Practical pest control

What do you need to know?

How would you assess your ability to control pests of grain produce in your on-farm storage? Can you:

- appraise your situation and make an appropriate management response to the pests of stored grain?
- identify the major pests in grain storage and their characteristics?
- prepare for storage by doing 'housekeeping' on the storage site, the storage structures and the grain handling equipment?
- monitor pest infestations?
- work to avoid resistance to control measures?
- recognise market standards on residues from control treatments?
- ensure your control strategies are effectively implemented?

We will also consider these management activities in relation to:

- the production calendar
- the storage structures
- market standards.

Use these lists to identify your own learning goals. By studying this and other sections of the web–CD, and by using our hotlinks to other information sources, you have the opportunity to achieve your goals.

Let's consider now the first requirement, to recognise the importance of pest control, and ask, why do we need insect pest control in on-farm grain storage?

Why control pests in grain storage?

In dry conditions, some cereals can be stored indefinitely without chemical or microbiological decay, provided the water activity is below that at which storage fungi can develop. Dry grain is, however, susceptible to attack by storage insects, and the temperature of grain harvested in Australia is suited to the rapid development of several insect species.

The development of insects produces water and heat which, if unchecked, lead to mould and formation of mycotoxins in bulk grain. This can be a very dangerous situation in bulk storage, as heating and caking may occur and the silo may become blocked with heating grain.

All markets have a nil-tolerance standard for live insects. This means that insects should not be detectable. Keeping a low nil-tolerance standard depends on improving the sampling rate, the sensitivity of the detection method and the effectiveness of the pest control method.

Quarantine considerations may apply to some species.

In favourable conditions insects multiply rapidly. For example, at a multiplication rate of ×30, an infestation of 0.1 insects per kg could increase to over 2000 insects per kg at the end of 3 months, obviously destroying all quality. This rate of increase depends on temperature: the reproduction rate falls to zero when the temperature is below about 15°C, depending on the insect species and humidity level. Insects are not killed at temperatures of 10-15°, and infestation will rapidly increase if a cooled bulk becomes warmer.

Not all insects respond to the same treatment. It is, therefore, important to identify insects correctly, in order to control them effectively. (The table Compounds used as grain protectants shows which protectant is effective for each insect.) The next section will guide you through the process of identifying insects.

Which insects are pests of stored grain?

In the following profiles the black and white illustrations of insects were reproduced from a set of slides from the Central Science Laboratory, Sand Hutton, York, UK, YO41 1LZ. Telephone 44 (01904) 462272, email science@csl.gov.uk.

Colour pictures from CSIRO Australia, Division of Entomology. Used by permission.

The lifecycle descriptions given in the lists are from work by Dr Peter Annis, CSIRO Australia, Division of Entomology, Stored Grain Research Laboratory. Reproduced by permission of GRDC.

The list illustrates the major pests of cereals in Australia. The last category covers minor pests. Study this section by clicking on any button to go to a profile of that pest.

❑	**Lesser grain borer—*Rhyzopertha dominica***
❑	**Sawtoothed grain beetle—*Oryzaephilus surinamensis***
❑	**Red rust flour beetle—*Tribolium castaneum***
❑	**Confused flour beetle—*Tribolium confusum***
❑	**Flat grain beetle—*Cryptolestes spp.***
❑	**Rice, maize or granary weevils—*Sitophilus spp.***
❑	**Psocids**
❑	**Some minor pests—moths and bruchids**

For a program to help you identify insects by their colour, size, wings and where they are found, try the second list of questions in Pest Web at Agriculture WA.

Life cycle and control measures

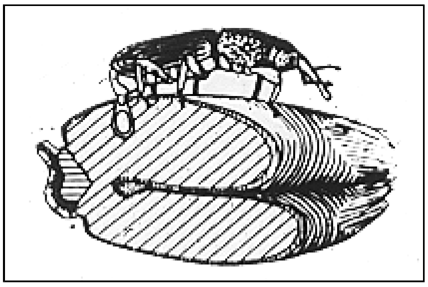
A control program that works well for one pest won't necessarily suit another. Designing any control program must, therefore, start with an understanding of the biology of the pest concerned.

❑	The life cycle of pests
❑	Timing the control treatment
❑	Problems of resistance and control
❑	Collecting insect specimens

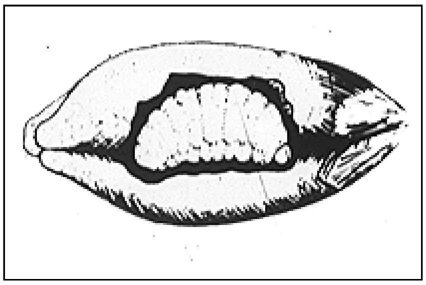
The life cycle of pests

As we will see in the following section, it is very important to understand the life cycle of any pest causing concern. This is because at different life stages, the insect responds differently to the pesticide. Most grain storage pests go through the regular insect life cycle of egg—larva—pupa—adult. The following figure shows the life cycle of the rice weevil, *Sitophilus oryzae*.

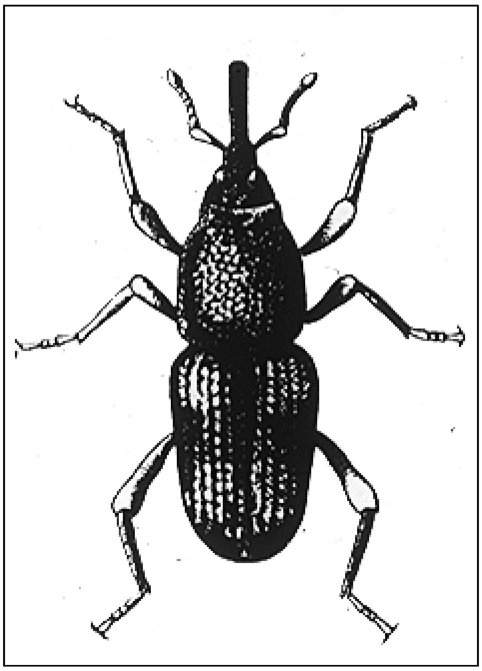
Figure: Life cycle of the rice weevil

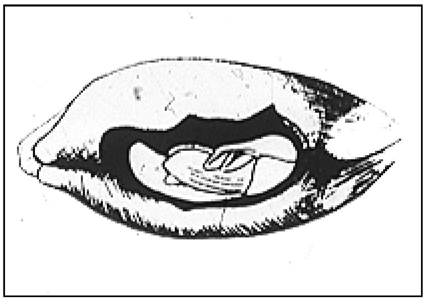


The egg is laid.



Larva





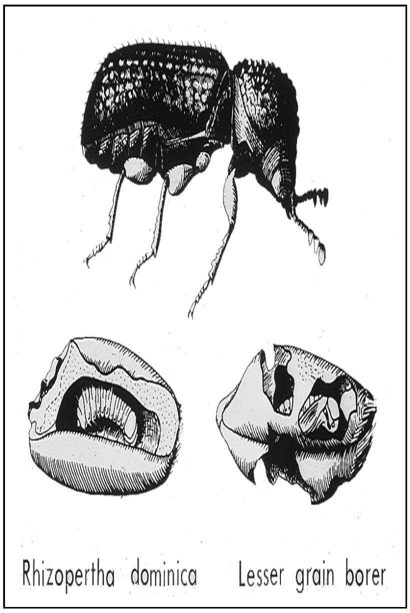
Pupa

Adult rice weevil

Archive material courtesy of the Central Science Laboratory, York. UK Crown Copyright.

This cycle takes about 25 days. In some species, such as the rice weevil *Sitophilus oryzae*, the pre-adult stages develop entirely within the grain, and only the adult stage is visible. In other species, such as the lesser grain borer (*Rhyzopertha dominica*) and the saw toothed grain beetle (*Oryzaephilus surinamensis*), the larval stage is not completely hidden but the adult stage is likely to be detected well before the other stages because of its greater mobility. The illustrations show:

- the lesser grain borer which is partly hidden on an individual grain
- the larval stage of the saw toothed grain beetle which moves freely through the grain.



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Timing the control treatment

The pupal stage is the most difficult to kill by chemical or physical treatments. This has important implications for the control of these pests.

In poor treatments, adult insects may be killed but the pre-adult stages may survive to appear as a renewed infestation in another two to three weeks. There are two ways of tackling this problem:

- The first is to ensure that the toxic dose is sufficient to kill all stages.
- The second is to hold the dose until the egg or pupa develops into the more susceptible larva or adult stage.

In the case of phosphine fumigation, only the second way is effective. The development is quicker at higher temperatures.

Example—Timing a pest control application. If you wish to control pests by fumigating with phosphine (❑), the gas must be kept in until the pupae develop into adults. As insect development is quicker at higher temperatures, fumigation is more effective at high temperatures, e.g. 30°C. Below 15°C the use of phosphine is not advised, due to low insect metabolism.

For moths, the larval stage is more difficult to kill than the adult. Mist treatments are very effective against adults but larvae may hardly be affected.

Click here (❑) to see a graph showing the susceptibility of different development stages to phosphine. This graph clearly illustrates the importance of timing in a phosphine treatment. (Close the figure window to return to this page.)

The worst consequence of ineffective phosphine fumigation is that survivors may develop a generation of more tolerant insects. This will lead to more frequent treatment failures. (This will be discussed in Managing pests ❑.) This is also one of the reasons why prevention is better than cure: it is easier and better to prevent an infestation than to treat an established one. This will be discussed in more detail in Preparing for storage (see sidebar).

Collecting, preserving and shipping specimens for identification

These notes have been provided by Dr Peter Annis, CSIRO Australia, Division of Entomology, Stored Grain Research Laboratory. Reproduced by permission of GRDC.

If pests are not controlled by properly applied pest control procedures, it may be useful to collect specimens and have them identified by your State department of agriculture. The following suggestions provide a guide for collecting them and sending them to a specialist for identification.

You will need to collect the following information about each specimen, as without these details, a specimen is worthless!

- **Place of collection: e.g. State, town or nearest town (with distance), name of farm**
- **Nature of location: e.g. silo, shed, flour mill, cell number**
- **Commodity from which it was collected**
- **Date of collection**
- **Person who collected it: name, phone number**

Write the above details, *in pencil*, at the time of collection on a small piece of paper. Put it into the tube or on a label firmly attached to the outside. Do not use biros, texta pens or similar—inks used in these products can be water or alcohol soluble.

Handling insect specimens

Insects are delicate and are damaged by rough handling. Avoid picking them up with your fingers. Use an artists paint brush, a scrap of paper or tip of a penknife blade to push them into a container. A torch is useful to find insects and see what you are doing.

Preservation of specimens

Preservative fluid: A solution of 70% alcohol (7 parts Metho (methylated spirits), 3 parts clean water) will kill and preserve specimens. Undiluted clear spirits (gin, vodka etc.) can be used in an emergency.

Containers: Keep fluid-preserved specimens in small glass tubes or bottles with screw-on or push-in air- and liquid-tight stoppers. See-through 35 mm film canisters make good, easy to obtain containers. Do not use any container that leaks if shaken, squeezed gently or turned upside down.

Follow these steps:

1. **Fill the tube with fluid to cover the specimens.**
2. **Insert a wad of paper tissue (not cotton wool) to hold the insects down.**
3. **Release trapped air bubbles with a pencil or an unfolded paper clip.**
4. **Secure the lid with masking or electricians tape.**

Packing and shipping

Before sending the samples, make sure that the planned recipient will accept them.
Wrap the tubes in corrugated cardboard or bubble wrap, or insert them into a hollowed-out block of waste styrofoam. Pack them in a padded bag or a small box. Make sure the tubes are wrapped sufficiently to stop them moving about inside the box or bag.

Be aware that there may be legal restrictions on sending grain seeds and insect specimens interstate and overseas.

We now turn to the very important subject of 'housekeeping' in grain storage. Select 'Preparing for storage' from the sidebar.