JANUARY 2016

ALL ABOUT ALMONDS

ORCHARD MANAGEMENT

MANAGING MICE IN AUSTRALIAN ALMONDS

House mice can cause serious problems to all aspects of the almond industry. A range of control methods are available to manage mice and populations need to be monitored. Management must be conducted over large areas to minimise re invasion. In orchards, a combination of poisoning and habitat manipulation is recommended. In processing facilities, a combination of poisoning, habitat manipulation, trapping, and mouse-proofing is recommended.

KEY POINTS

- Mice can cause damage to almonds from flowering through to harvest, but also post harvest.
- Mouse populations have an ability to increase rapidly in size in a very short period.
- In any rodent control program it is important to keep all potential hiding or nesting sites to a minimum.
- Orchard baiting is not recommended due to food safety risks.

INTRODUCTION

PROBLEMS OF MICE AND THE IMPORTANCE OF MANAGEMENT

The house mouse (*Mus domesticus*) is a serious pest to agriculture in Australia when climatic conditions are optimal. Mouse populations have the potential to undergo widespread eruptions (i.e. mouse plagues) in the grain-growing regions of Australia.

House mice cause significant damage to almond orchards and in hulling/shelling and processing facilities.

Mice need to be managed to reduce the damage that they are causing to almond orchards, and to reduce damage and contamination to shelling and hulling and processing facilities.

DAMAGE MICE CAUSE TO THE ALMOND INDUSTRY

Mice can cause problems in food processing and storage areas through:

- Direct consumption of food;
- Food contamination and damage;
- Loss of consumer confidence and damaged public relations;
- Structural damage;
- Disease transmission to workers and consumers (e.g. Leptospirosis; Salmonellosis); and
- Costs associated with pest control operations.

For the almond industry, mice can cause damage to almonds through various stages from flowering to harvest, but also post-harvest in hulling, shelling and processing facilities. Damage can be gnawing on the product, allowing infections to the kernel, also through contamination from urine and faeces. In hulling, shelling and processing facilities, damage/ contamination can occur prior, during and after processing.

BIOLOGY AND ECOLOGY

CHARACTERISTICS OF MICE

The success of the house mouse as a pest species can be attributed to its ability to live in a wide variety of habitats, to its small size, behaviour, reproductive potential and omnivorous feeding habits.

BIOLOGY AND BREEDING

In the field, house mice have a reasonably well-defined breeding season. It commences early in spring after good rainfall has promoted growth of important food resources that can trigger breeding. It seems that the quality, not quantity, of the food is important in triggering breeding activity. Mice continue breeding through summer and into early winter. Breeding continues provided there is sufficient high quality food available.

Mouse populations have an ability to increase rapidly in size in a very short period. Theoretically, one breeding pair of mice can produce 500 mice within 21 weeks.

The common house mouse (Mus domesticus)

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TRAPPING CAN BE AN EFFECTIVE TECHNIQUE IF USED CORRECTLY, BUT ITS EFFECTIVENESS IS REDUCED DURING A MOUSE PLAGUE (WHEN DENSITIES ARE SOMETIMES VERY HIGH) AND CAN BE USED AS A MEASURE OF ABUNDANCE OF MICE IN THE FACILITY.

MANAGEMENT PRACTICES

PRINCIPLES OF RODENT MANAGEMENT

An effective rodent control strategy must have clearly defined objectives which for the almond industry, would be no positive salmonella samples. The strategy must be well planned and include a method of monitoring and regular recording of information so that effectiveness can be determined. If infestation does occur, note that the house mouse has a home range of 20m x 20m in breeding season, and 36m x 36m outside of breeding.

POISONING

There are different types of baits and depending on what is used, they can be broadcast onto the ground or placed inside bait stations. However, poison bait stations may not be the "best" method available, may be ineffective if used inappropriately, or it may take a few days after an animal that consumed the poison bait to die, thus causing damage or spoiling product prior to death.

There are two categories of rodenticides available:

- Acute rodenticides (fast acting) such as strychnine and zinc phosphide. Death usually occurs 20 minutes to 24 hours after ingestion. The chance of "bait shyness" is high because of the short period from ingestion of the bait and the onset of symptoms of poisoning, and animals can associate their consumption of the bait with the sickness. There are no antidotes to the acute rodenticides. Zinc phosphide (Zn3P2) is readily available and strychnine is available as "Dynamice" ® in South Australia.
- Chronic rodenticides (slow acting) such as Warfarin, a first-generation anticoagulant that requires multiple feeds and kills in up to 10 days; and Brodifacoum, a second-generation rodenticide that requires only a single feed and kills in 3-7 days after consumption. Vitamin K can be administered as an antidote. Bait shyness is rare when using anticoagulants because of the long delay from ingestion of bait and onset of sickness.

Note: Zinc phosphide is not registered for use in bait stations and cannot be used in and around buildings and storage sheds. Furthermore, zinc phosphide can only be used once every 3 months because surviving animals develop strong bait aversion, and may also require pre-feeding.

Bait stations need to be set correctly (Figure 2). It is important to ensure they are set against the external walls of sheds. Mice use the edges of these structures to move about the facility and so the bait stations should intercept these movements as much as possible to increase the chance of animals entering the stations. If the bait stations are not touching the structures, there is a strong chance that rats and mice will walk straight past the bait station.

Neither of these two rodenticides are a one-stop-shop for the control of mice and they need to be used in a resistance management practice to minimise the development of resistance. Being such prolific reproducers, the most influential tool in combating the severity of a potential mouse plague is the preventative practices of maintaining high levels of hygiene and minimising the areas of potential habitat creation, providing protection from natural predators.

TRAPPING

Trapping can be an effective technique if used correctly, but its effectiveness is reduced during a mouse plague (when densities are sometimes very high) and can be used as a measure of abundance of mice in the facility.

A few simple things can improve the effectiveness of a mouse or rat trap:

- **Bait type** Rats and mice prefer to eat bacon rind, chocolate or leather soaked in linseed oil and do not like to eat cheese. An advantage of leather is that it can be tied securely to the trap trigger so the rodents cannot remove the bait, and it can be used repeatedly.
- **Positioning of trap** Set each trap at right angles to a wall or barrier with the trigger next to the wall. Rodents do not like moving away from walls into the open (Figure 2).

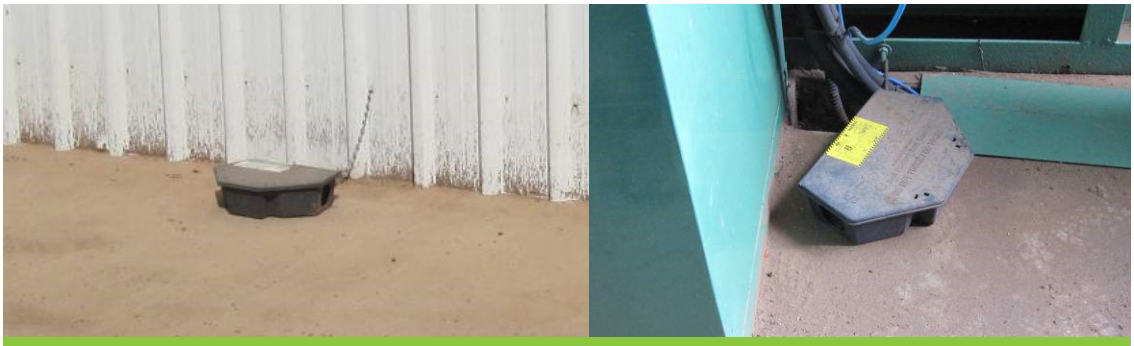

Figure 2: Example of bait stations that are not set properly. Bait stations must be placed against the walls of structures to increase the chance of rats or mice entering and consuming the bait

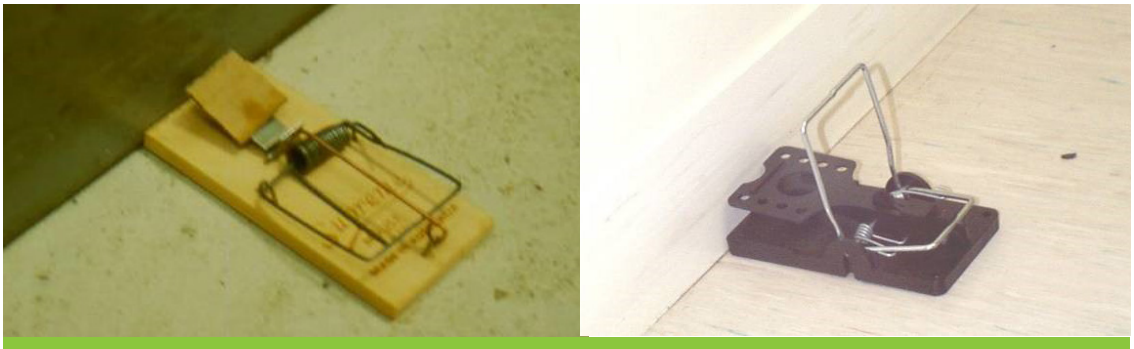

*Figure 3: Kill traps. (a) Mouse Trap: "Supreme" - 10cm long, set against of all. Surface of trigger has been enlarged using leather soaked in linseed oil. (b) Strong plastic moulded rat trap - 14cm long. **NB** Photos not to scale*

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ALWAYS CARRY OUT A PRE-CHECK OF MACHINERY, ESPECIALLY ALL HARVESTING MACHINERY, BEFORE OPERATION TO ENSURE THAT A MOUSE, DEAD OR ALIVE, DOES NOT INFECT THE CROP FOR PROCESSING.

- **Enlargement of trigger** Use a piece of cardboard or leather to increase the size of the trigger (Figure 3a).

For rats: leave traps baited but unset for a few days. Once there is evidence that rats are chewing on the leather, re-bait and set the trap. Snap traps made of strong moulded plastic are a good option (Figure 3b).

SITE HOUSEKEEPING

In any rodent control program, it is important to keep all potential hiding or nesting sites to a minimum (Figure 6). These include piles of old rubbish and areas of thick grass and weeds. Seeds from grasses and weeds can be a source of high quality food for mice, while long grass can provide shelter from predators. Clean up piles of rubbish or move them further away from facilities, and keep vegetation short (mowing, slashing etc.) to reduce cover and food sources for mice.

Always carry out a pre-check of machinery, especially all harvesting machinery, before operation to ensure that a mouse, dead or alive, does not infect the crop for processing.

MONITORING

Monitoring can be in the form of number of mice captured in snap traps, amount of poison baits consumed, number and proportion of census cards eaten, and/or presence of rodent faeces in set areas. These techniques are all relatively simple to conduct. It is important to keep good records, so that when activity increases, control efforts can be implemented accordingly.

A census card (canola square) is a piece of paper with a 10 x 10 cm grid marked on it, which is soaked in canola oil and pegged into the ground (Figure 5). In almond orchards, they can be set in lines through the orchard, on perimeters and in adjacent crop fields.

Figure 5: Census card (canola square) held in place by wire. 40% destruction after overnight field evaluation.

ORCHARD CONTROL ACTIONS

PREVENTATIVE CONTROL

Minimising an available food source in the orchard plays an integral role in minimising the level of populations that can be experienced. Maintaining high standards of orchard hygiene help to minimise the amount of food available with a key component being to eliminate the number of mummies remaining on the trees. Leaving mummies as a food source can lead to the development of foraging behaviours whereby the mouse can start to chew pink buds in the search for nectar.

MANAGEMENT OF MICE IN ADJACENT AGRICULTURAL FIELDS

There is a range of farm management practices that can be used to reduce the abundance of mice in nearby cereal fields. Results of field trials have shown that when refuge habitats were manipulated to reduce the number of weeds and grasses along the margins of crops (e.g. fence lines) through spraying, slashing or grazing by sheep, there were fewer mice and in some cases, less damage to crops compared to untreated areas. Fence lines are an important habitat for mice because it is undisturbed (does not get ploughed) and high quality food and cover is often available (roly-poly tumble weeds, barley grass etc.). For the almond industry, the management of surrounding cropping fields should be considered as part of an overall management package (management units of around 1,000 ha).

Figure 4: A bait station set on the edge of an orchard. Small holes are located at the ends of the tube.

PERIMETER BAITING

Perimeter baiting using anticoagulant baits in bait stations has been implemented in many orchards. These are "hand-made" using 75 mm PVC storm water pipe (Figure 4). In most cases, a single bait station can be positioned at the end of a row of trees and every 10 m or so along perimeter fences, which would be adequate coverage.

MANAGEMENT OF HABITATS WITHIN ORCHARDS

In almond orchards, the ground surface is largely undisturbed which means mouse burrows are also not disturbed. Some weed spraying is conducted to clean the ground surface to assist with clean harvesting of the almonds (Figure 6). Weeds around the perimeter of orchards and neighbouring areas also should be sprayed. This can help remove potential cover and food sources provided by weeds. Mice seem to construct burrows

Figure 6: Long grass and old rubbish provides an ideal habitat for mice giving them cover and food.

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near the base of the almond trees, and this may be a result of the shaking process to knock the almonds off the tree at harvest which loosens the soil. This enables mice to easily dig in the loosened soil near the tree trunk (Figure 7). Mice are unlikely to cause damage to the roots of the trees.

Management should be conducted over the entire orchard to minimise re invasion of mice from surrounding areas. However, orchard baiting is not recommended due to ground harvesting and associated food safety risks.

Figure 7: (a) Orchard floor is relatively clean due to weed control sprays. This can benefit mouse control due to reduced food sources. (b) Mouse burrow near base of tree due to loose soil from tree shaking at harvest.

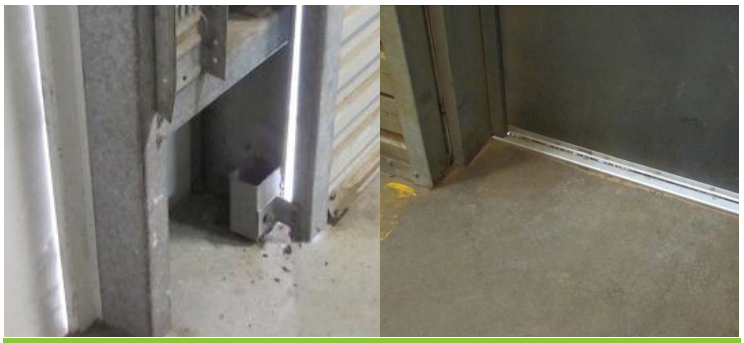

Figure 8: Small holes (>6mm) allow entry into facilities. This is especially important around roller doors where it is difficult to reduce gaps. (a) Small gap alongside roller door allowing entry. (b) Well fitting metal door strips improve management of entry of mice.

Timing	Mouse activity low	Mouse activity moderate	Mouse activity high
Spring	Manage habitat using weed spraying and slashing of early spring grasses and weeds to remove cover/shelter Remove potential food sources	Manage habitat using weed spraying and slashing of early spring grasses and weeds to remove cover/shelter Remove potential food sources	Manage habitat using weed spraying and slashing of early spring grasses and weeds to remove cover/shelter Remove potential food sources Apply rodenticide over entire orchard and surrounding fields (obtain necessary approvals and permissions)
Summer	Manage habitat using weed spraying and slashing of early spring grasses and weeds to remove cover/shelter Remove potential food sources	Manage habitat using weed spraying and slashing of grasses and weeds to remove cover/shelter Remove potential food sources	Manage habitat using weed spraying and slashing of early spring grasses and weeds to remove cover/shelter Remove potential food sources Apply rodenticide over entire orchard and surrounding fields (obtain necessary approvals and permissions) (beware of withholding period before harvest)
Autumn	Management may not be necessary	Remove potential food sources	Remove potential food sources Apply rodenticide over entire orchard and surrounding fields (obtain necessary approvals and permissions) (beware of withholding period before harvest)
Winter	Management may not be necessary	Remove potential food sources	Remove potential food sources Apply rodenticide over entire orchard and surrounding fields (obtain necessary approvals and permissions)

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MORE INFORMATION

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