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A new approach to grain insect control

by G. D. Rimes, Entomology Branch, Department of Agriculture and M. T. Sexton, Agriculture Protection Board

Western Australian farmers now have a legal responsibility to control stored grain insects on their farms.

Ten species of insects, usually referred to collectively as "weevils", have been declared under the Agriculture and Related Resources Protection Act. Section 49 of the Act says "the occupier of any private land shall control declared plants and declared animals on and in relation to that land".

The decision by the Agriculture Protection Board to declare weevils was taken to protect the State's export grain industry. Western Australia is the first Australian State to make such a move.

Cereal grain and flour exports from Western Australia were worth $426 million in 1975-76 yet as explained in this article, this export market is threatened by the development of grain insects which are resistant to many of the presently available insecticides.

If the number of insects being delivered into the bulk handling system can be greatly reduced, there will be less need to use insecticides and fumigants on bulk grain. This will depend on farmers maintaining a "clean pipeline" for handling grain, from the paddock to the C.B.H. bin.

With a reduction in the use of insecticides and fumigants, the development of insecticide resistant strains of grain insects will slow down because there will be less selection pressure on the insect populations. This will "buy time" for the industry to be able to continue selling uncontaminated grain, while the search goes on for new weevil control measures.

Barley badly damaged by grain insects
**Nil tolerance**

After malathion (Malathion) became commonly used to treat grain on farms and in C.B.H. storages, it was possible in 1968 to introduce the present nil tolerance for insects in export grain consignments. As a result, if even one grain insect is detected by Australian Department of Agriculture inspectors at export terminals, loading of the ship is stopped and the infested cell in the terminal is fumigated.

This rigid standard allows Australia to compete favourably on the international market with countries such as Canada which is able to guarantee insect-free grain because its climate is too cold for the insects to develop.

In the early 1970's, Malathion resistant grain insects were found in Australia. Recognising the danger to export markets, Departments of Agriculture throughout Australia began to monitor the development of Malathion resistance.

**Malathion resistance**

In 1972 a survey was conducted on 525 farms throughout the W.A. wheatbelt. Grain insects were found on 87 per cent of the farms. Malathion resistant grain insects were collected from 13.5 per cent of farms.

In June 1977, Agriculture Protection Board officers surveyed 91 farms in the Merredin region for grain insects. They found insects on 84 per cent of these farms—about the same proportion as for the 1972 survey.

But the level of Malathion resistance in the 1977 survey had changed markedly. Tests by the Entomology Branch of the Department of Agriculture showed that some 90 per cent of the samples of rust red flour beetles (*Tribolium castaneum*) collected during the latest survey were resistant to Malathion.

In insect control it is often possible to overcome resistance by increasing the rate of insecticide; however, in the case of export grain, strict international requirements rule this out. The internationally accepted tolerance or code of eight parts per million of Malathion is rigidly enforced by bulk handling authorities in Australia to safeguard our markets.

A limited number of alternative materials have been developed as grain protectants, but, like Malathion, they mostly belong to the organo-phosphorus group of chemicals. There is an ever present risk that cross resistance to these related chemicals will develop among insects already resistant to Malathion. Malathion resistance is of two types—Malathion specific; and Malathion non-specific resistance. The latter type confers resistance to other closely related chemicals as well as to Malathion. For example, three strains of the confused flour beetle (*Tribolium confusum*) have been shown in the laboratory to be resistant to Malathion, dichlorvos, fenitrothion, phosphine and methyl bromide, yet it is reasonably certain that they could only have been exposed to Malathion and phosphine.

**Surveys**

Surveys by the Department of Agriculture in conjunction with C.B.H. have demonstrated the level of infestation in farmers' grain deliveries.

In a 1974 survey of late deliveries to C.B.H., 65 per cent of samples taken were infested with grain insects. Similar levels of infestation have been shown in other States of Australia. The figures must be regarded as conservative, as it is...
A 'clean pipeline' for handling grain, from the paddock to the C.B.H. bin, must be maintained to control grain insects and thus protect export markets.

Cleaning machinery

Thorough cleaning of all harvesting and grain handling machinery is the basis of the clean pipeline approach to weevil control.

Insects are likely to breed in any place where grain is left undisturbed, and an infestation is often not obvious until the insects have bred up to huge numbers. Clean equipment and buildings will prevent the damage.

Headers should be cleaned straight after harvest finishes. Begin by running the machine for several minutes in the paddock with all the inspection covers open. This shakes out much of the loose grain. The header should then be systematically cleaned using compressed air and a small straw whisk broom.

High pressure water is not suitable for cleaning headers because it does not remove all the grain and straw. Also water tends to cake the remaining debris into corners, forming an ideal breeding ground for weevils.

Field bins, bulk bins on trucks and augers should also be carefully cleaned of all grain residues before being stored away.

After cleaning, dust the inside surfaces of headers and grain equipment with 1 per cent Malathion dust.

Stored grain

If grain is to be stored on the farm for more than six weeks it should be protected with maldison (Malathion) which is the recommended insecticide for mixing with grain. It can be applied in either liquid or dust form.

The mixture rate for the liquid form is one litre of 100 per cent or 103 per cent Malathion to 40 litres of water, or one litre of 80 per cent Malathion to 30 litres of water.

Where insects are known to be resistant to Malathion, one per cent fenitrothion is recommended.

Never add new season's grain to a storage already containing some of the previous year's crop. With age and pesticide breakdown, old grain is prone to insect attack.

Grain residues and rubbish removed from bins and machinery must be burnt as it is a proven breeding ground for all grain insects.

Weeds and debris should be cleared from an area about 3 metres wide around storage sheds and silos, so there is no harbour from which insects can reinfest the cleaned storages. Do not leave a filled bulk transporter in a shed containing infested grain residues overnight, as cross infestation can readily occur.

Fumigating storages

If grain becomes infested during storage, fumigation is usually the most convenient way of eradicating the insects. However, the storage must be gas tight, to hold gas long enough to eradicate the young, adults and eggs of grain insects.

As fumigation gives no protection once the gas has dispersed, it is important that all machinery, building structures and floors be treated with an insecticide (i.e. 2.5 per cent Malathion) before fumigating. This should ensure a complete kill in the immediate area and prevent quick reinfestation.

Phosphine (phostoxin) is an effective fumigant and convenient to use as it is in tablet form. To fumigate bagged grain, push one tablet into the centre of each bag. Then cover the stack of bags with a plastic sheet for five days. Avoid handling the grain for another five days to let the gas disperse completely.

difficult to detect infestations at low levels unless the samples are incubated. This is time consuming and was not done in this survey.

The W.A. Department of Agriculture regularly tests samples submitted by C.B.H. and the Australian Wheat Board and samples taken by Departmental inspectors at produce stores and flour mills.

In Western Australia, grain storage insects are not found in standing cereal crops, as they are in Queensland and northern New South Wales. Thus, it should be possible to set up a clean delivery "pipeline" from the paddock to the C.B.H. bin.

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High pressure water is not suitable for cleaning headers because it does not remove all the grain and straw. Also water tends to cake the remaining debris into corners, forming an ideal breeding ground for weevils.

Field bins, bulk bins on trucks and augers should also be carefully cleaned of all grain residues before being stored away.

After cleaning, dust the inside surfaces of headers and grain equipment with 1 per cent Malathion dust.

Stored grain

If grain is to be stored on the farm for more than six weeks it should be protected with maldison (Malathion) which is the recommended insecticide for mixing with grain. It can be applied in either liquid or dust form.

The mixture rate for the liquid form is one litre of 100 per cent or 103 per cent Malathion to 72 litres of water, to be applied at 0.85 litres per tonne of grain. If 80 per cent Malathion is used, the mixture will be one litre of Malathion to 56 litres of water. Specially calibrated spray nozzles will be needed to apply the solution at the correct rate as the grain is being augered into storage.

Alternatively, Malathion dust can be used at 1 kg per tonne of grain, but it must be thoroughly mixed with the grain as it goes through the auger.

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Phosphine (phostoxin) is an effective fumigant and convenient to use as it is in tablet form. To fumigate bagged grain, push one tablet into the centre of each bag. Then cover the stack of bags with a plastic sheet for five days. Avoid handling the grain for another five days to let the gas disperse completely.
Harvester should be cleaned of grain after harvest. Compressed air is ideal

To fumigate grain in silos, use six to eight Phostoxin tablets per tonne of grain.

Thorough cleaning of a harvester is acknowledged to be a tedious job; however, if about half a day is spent immediately after harvest cleaning out the worst of the grain residues, the machine can be fumigated just before the next harvest to safeguard the “clean pipeline”.

The technique for fumigating a harvester is:
- put the machine on a flat surface, preferably concrete and start it up, to remove any remaining loose grain.
- cover sharp corners with bags, then put a polythene sheet over the entire machine. A suitably sized sheet can be made up from “10 thousand” sheeting stuck together with sealing tape on both sides of the join.
- moisten the floor to increase the humidity under the sheet.
- seal the edges of the sheet to the floor with a layer of sand to make it gas tight.
- introduce 45 Phostoxin tablets on a long handled shovel under the edge of the sheet and leave for five days.
- first harvest loads: Consider keeping the first few loads from the harvester on the farm for stock feed. The first tonne or so of grain can have a flushing action through the fumigated harvester and will aid the fumigation process in ensuring harvester cleanliness.

The declared insects

The grain storage insects which have been declared under the Agriculture and Related Resources Protection Act are:—
- Rust Red Flour Beetle Tribolium castaneum
- Confused Flour Beetle Tribolium confusum
- Lesser Grain Borer Rhizopertha dominica
- Rice Weevil Sitophilus oryzae
- Granary Weevil Sitophilus granarius
- Saw Toothed Grain Beetle Oryzaephilus surinamensis
Primary insects

The grain borer, the rice weevils and the Angoumois grain moth are called primary insects, because they attack whole grain.

Secondary insects

The saw-toothed grain beetle only attacks broken grain, but as most storages contain a percentage of broken grain, the saw-toothed beetle is often found in bulk grain.

The flour beetles are often found in farm storages after the primary insects have caused damage. Cereal dusts and pelleted foodstuffs will usually support high populations of these insects. The flat grain beetle is found in similar places. The grain moths may be found above the surface of grain in neglected silos, or around broken bags which have been neglected for long periods.

Precautions with pesticides

by K. T. Richards, Entomology Branch

Pesticides are toxic materials, and must be handled with care, but as with all dangerous things, they can be used safely. The best precautions are a sound knowledge of the pesticide plus commonsense.

1. Before using any pesticide, stop and read the label carefully. This is absolutely essential, but is often ignored.

2. Use rubber gloves and protective clothing, particularly while handling the pesticide concentrate. Absorption through the skin is one of the least obvious but one of the most common causes of pesticide poisoning.

If any pesticide is splashed on the skin, wash it off immediately with soap and water. Splashes in the eyes should be immediately flushed out with plenty of clean water. Any clothing which becomes soaked with pesticide should be changed as soon as possible.

• Ensure that the spraying or dusting equipment is in good condition. Leaky hoses and connections greatly increase the hazards to the user. Do not clear blocked spray nozzles with the mouth!

• After spraying or dusting, and before eating or drinking, thoroughly wash the face and hands and other exposed parts with soap and water. Do not smoke or eat while preparing or using pesticides.

• Avoid spraying or dusting against the wind. If this is not possible, a suitable respirator should be worn. A respirator is essential when applying pesticides in confined spaces such as under houses.

• During spraying or dusting, avoid contamination of children's toys, and food containers or drinking vessels of pets. Also avoid drift near fish ponds, bee-hives, poultry and caged birds.

• Many pesticides leave long-lasting, toxic residues on fruit, vegetables and other foods.

Certain pesticides cannot be used on livestock, on crops or pastures to be eaten by stock, or on fruit and the edible parts of vegetables.

Other pesticides can only be used up to a certain period before harvest. This period varies according to the type of pesticide being used.

Consult the label on the container of the particular pesticide for the recommended minimum time between the last application and harvest.

• Keep all pesticide concentrates in a locked cupboard or shed, and well away from any foodstuffs.

Transfer the contents of any leaking containers into sound tins or drums. If the original label cannot be transferred, make sure that the word "POISON" and sufficient details for the use of the pesticide are on the container.

Cover any spilled pesticide with sand or sawdust, and later wash or sweep it up. Empty containers should be flattened, holed or otherwise destroyed before disposal. Two good rinses will remove most of the chemical before disposal.

• If poisoning by pesticides does occur, immediately follow the first-aid treatment advised on the label, and obtain medical attention without delay.

• Always use the correct pesticide for the job. Check with the Department of Agriculture for the most effective and safest pesticide to use. Newer and safer materials are constantly becoming available.