

SNAIL MANAGEMENT FACT SHEET

SOUTHERN AND WESTERN REGIONS

ALL-YEAR-ROUND ATTACK ON SNAILS REQUIRED

A run of wet winters and moist summers have resulted in snail numbers increasing in many regions. While snails cause problems at crop emergence and harvest, integrated management needs to occur across the seasons.

KEY POINTS

- Snail numbers can explode in seasons with wet springs, summers and autumns.
- There are currently no means to control juvenile snails (less than seven millimetres) after sowing.
- A rule of thumb is if snail numbers are above 20 per square metre in cereals and 5/m² in pulses and oilseeds, be prepared to deal with grain contamination at harvest.
- Use header modifications and grain cleaning to eliminate snail contamination of grain.
- Snails appear to build up most rapidly in canola, field peas and beans. However, they can feed and multiply in all crops and pastures.
- Baiting before egg laying is vital. Timing and choice of controls will depend on the season. Understand the factors that determine control effectiveness.
- Stop baiting eight weeks before harvest to avoid bait contamination in grain.
- Monitor snails regularly to establish numbers, types, activity and success of controls.
- To control snails, you will need to apply a combination of treatments throughout the year.

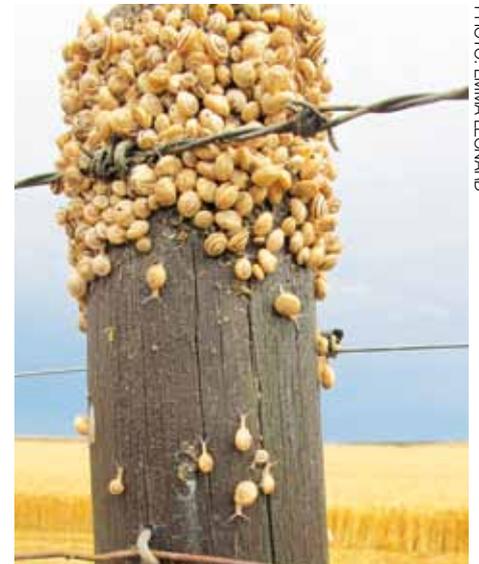


PHOTO: EMMA LEONARD

Summer rain can trigger activity and where crops have been harvested it can provide an early baiting opportunity, if snails stay down for a few days.

Avoid rejection due to snail contamination

Greater use of conservation farming practices, continuous cropping and a run of wet winters and moist, cool summers have resulted in an explosion of snail populations in some cropping regions.

There are two round and two pointed (conical) species of pest snail (Figure 1, page 2) that damage emerging and young crops, especially canola, or contaminate grain at harvest.

While mature snails (larger than 7mm diameter or length) of all species will feed on bait, many of the controls or cleaning techniques are less effective on juvenile snails.

Knowing the species and sizes of snails present in your paddocks helps when selecting management options. More details of the differences between species are found in the publication *Bash 'Em, Burn 'Em, Bait 'Em* (see Useful resources).

For some growers, the first time they discover that snails are a problem in their crops is when a buyer rejects their grain. Rejection will occur if more than half a dead or one live snail is found in a 0.5 litre wheat sample or 200 gram pulse sample (Grain Trade Australia). Check with your buyers for specific regulations.

Using the Bash 'Em, Burn 'Em, Bait 'Em principles of integrated snail management will help reduce snail numbers. However, in cool, moist seasons, snail numbers can still remain high at harvest. The target is to

eliminate snails, but if round snail numbers increase above 80/m² in pastures, 20/m² in cereals and 5/m² in pulses and oilseeds, integrated management and regular monitoring are essential. Thresholds for small pointed snails are higher (pastures 100/m², cereals 40/m², oilseeds 20/m²). No thresholds for conical snails have been established.

Harvester modifications and grain cleaning can help to ensure grain can be successfully delivered, but these usually incur some grain wastage.

Identifying snail species and monitoring numbers before harvest and before and after control operations is essential (see 'Where do I look for snails'). Without this information, growers can not make appropriate management decisions.



PHOTO: EMMA LEONARD

Use a quadrat and simple sieve boxes to monitor snail type, size and number before and after controls and before harvest to identify if populations are changing or harvest problems are likely.

Key monitoring and control times

Check in the early morning or in the evening when conditions are cooler and snails are more active. A wide range of snail sizes in an area indicates that snail are breeding there; if most snails are the same size, snails are moving in from other areas.

Key times include:

- ▶ three to four weeks before harvest – assess the need for harvester modifications and cleaning. Check for snails and holes in crop leaves;
- ▶ after summer rain – identify if snails move from resting sites. If they do, consider baiting as this can be very successful;
- ▶ summer to pre-seeding – assess



PHOTO: EMMA LEONARD



Vineyard or common white

Cernuella virgata

White Italian

Theba pisana

Conical or pointed

Cochlicella acuta

Small conical or small pointed

Cochlicella barbara

Figure 1 Four types of pest snail found in broadacre agriculture, with examples of the difference in size. Mature white Italian snails can be as large as 3cm and common white snails up to 2cm. Snails smaller than 7mm diameter or length are unlikely to take bait.

numbers in stubble before and after bashing (rolling, slashing or cabling standing stubble). Only bash if soil temperatures are above 35°C. Repeat operations are more effective. Kill summer weeds before bashing or burning;

- ▶ late summer to pre-seeding – consider burning paddocks where infestation is high and ensure hot, even burns. To maximise value, bait applications or tillage must occur before egg laying; and
- ▶ eight weeks before harvest – stop baiting to avoid bait contamination in grain.

Snail facts

Where do snails come from?

The four species of round and pointed snails originated in Europe and arrived in Australia in the early 1900s. Snails are great hitchhikers and consequently are a biosecurity risk between paddocks, farms and regions. They travel on machinery and hay and in grain. Roadsides and remnant vegetation provide safe havens for snails.

Action

- ▶ Inspect machinery and produce, and clean equipment where necessary before it enters your property.
- ▶ Monitor numbers to ensure early identification of population growth.

- ▶ Check for reinfestation from remnant vegetation and fence lines about a week after control.

Where do I look for snails?

In summer, round snails favour resting places off the ground on stubble, vegetation and fence posts, while pointed snails are often found on the ground in cool shady places.

At harvest, snails crawl up the crop and often shelter in between creals and grains or under leaves. They tend to migrate into windrows of canola and faba beans.

Snails love summer weeds as they provide shelter, moisture and food through the summer. Controlling summer weeds removes an important source of moisture and helps achieve better stubble management. Dying weeds continue to provide food and shelter.

In autumn to spring, snails are generally found on the ground and on the youngest leaves as crops grow. Numbers are often higher around the paddock perimeter.

Look closely in the crowns of last year's stubble; snails can be easily missed on a casual inspection.

Action

- ▶ Sample 10cm by 10cm quadrats at 50 location across the paddock. Take samples from the perimeter to the interior of the paddock and note density in different areas.
- ▶ Use simple sieve boxes to separate snails by size, as those larger than 7mm are more likely to take bait.
- ▶ When looking for snails, check under weeds, and shake and thresh samples of mature crops onto a small tarp or sack, to see if snails are in the portion of crop that will enter the harvester.

How many snails represent a problem?

In emerging crops, if numbers of round snails greater than 7mm in diameter are above 20/m² in cereals and 5/m² in pulses and oilseeds, crop damage is likely to exceed the costs of baiting.

Baiting thresholds for small pointed snails are higher (40/m² cereals and 20/m² oilseeds). No thresholds are established for

pulses. As juveniles, small pointed snails can be tiny – less than 1mm – so accurate counts are hard to achieve.

In pasture, a threshold of 80/m² for round snails and 100/m² for small pointed has been established.

Snails that survive baiting can become a harvest contaminant. For a fixed number of snails, grain contamination is a greater risk in lower-yielding crops.

Snail thresholds to warrant harvester modifications are hard to define. This is because the risk of contamination depends on snail type and size in relation to grain, and position of snails relative to cutting height.

How fast do snails move?

In cool, moist conditions snails have been recorded moving 30m in a seven-day period. At this pace, it is feasible that paddock perimeters may be reinvaded after treatment by snails living on fence lines, remnant vegetation and roadsides. Hitchhiker snails move at 50 kilometres per hour in a built-up area and 100km/hr on the open road!

When are snails active?

Snails need moisture to be active and rainfall is the main trigger for activity. They are generally actively feeding and breeding when conditions are cool and moist.

In late spring/early summer they aestivate (are dormant). This period of inactivity is triggered by dryness and high temperatures.

However, they can become active in summer after rainfall.

At the start of harvest a rain shower of 5mm is enough to cause snails to crawl down from crops, but a similar-sized rainfall event later in harvest often causes little movement.

In late summer, one to two millimetres of rain are enough to trigger activity, but snails will only remain active if conditions stay moist.

When do snails breed?

Snails generally start to breed about two to three weeks after the first heavy autumn rain, providing conditions stay moist. This period provides time for them to feed and for reproductive organs to mature.

If summer weeds are present and summer

conditions remain cool and moist, there is anecdotal evidence that snails can breed as early as January.

Snails are hermaphrodites, enabling each to lay an egg cluster after mating. Round snails lay up to double the number of eggs of pointed snails. In the field, each round snail can lay up to 400 eggs per year. Eggs are laid in the top soil.

Action

- ▶ Controlling snails before egg laying commences is fundamental to successful integrated control.

What damage do snails cause?

While the pointed snail favours dead organic material, the two species of round snail and the small pointed snail eat green plant material and dead organic matter.

Chewed leaf margins and irregular holes are typical damage. Cereal crops are likely to survive snail damage, especially if sown at the correct depth in a firm seedbed, preventing snails from grazing on the growing point.

Damage to germinating canola and legume crops can be difficult to detect if the snails eat cotyledon leaves. The result will look like crop failure. If damage is widespread re-sowing could be necessary.

Action

- ▶ Monitor and control snails pre-seeding, especially in paddocks to be sown to canola or pulses.

Management at harvest

At harvest the objective is to minimise the intake of snails into the harvester.

Where snail populations are high, even with harvester modifications, it is unlikely that grain will be deliverable without additional cleaning.

Where snail numbers are high and large numbers enter the machine, harvesters can become clogged by a mixture of crushed snail guts and dust. If allowed to dry, this mixture sets like concrete.

A combination of harvester modifications has been found to drastically reduce the number of snails entering the grain sample. However, to achieve this reduction there is generally a trade-off between reduced harvester throughput and/or increased grain losses.

Minimising snail intake

Early and strategic harvesting

As summer progresses, snails become harder to dislodge from the canopy and are less likely to move down the canopy after light rainfall.

Windrowing (swathing)

In trials, windrowing barley directly in front of the harvester resulted in 55 to 75 per cent less round snails entering the harvester than direct heading.

Windrowing when cool and earlier in the season produces better results.

Snails tend to invade windrows of crops cut down to dry. If picking up windrows with harvesters, open raking fronts (rather than belt feeders) fitted with crop lifters and PVC pipe covers to mask the unused width of the cutter bar will result in less snails entering the harvester.



Figure 2 A rigid pusher bar suited to cereal crops. Currently, the preferred material is 100 to 125mm DuraGal® tubing. The bar is set 2 to 2.2m in front of the knife and the lower edge is 50 to 70mm above the cutting height.

PHOTO: G. HAYES

Table 1 The best performing combinations of chaffer and shoe sieve from the trials run between 2000 and 2002. Screen size should be selected to allow easy passage of harvested grain.

Crop	Chaffer screen			Cleaning screen (shoe)		
	PHS	EMM	WWM	PHS	EMM	WWM
Canola	4.76mm round 3.97mm round	7x19mm 6x16mm 5.5x10mm	3.25mm	3.25mm round 2.41mm round*	3.5x6mm	-
Peas	11.0mm round	-	10mm	9.53mm hex 9.53mm round 8.5mm round*	-	8mm
Barley	9.5mm hex	9x28mm	8mm	7.94mm round	7x19mm	6.3mm
Wheat	9.5mm hex	9x28mm	8mm	6.3mm round or square	6x16mm	6.3mm

PHS – punch hole screen: round, square or hexagonal (hex)

EMM – expanded metal mesh (crosswise orientation, with raised knuckle to the front, is better for removal of pointed snails and harvester throughput)

WWM – woven or welded wire mesh

Sizes are hole diameter (PHS), nominal mesh size (EMM) and nominal aperture size (WWM).

*higher risk of clogging

Stripper fronts and cutting height

A stripper front proved to be the most effective way of reducing snail contamination in medium to heavy crops. By vibrating snails off standing cereals and taking in less material, stripper fronts reduced snail contamination in grain by 50 per cent compared to a standard open front. At the same time harvest ground speed and harvest capacity were increased by up to 100 per cent in suitable conditions.

A cheaper but less effective alternative is to raise the cutting height and add a dislodger bar.

In crops heavily contaminated with snails, the intake of more rather than less straw may help absorb moisture from crushed snails and increase their ejection over the chaffer sieve.

Dislodger bars

Fitting a rigid bar (Figure 2) or flexible fingers (in tall pulse crops) about 2m in front of the knife has been found to reduce the intake of round snails by up to 80 per cent in cereals and 60 per cent in pulses.

A rigid bar fitted with dangling V-belts, set at 100mm spacing, proved effective

at dislodging round snails in standing tall pulse crops or can be added to a windrow pick-up.

Crop losses of up to five per cent have been recorded with dislodger bars, depending on design, crop type and maturity. Double pusher bars offer no advantage.

Maximising snail and grain separation

Threshing intensity

Increasing threshing intensity is only really effective at crushing large round snails. However, it can result in clogging of the grain transfer and sieve components and physically damaging grain.

Fixed aperture sieves

Where snails are the same size as grain, separation in the harvester or by cleaning is very difficult. However, when there is a significant size difference, scalping larger snails and sieving smaller snails has been successful.

While adjustable louvre sieves are suitable for large grains such as faba beans, fixed aperture sieves that rely more on physical

screening and less on air separation have proved useful for smaller grains.

Three types of mesh were tested in the chaffer and shoe screen positions (Table 1). The recommended option is to replace both the chaffer and shoe sieve to gain maximum separation.

Where repeat ratios are low in grain but high in snails and there is a high risk of clogging the harvester, an option is to open the repeats door and waste the grain on the ground.

When harvesting snail-infested crops loosen grain conveyor belts to allow conveyors to stop before clogging and harvester damage occur.

Post-harvest cleaning

The snail-crushing roller produced by Shmik Engineering has been a pivotal development in managing grain contaminated with snails. A two-roller machine has the capacity to process 25 tonnes of grain per hour, and a dual-roller machine up to 45t/hr.

Table 2 The most appropriate set-up and moisture content established when using a snail-crushing roller.

Grain type	Grain moisture content (%)	Roller clearance
Cereals	Less than 14	Less than 1mm
Peas	14-15	1-2.5mm
Lentils	12-14	1mm
Faba Beans	14-15	Less than half the width of the seed
Canola	Poor suitability due to high wastage	

Table 3 Typical results for screen tests to remove snails from harvested grain

Grain type	Screen	Grain loss (%)	Snails removed (%)
Wheat, barley	25mm by 2.6mm slot	5	50
Peas	5.15mm diameter round	2	10
Lentils	25mm by 2.65mm slot	6	48
Canola	2.2mm diameter round	5	12

Table 4 Bait rates for broadacre crops tested in SA pre-2003 (metaldehyde 15g/kg).

Snail type	Crop	Number	Label bait rate*
Mature round and pointed	Canola and pulses	More than 5/m ²	5-10kg/ha
Mature round and pointed	Cereals	20 to 80/m ²	5kg/ha
Mature round	Cereals	More than 80/m ²	10kg/ha
Mature pointed	Cereals	More than 80/m ²	2 x 5kg/ha applications two weeks apart

*Always refer to product label

On farm, grain with 80 snails per litre, scalped before rolling and screened after rolling to remove crushed shell and residue, was delivered snail-free. As little as one per cent grain loss can be achieved, which is small grains or screenings.

For lentils, an aspirator is added to help remove crushed shells and pods before entering the screen cleaner.

Adjustment and monitoring of the roller machine is very important for good results (Table 2). In trials, when the machine was first launched, grain loss for the whole scalping, rolling and screening process was nearer six per cent.

Rolling has been used successfully on wheat, barley, field peas, beans and lentils, with thousands of tonnes processed to meet market standards. Rolling to remove snails from canola is possible but results in about 15 to 30 per cent of canola seed being crushed, depending on the size of snail being targeted.

With screens alone, 50 per cent snail removal was the best effort achieved with grain losses of about five per cent (Table 3).

Gravity separation has also been successful. The bulk density of round (3 to 12mm) and pointed (2 to 8mm) snails was found to differ from that of canola, barley peas and lentil. Other grains were not tested. As snails die and dry they become lighter, so gravity separation is suitable for grain coming out of storage.

Control options

Bash 'Em

The objective of stubble bashing is to knock snails onto the hot soil surface to dehydrate and kill them. This can be achieved by grazing or mechanical stubble bashing. Bashing cannot occur if fire or machinery bans are in place.

Rolling, slashing and cabling standing cereal or canola stubble are effective techniques for killing snails. In paddock trials, kill rates ranged between 50 to 90, per cent providing air temperature was greater than 35°C. This compares to about 30 per cent kill from grazing.

Rolling and slashing are generally only effective on round snails as pointed snails often hide under rocks. These can be flipped over when cabling, exposing snails to the heat of the sun.

Slashing is relatively slow, leaves short stubble for snails to escape the hot soil surface and can be a fire risk, especially in stony paddocks.

Rubber tyre or steel rollers can be used to flatten stubble. One pass is sufficient for cereal and canola stubble, while barley stubble generally requires two passes. In light soils and thin stubbles, steel ribbed rollers can reduce the likelihood of soil erosion.

Dragging an old punt cable with a connecting safety chain or 20 to 25mm chain between two tractors, driven about 300m apart, has proved a fast and effective method to bash stubble. Kill rates are on average 70 per cent from one pass, providing there is no dew at night to enable the snails to rehydrate.

Burn 'Em

Strategic burning remains the most effective method of pre-breeding snail control, providing a hot, even burn is achieved. If summer weeds are controlled prior to burning and rocks are turned by fire harrowing or cabling up, nearly 100 per cent snail kill has been achieved. Without summer weed control, results are nearer 60 per cent kill.

Burning must be avoided on soils that are prone to erosion.

While burning is highly effective, it should be used judiciously to minimise the loss of stubble being returned to the system.

Bait 'Em

Baiting is the only control option once crops have been sown. Without baiting the benefits of stubble management can be lost.

Mature snails are more likely to take the bait. Generally snails more than 7mm in diameter (round) or length (conical) are considered mature. Snail mortality after



Vigilant cleaning of harvesters and equipment will help reduce snail occurrences in future crops. Pictured here are a snail crushing roller, followed by an aspirator and a screen cleaner.

PHOTO: G. HAYES



PHOTO: EMMA LEONARD

Baiting as soon as there is sufficient moisture for snails to start moving down to the soil surface provides good results, even in late summer. In spring, baiting must stop eight weeks before harvest to prevent bait contamination of grain.

baiting is between 60 to 90 per cent for mature round snails and 50 to 70 per cent for mature pointed snails.

More bait points per hectare rather than higher concentrations of active ingredient have been shown to result in better kill rates.

When to bait

The key is to start baiting before snails lay eggs. This will occur in cool moist conditions and growers suggest it can be as early as January. Generally, egg laying will be in late summer/early autumn.

Baiting can start before heavy dew or light rainfall (1 to 2mm) occurs. In cool, moist summers, baiting pastures or stubbles after harvest in December has seen good kill rates.

Moisture softens the bait and it may disintegrate but the chemical is still active. Growers have had success baiting after substantial summer rainfall has encouraged snails down to the soil surface.

Bait degrades in UV light; degradation rates are reduced as day length shortens. In trials, the concentration of metaldehyde fell from 15 to 4.9 per cent in four weeks when bait was spread in February, but to 7.5 per cent when spread a month later.

Baiting must finish two months prior to harvest to prevent bait becoming a

contaminant of harvested grain. There is zero tolerance of bait contamination of grain.

Bait rates

Bait rates should be based on the number of mature snails (Table 4). As snail numbers increase higher bait rates are likely to be beneficial. If snail invasion is high it may be prudent to increase bait rates at paddock perimeters.

Snails are only marginally attracted to the bait but will eat a pellet if they happen to bump into it. Therefore, baits with smaller bait size achieve more bait points per hectare and increase the potential for snails to hit a bait pellet.

Tests showed at 5kg/ha, 5mm diameter bait is spread at four bait points per square metre, while 2mm diameter bait would have 12 bait points in the same area.

Currently, there are three active ingredients used in snail bait sold in Australia (Table 5). Always check the product label and ensure products are registered for use in your state.

GRDC is conducting new research on baits with a focus on juvenile snail control, including formulation testing of alternative ingredients and biological control agents. Previous research found no difference in kill between active ingredients.

Table 5 Snail baits commonly used in broadacre agriculture:

Active ingredient	Mode of action
15 to 50g/kg metaldehyde	Irritant which causes excess mucus secretion and desiccation; nerve poison at high concentrations.
20g/kg methiocarb	Inhibits nervous system
60g/kg Fe-EDTA	Stomach poison



Snails pose a significant biosecurity threat as they are easily transported between paddock, farms and regions – inspect and clean equipment, machinery, vehicles and fodder before bringing on to your farm.

USEFUL RESOURCES

Bash 'Em, Burn 'Em Bait 'Em – integrated snail management in crops and pastures

www.grdc.com.au/Media-Centre/Bookshop/

Snail Back Pocket Guide

www.grdc.com.au/Media-Centre/Bookshop/

GRDC Pestlinks

www.grdc.com.au

Bulletin 4713: Identification and control of pests, slugs and snails for broadacre crops in Western Australia

www.agric.wa.gov.au

Ground Cover TV: Snails

www.grdc.com.au/GCTV

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