, pellet admixtures with wheat seeds can be effective.

The best time to apply pellets is just before the susceptible crop stage, when optimum weather conditions prevail. It can be beneficial to repeat treatment when new feeding damage is observed, when traps indicate an increase in activity or if pellets disintegrate or go mouldy. It is important to note that pellets can be rendered ineffective after prolonged heavy rain.

Potatoes

There are two critical control periods:

1. 50–75% canopy closure, usually in late June to early July, when the canopy is sufficiently open to allow pellet penetration.
2. Early stages of tuber bulking, before slugs go underground to find developing tubers. August is the pivotal month for follow-up applications and when damage usually begins to appear.

Field vegetables

The sensitive phase for lettuce and celery lasts for the whole of the growing period. Pellet application before a crop is planted may be justified.

Brussels sprouts are most sensitive at the seedling stage and when harvestable buttons start to develop. Application of slug pellets should be limited to the sensitive phases only.

Metaldehyde slug pellet stewardship

Figure 16. Dark spots often form a reticulate pattern behind the grey field slug's mantle

Metaldehyde is often detected in raw water above the drinking water standard, with peaks following rainfall. While levels detected pose no danger to health or the environment, the UK's environment agencies and Defra are responsible for the implementation of the Water Framework Directive (WFD). Unless action is taken, regulatory restrictions, or even withdrawal, may be enforced.

What's in Your Backyard?

Find out if you farm in a Drinking Water Protected Area (DrWPA) or Safeguard Zone. Enter your postcode into the Environment Agency's online tool 'What's in Your Backyard': **wiyby.co.uk**

Use the tool to create a targeted slug control programme that is up to date and tailored to your farm.

Application guidelines

- Use minimum active substance (a.s.) per hectare to avoid drainage and run-off losses
- Maximum application rate: 210 g metaldehyde a.s./ha*. For additional protection of water, BASIS-qualified suppliers or advisers may recommend rates reduced to 160 g a.s./ha or less*
- Maximum total dose from 1 August to 31 December: 210 g metaldehyde a.s./ha*. For additional protection of water, BASIS-qualified suppliers or advisers may recommend rates reduced to 160 g a.s./ha or less*
- Maximum total dose rate: 700 g metaldehyde a.s./ha/ calendar year*
- No pellets to be allowed to fall within a minimum of 10 metres of any field boundary or watercourse

Figure 18. Slug-damaged grain

- Do not apply when heavy rain is forecast
- If drains are flowing, do not apply metaldehyde-based slug pellets

*from any combination of metaldehyde products. 700 g is also the statutory limit.

a.s. = active substance (or active ingredient)

Figure 17. A field slug with an oilseed rape seedling

Further information

ahdb.org.uk/slugs

An industry-led voluntary approach, the Metaldehyde Stewardship Group (MSG) promotes and encourages best practice with metaldehyde slug pellets to minimise environmental impacts.

getpelletwise.co.uk

Publication orders

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