GRDC GROWNOTES™

NATIONAL

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TIPS & TACTICS

BETTER MOUSE MANAGEMENT

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

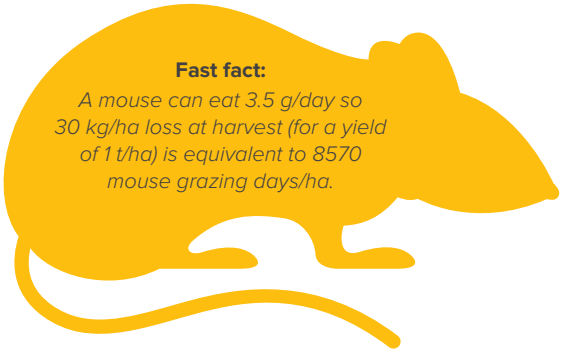
Detecting mice early through monitoring is critical for controlling numbers effectively and reducing crop damage

Mouse numbers can build rapidly under the right conditions, leading to crop damage throughout the growing season. Early detection and integrated management across farm are crucial for reducing the risk of mouse impacts. Once mouse numbers are very high, it is very difficult to reduce damage and control strategies can be costly.

KEY POINTS

- High numbers of mice cause crop damage, loss of livestock feed and fodder, contamination of stored grain and spread of disease.
- The breeding season is usually October to May but the start and duration is determined by the availability and quality of food.
- Monitoring reveals changes in populations and can help indicate when control is needed.
- The most important times to undertake monitoring are prior to sowing (March–April) and in early spring (September–October).
- Year-round paddock and farm hygiene practices are key to minimising the availability of quality food to mice.

Photo 1: In cereal crops mouse damage can occur at sowing, when mice dig out the newly sown seed; at booting, when mice attack the nodes during the vegetative growth stage; and flowering, when mice attack the heads.
Source: GRDC.



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Observe and monitor

There are simple in-paddock monitoring techniques—mouse chew cards and active burrow counts—that can be used when conditions indicate there is a risk of increasing mouse numbers. Mice build up locally within paddocks and they generally travel around 100 m to forage for food.

The most important times to undertake monitoring are prior to sowing (March–April) and in early spring (September–October), but monitoring can be conducted at any time depending on conditions. Mouse numbers are normally highest at the end of the breeding season in late autumn, which coincides with sowing of winter crops across southern Australia and sowing of summer crops in the north. When mouse numbers have been high in autumn, monitoring should continue through winter and spring.

Growers should become familiar with indicators of 'normal' mouse activity for their properties and:

1. Record observations.
2. Report observations.
3. Observe what others have reported in their region.

There are tools to help such as the *MouseAlert* phone app or website (https://www.feralscan.org.au/mousealert) or subscribe to receive direct alerts and submit surveillance through GRDC's GrowNotes™ Alert (www.grdc.com.au/grownotesalert).

Following these three steps will help growers to make informed management decisions.

Have mouse numbers increased?

Indicators that mouse numbers have increased (Photo 2) include:

- numerous burrows or fresh activity in paddocks
- large numbers of mice seen at night, in paddocks or on roads
- signs of seeds being dug up, plants being gnawed or pod and head damage
- frequent daytime sightings
- more birds of prey (such as kestrels or kites) than normal (although an increase in the number of birds of prey is often delayed compared to an increase in mouse abundance).

Photo 2: Signs of mouse damage evident at different stages: A) at sowing, where they have dug out individual seeds (this photograph was taken in South Australia during an outbreak in 2002, where mouse numbers were greater than 500 mice/ha); B) after tillering (note mouse chew marks); C) after grain filling (maturing wheat near active burrow); D) after grain filling (sorghum with germ removed).
Source: A: Charles Krebs, University of British Columbia; B, C, D: Peter Brown, CSIRO.

Monitoring techniques

Active burrow counts

To look for active burrows, walk about 30 m in from the edge of the paddock and set a 100 m x 1 m wide transect through a crop (following the furrows). Walk slowly along the transect scanning for evidence of mouse burrows. Be strict about keeping within the 1 m transect width. Take note of any mouse burrows that look active (Photo 3).

Record the number of active burrows per 100 m transect. Repeat across 2 or 4 transects (to cover a large area). **If there are more than 2–3 active burrows per 100 m, then there is a mouse problem!**

Corn flour can be used to mark potentially active burrows. Go back the following day to look for evidence of fresh tracks or disturbed soil. Checks should be made across a paddock as populations can be patchy.

Evidence of active burrows varies depending on soil type and crop coverage. In cracking soils, holes used by mice may be difficult to identify, so look for trails in and out of cracks. In hard-setting soils, there may be few holes but each can be used by many mice.

Photo 3: Signs of active mouse burrows in sandy and clay soils (note fresh footprints and fresh soil). Corn flour was used to mark potentially active burrows.
Source: Peter Brown, CSIRO.

Photo 4: Mouse chew card firmly pegged to the ground.
Source: Peter Brown, CSIRO.

Mouse chew cards

Mouse chew cards are set out overnight and the proportion of the card that has been chewed by mice is recorded when it is collected the following day (Photo 4). This method is most reliable when alternative food is scarce. Note that snails can remove material from chew cards but it is fairly easy to distinguish between the patterns of damage caused by mice versus snails.

How to use chew cards:

1. Make chew cards (10 x 10 cm) using standard printer/photocopy paper, with a 1 cm printed grid. A template is available from the MouseAlert website. Pre-soak the cards in canola and/or linseed oil (for about 10–15 minutes) and ensure you have enough fasteners; bent wire pegs are the best.
2. Select a few paddocks that are representative of the farm.
3. Place the chew cards approximately 30 m in from the edge of the paddock. Peg each chew card to the ground in a line of 10 cards spaced at 1 card every 10 m. Follow the furrows to make it easier to find the cards again the next morning.
4. While walking through the paddock, look for signs of fresh mouse activity or damage.
5. Retrieve the chew cards the following morning and assess for evidence of mouse damage by averaging the damage across the 10 cards.

DAMAGE RATING FOR CHEW CARDS

	**< 10 squares per card eaten =** low to moderate mouse activity
	**> 10 squares per card eaten =** moderate to high mouse activity **crop damage possible**
	**> 20 squares per card eaten =** high to very high mouse activity **crop damage likely and ongoing mouse problem**

A note on trapping

Trapping is not recommended as a method for monitoring mice as it is time-consuming and there is a risk of capturing non-target species. Using mouse chew cards and looking for active burrows should be sufficient to gauge mouse activity.

CONDITIONS THAT ENCOURAGE MICE

Mice are always present in crops in low numbers, but numbers can increase rapidly and cause economic damage under favourable conditions, including:

- prolonged availability of high-quality feed
- high crop yields
- grain left in paddocks at harvest or due to poor harvesting efficiency
- early autumn rains that produce early seedset of winter weeds
- late spring or early summer rains or intense wind events that damage mature crops and produce a flush of summer weeds
- favourable burrowing conditions, such as cracking or light soils
- heavy crop stubbles
- poor hygiene around grain stores.

Note that high numbers in localised areas, e.g. around haystacks and buildings, does not necessarily mean there are high numbers in paddocks.

All these factors help extend the breeding season beyond the usual October to May period. The rapid-increase phase in mouse populations is often not fully recognised until numbers are approaching plague proportions. At this point, control and damage minimisation strategies are extremely difficult, so early detection and proactive actions are essential.

IS IT A PLAGUE?

A mouse density greater than 800 mice/ha is considered a plague (Singleton et al. 2005). Economic damage occurs when densities are over 200 mice/ha (equivalent to one sheep grazing) (Brown et al. 2007).

The build up to a mouse plague and the subsequent population decline are affected by factors such as weather, food supply, predation, disease and social structure and it is different depending on the region:

- Southern Region: the interval from a plague trigger to peak population densities is 12–18 months and the entire cycle of a plague is 1–2 years (Figure 1).
- Northern Region: outbreaks are more frequent (every 2–3 years). The build up can be shorter (12 months), and outbreaks are often trigged by dry conditions.
- Western Region: widespread outbreaks generally do not occur, but can occur at a localised level.

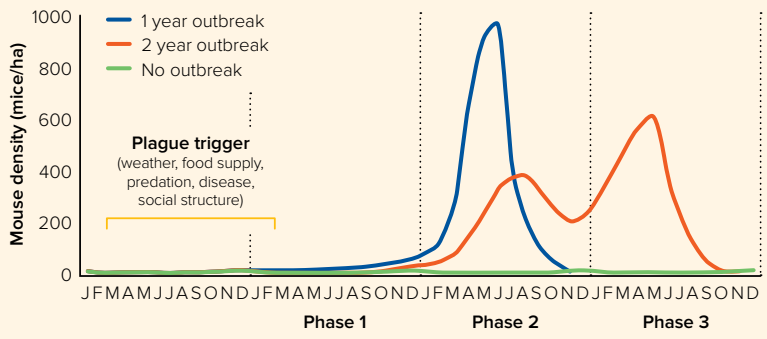

Figure 1: **Population trends of mouse plagues in the Southern Region.** Changes in abundance of mice leading up to and during a plague; the heights of peaks may vary between plagues. Seasonal conditions during Phase 2 may prevent the population peak at Phase 3. The population peaks occur 4–6 months after maximum feed availability, which will vary in irrigated and summer cropping systems.

Control mice with an integrated approach

An integrated approach—employing a number of control mechanisms across the farm—is the best way to minimise damage, especially in seasons conducive to high mouse populations.

There are four key timings to consider for control: year-round, at sowing (autumn), during crop growth (winter), prior to harvest (spring and summer).

Year-round

- Consider management activities over large areas (i.e. 1,000 ha) to reduce the chance of reinvasion by mice.
- Coordinate management activities with neighbours.
- Practice good farm hygiene, including in storage areas, to minimise the availability of grain as a food source to mice.

At sowing (autumn)

This is when mouse populations are normally at their peak and can cause economic damage.

- Control weeds and volunteer crops along fence lines, crop margins and channel banks in autumn and before seedset to minimise sources of food and shelter.
- Consider changing crops in the rotation if mouse numbers are high. For example, chickpeas after barley are considered higher risk than beans.
- Sow as evenly and as early as possible for each crop to ensure strong plants establish rapidly.
- Do not dry sow because this delays establishment and leaves seeds vulnerable to mouse damage.
- Slightly increase seeding rates and sow as deeply as possible if mouse numbers are high at seeding. This will compensate for losses.
- Cross-harrow or roll after sowing to ensure good seed coverage and to remove sowing lines.
- When mouse populations are high at seeding, these practices are often insufficient to control damage and baiting at sowing may be necessary (see ‘Baiting’, page 5).

During crop growth (winter)

Mouse numbers decline through winter, but can still cause economic damage if numbers are high. Crops will compensate for minor damage, but cannot compensate for heavy damage.

- Control weeds and grasses along fence lines and crop margins before seedset by spraying or slashing.
- Mouse-proof houses and grain and stock feed storages.
- Bait around buildings if necessary (see 'Baiting outside of crops', page 6).
- Monitor for signs of mouse activity.

Prior to harvest (spring and summer)

Mice begin breeding in early spring and numbers will increase through spring and into summer. If mouse abundance is high, some damage is possible as winter crops are maturing.

- If mouse abundance is high and baiting is warranted, be aware of the withholding period before harvest.
- Harvest crops before they are overripe to minimise pod shatter or grain loss.
- Roll standing stubble to increase exposure of mice to predators.
- Minimise spilled grain in paddocks. This is key to limiting mouse populations and damage in next year's crop. Set harvesters to minimise grain loss and monitor how much grain is left in the paddock (Table 1).
- Grazing stubbles can help clean up residual grain, but sufficient ground cover should be left to minimise erosion.
- Use seed destroyers to reduce potential food sources for mice.
- Be aware that windrowed crops provide mice with a good source of food and shelter. In paddocks with crops that will be windrowed, efforts should be made early to reduce the number of mice.
- Clean up any spills of grain around field bins, augers, silo bags and other grain storage.
- Remove or reduce plant material, rubbish and general clutter around buildings, silos and fodder storage as these all provide protection for mice.

Table 1: How much grain is left on the ground? An acceptable level of harvester grain loss is 10 to 30 kg/t (for a yield of 1 t/ha) but this can result in 1 to 100 grains for every 10 x 10 cm quadrant (depending on crop type) and this is a lot of mouse food. A mouse can eat 3.5 g/day, so 30 kg/ka is equivalent to 8570 mouse grazing days/ha.

Grain type	Weight of 100 grains (g)	Grain count in 0.01 m^2 for a loss of 30 kg/ha
Wheat, oats	3 to 4	10 to 7.5
Kabuli chickpeas, faba beans	25 to 36	1.2 to 0.8
Desi chickpeas, field peas, lupins	17 to 25	1.7 to 1.2
Lentils	3 to 6	10 to 5
Barley	4 to 5	7.5 to 6
Canola	0.3 to 0.4	100 to 75

Baiting

Baiting is not a total solution for crop protection, but assists in minimising potential damage. In trials of zinc phosphide-treated wheat grains at 1 kg/ha, 90–95% of the mouse population in the baited area were killed.

Only chemicals that are registered to control mice can be legally used for this purpose. It is an offence to possess or use home-made mouse bait and there are heavy penalties under the Agricultural and Veterinary Products (Control of Use) Act 2002.

Bait is available commercially on sterilised wheat grain, but can also be applied to unsterilised wheat grain at regional mixing stations in some states. Zinc phosphide pellet formulations are also now available. Contact your local rural supply company or refer to state government or APVMA websites for more details (the APVMA PubCRIS website is: https://portal.apvma.gov.au/pubcris; use 'mouse' as the search word).

Mouse baiting recommendations

- Check requirements for baiting with your State/Territory government department (some departments may require specific actions to be taken when baiting).
- Apply bait according to label (i.e. 1 kg/ha).
- Bait must not be laid within 50 m of the crop perimeter or native vegetation.
- Ideally, bait should be used in dry conditions to achieve maximum ingestion of the active ingredient.
- Apply baits six weeks prior to sowing if there is sufficient evidence of mice (more than three active burrows per 100 x 1 m transect and/or evidence of significant chew card activity), then reassess prior to sowing (if baiting only once, then bait at sowing).
- Allow at least four to six weeks before reapplication of baits to minimise the chance of bait aversion. This allows mice that have previously eaten a non-lethal dose to try it again (overcome bait aversion), and also targets new mice in the population that are susceptible to the bait (through immigration or a new generation of mice).
- If baiting at sowing: apply directly after sowing (e.g. using a bait spreader on back of the seeder). Mice forage more after sowing because of the soil disturbance. If a novel food is available on the surface they will eat that in preference to digging up the planted seed. Baiting more than 24 hours after sowing will be less effective.
- Baiting must not occur within two weeks of harvest, due to the withholding period.
- If it rains zinc phosphide bait may become less effective. Zinc phosphide will tolerate some rain but rain erodes the poison off the bait.
- Bait over large areas. Encourage neighbours to bait at the same time if they also have a mouse problem. The larger the area treated, the lower the chance of reinvasion.

In-crop baiting: options and risks

Currently, zinc phosphide is the only rodenticide registered for in-crop use (consult the label for instructions).

Strict baiting criteria have been established to minimise risks associated with the release of toxic phosphine gas (given off in the acidic environment of the stomach). The gas is not readily released into the atmosphere and the concentrations are insufficient to be harmful to grazing animals or humans.

However, bee hives should be moved away from areas that will be baited. Many grain-eating birds feed in crops and are at risk if bait is laid on bare ground or if patches of bait are spilled during baiting operations.

Native small mammals mostly feed on insects and are seldom found in crops, so they are at little risk.

Other chemicals are not registered because they are either not effective or they have the potential to cause serious loss of wildlife.

Zinc phosphide baits can be laid through aerial or ground application. A rate of 1 kg/ha provides 20,000 to 30,000 lethal doses per hectare.

Baiting at the time of sowing is most effective for protecting recently sown crops but baiting is also effective for controlling mouse damage during vegetative growth, flowering and seedset.

Baiting outside of crops

A wide range of baits are registered for use in bait stations in and around buildings and farm storages (within 2 m) or enclosed spaces, e.g. drains. Consult the APVMA for a complete listing of currently registered products.

Note that zinc phosphide cannot be used around buildings, in towns or residential areas.

There are no rodenticides registered for use around crop perimeters, for use in native vegetation, other non-cropping areas such as roadsides or on Crown land.

USEFUL RESOURCES

PestSmart Connect (2017) House mouse. http://www.pestsmart.org.au/pest-animal-species/mouse

GrowNotes™ Alerts: delivered via SMS, email, web portal or via the iOS App. Sign up: www.grdc.com.au/grownotesalert. There are also three dedicated regional Twitter handles: @GNAlertNorth, @GNAlertSouth and @GNAlertWest

MouseAlert app (Photo 5), https://www.feralscan.org.au/mousealert and on Twitter: @MouseAlert

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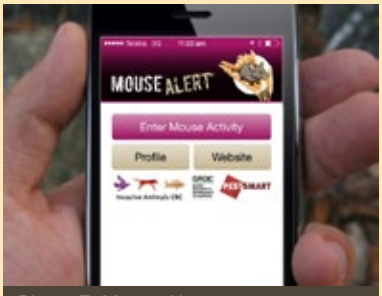

Photo 5: MouseAlert app.
Source: Peter West, NSW DPI.

FAQ's

How long will mice continue to cause damage?

Mice can cause damage to sown seed and emerging, growing and ripening crops. Mice will continue to feed on a crop while it is a food source (Photo 6). Damage is most severe for about two to three weeks after crop emergence and again around seedset. However, mice will sometimes cause significant damage to tillering cereals.

How many applications of bait are required?

Monitoring is the only method of establishing if further applications of bait are required. After baiting, continue to monitor mouse activity. Rebaiting should occur more than four weeks after the first bait application to overcome bait aversion. See 'Mouse baiting recommendations' on page 5.

Are other animals at risk from mouse bait or baited mice?

Mouse bodies poisoned with zinc phosphide present a low risk to dogs and other animals. Phosphine is given off in the acidic environment of the stomach, so secondary poisoning risk is low. However, primary poisoning—by directly eating poisoned bait—is a risk to dogs and other animals. There is no antidote for zinc phosphide poisoning. Growers should restrain working dogs and pets during the baiting program and be very careful to consider the risk to grain-eating birds.

Where can I get bait?

Check with your State/Territory government agency first to confirm if there are any local restrictions. Bait is available through most rural supply companies.

Acknowledgements

National Mouse Management Working Group.

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MORE INFORMATION

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Photo 6: Mouse damage to maize.
Source: Peter Brown, CSIRO.