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GRAIN STORAGE PESTS AND THE FARMER

By G. D. RIMES, Entomologist, and C. F. H. JENKINS, Chief, Biological Services Division.

WITH the grain buying countries of the world becoming more selective, farmers must take all possible precautions to ensure that they deliver insect-free grain to country terminals.

Stringent requirements regarding insect contamination have been set down by the Department of Primary Industry for this coming season. This article gives a complete programme for control of grain pests through preparation of buildings, storages and equipment, and treatment of grain.

Hygiene

Storage insects have the ability to survive from one season to the next in small grain residues normally found on the farm.

The small quantities of grain that invariably remain in farm machinery should be found and cleaned out. Harvesters have traps to aid cleaning and a compressed air hose makes the job easier. The augers at the base of bulk transporters are often a collection point and can yield up to 20 lb. of highly infested grain. Seed boxes on drills and combines must not be overlooked. Cleaning should be carried out on a concrete floor and grain residues should be swept up and burnt.

If bags have been used for storage in previous seasons they may contain residues which are probably harbouring insects. If bags are to be re-used, they should be turned inside out and brushed and, preferably, fumigated. A small silo or disused water tank can often be used for fumigation with Phostoxin tablets, which are a convenient and reliable fumigant when used correctly (see section on fumigation methods).

Storages

All grain storages must be completely weatherproof as dampness favours insect development. If bagged grain is being stored it should be on a concrete floor in a dry situation. Pre-treatment of the storage area with malathion dust or spray is beneficial.

Proprietary galvanised iron silos are weatherproof, but the temporary welded mesh types are often unsatisfactory for long storage. The lining used in temporary storages has an important bearing on the results and a weatherproof roof is essential.

Fumigation methods

The only materials available to farmers for grain fumigation are carbon bi-sulphide and Phostoxin tablets. As carbon bi-sulphide may form explosive mixtures with air, it is not generally recommended.

Phostoxin tablets release phosphine, a poisonous gas, on combination with moisture. The moisture comes from the grain itself or must be provided in some way. Failures with Phostoxin can result from use with grain having a moisture content less than 10 per cent. For fumigation of empty bags and equipment in chambers or under sheeting, the tablets must be placed in contact with moisture such as a damp bag.

Phostoxin tablets can be conveniently inserted into a grain stream when filling a silo, or inserted into a grain mass with a probe. A simple steel tube with handles for pushing into the grain mass will enable tablets to be placed at depth. Grain will not flow into tube with an internal diameter of about \( \frac{1}{2} \) in. Six tablets are needed per ton of grain.

Safety precautions should be observed when handling Phostoxin. Gloves should be worn when handling the tablets and the job must be done in a single operation and then the silo closed. A safety margin of four hours is allowed before the tablets start to give off the phosphine gas, so this is the maximum period that the operator can remain in the silo.

If bagged grain is being fumigated, a tablet must be placed in the centre of each bag and the stack must be built to a size and shape that can be covered by a plastic sheet within the necessary four-hour period. The stack should be built on a concrete floor and the plastic sheet sealed with sand at its junction with the floor.
<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Before harvest</th>
<th>HYGIENE</th>
<th>After harvest</th>
<th>Before harvest</th>
<th>PESTICIDES</th>
<th>After harvest</th>
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</thead>
<tbody>
<tr>
<td>BUILDINGS</td>
<td>• Buildings should be free of cracks and crevices to make cleaning easier</td>
<td>• Keep buildings weatherproof</td>
<td>• Keep away bags, bagged feed and other likely contaminants including straw hay</td>
<td>• Treat all surfaces to come in contact with grain with 2.5% malathion spray to runoff point</td>
<td>• Clean out harvester (Hygiene)</td>
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<td></td>
<td>• Clean out all grain accumulations and residues and grain from cracks and crevices and burn</td>
<td>• Keep away bags, bagged feed and other likely contaminants including straw hay</td>
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<td>• Treat all surfaces to come in contact with grain with 2.5% malathion spray to runoff point</td>
<td>• Sprinkle machine inside with 1% malathion dust. Amount to use:</td>
<td></td>
</tr>
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<td>• Treat all surfaces to come in contact with grain with 2.5% malathion spray to runoff point</td>
<td>drum and return auger to drum (½ lb.)</td>
<td></td>
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<tr>
<td>BUILDING SURROUNDS</td>
<td>• All debris and grain spillages should be cleaned up and burnt</td>
<td>• Clean up all grain spills and clean up all grain spills and burnt</td>
<td>• Keep debris, old bags and other likely contaminants including straw hay</td>
<td>• Clean up all grain spills and burnt</td>
<td>screen (2 lb.)</td>
<td></td>
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<tr>
<td></td>
<td>• Spray strip 10 ft. wide around each building with suitable weedicide</td>
<td>• Clean up all grain spills and clean up all grain spills and burnt</td>
<td>• Keep debris, old bags and other likely contaminants including straw hay</td>
<td>• Clean up all grain spills and burnt</td>
<td>straw walkers, augers under riddles (1 lb.)</td>
<td></td>
</tr>
<tr>
<td>EQUIPMENT</td>
<td>• Clean all bins, augers and harvesting equipment</td>
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<td>• Remove as much of last year’s insecticide as possible by running machines with all covers and hatches open</td>
<td>• Don’t breathe in insecticidal</td>
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<tr>
<td></td>
<td>• Open all covers and hatches on harvesters and run machines for two minutes</td>
<td>• Open all covers and hatches on harvesters and run machines for 2 minutes</td>
<td>• Blow out with compressed air if possible—otherwise use brush</td>
<td>• Don’t breathe in insecticidal</td>
<td>• Don’t breathe in dust</td>
<td></td>
</tr>
<tr>
<td>BAG-STORED GRAIN</td>
<td>• Keep old stored grain away from areas where new grain is to be stored</td>
<td>• Keep away from old grain</td>
<td>• Keep away from old grain</td>
<td>• Remove as much of last year’s insecticide as possible by running machines with all covers and hatches open</td>
<td>• Keep away from old grain</td>
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<td></td>
<td>• Stack bags compactly</td>
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<td>• Treat old grain if possible (see pesticide section)</td>
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<td>• Remove as much of last year’s insecticide as possible by running machines with all covers and hatches open</td>
<td>• Treat old grain if possible</td>
<td></td>
</tr>
<tr>
<td>BULK-STORED GRAIN</td>
<td>• Clean out all bulk storages including cracks and crevices—Burn residues</td>
<td>• Keep storage weatherproof</td>
<td>• Keep other bags, bagged grain and cereal hay away from storage area</td>
<td>• Treat all surfaces to come in contact with grain with 2.5% malathion spray to runoff point</td>
<td>• Keep storage weatherproof</td>
<td></td>
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<tr>
<td></td>
<td>• Check storage is weatherproof</td>
<td>• Keep other bags, bagged grain and cereal hay away from storage area</td>
<td>• Keep surrounding area free of grass and other debris</td>
<td>• Treat all surfaces to come in contact with grain with 2.5% malathion spray to runoff point</td>
<td>• Keep surrounding area free of grass and other debris</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Clean area around storage and burn debris</td>
<td>• Keep surrounding area free of grass and other debris</td>
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<td>• Treat all surfaces to come in contact with grain with 2.5% malathion spray to runoff point</td>
<td>• Keep surrounding area free of grass and other debris</td>
<td></td>
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</tbody>
</table>

**PESTICIDES**

- **Before harvest**
  - Treat all surfaces to come in contact with grain with 2.5% malathion spray to runoff point
  - 2.5% malathion plus 1% lindane at 1 gal per 1,000 sq ft.

- **After harvest**
  - Clean out harvester (Hygiene)
  - Sprinkle machine inside with 1% malathion dust.
  - Amount to use: drum and return auger to drum (½ lb.)
  - screen (2 lb.)
  - straw walkers, augers under riddles (1 lb.)
  - front elevators, bulk bins, and augers (2 lb.)
  - Remove riddles if possible to aid access beneath
  - 3 ozs. 1% malathion dust per bag during bagging operation.
  - If moths present:
    - In open spaces
      - If immature moths present, spray grain surface with 0-5% dichlorvos emulsion 1 gal per 1,000 sq ft.
    - Enclosed areas
      - If moths present hang 1 dichlorvos strip per 1,000 cu ft of space. Replace every 6 weeks
  - Infested grain
    - Fumigate with Phostoxin tablets at six tablets per ton under reasonably airtight conditions

* Premium grade malathion prepared for grain application
Five days should be allowed for the fumigation and a further five days for ventilation before using the grain.

Phostoxin tablets form a convenient and safe method for fumigation if the above precautions are observed.

**Malathion treatment**

When grain is to be stored for any period on the farm, malathion is the only long-acting chemical that can be used. For storage periods up to three months the recommended dose is obtained by diluting 1 pint of malathion concentrate (103%) in 9 gallons of water and applying it to the grain at 1½ pints per ton. This gives a malathion concentration of 12 parts per million in the grain and makes grain safe for human consumption at the end of short storage when some breakdown has occurred. Malathion concentrate refers to premium grade malathion prepared for grain application and generally marketed as 103% w.v. concentrate.

For longer term storage (6 to 12 months) the application must be increased to 1½ pints of malathion concentrate in the above 9 gallons of water (18 p.p.m. in the grain). The higher rate can also be achieved by mixing 1½ lb. of 1% malathion dust per 1,000 lb. of grain.

Grain to be stored on the farm for stock feed must not on any account be treated with BHC, DDT, dieldrin, thiodan, endrin, chlordane, aldrin or heptachlor.

Application rates must be checked when using sprays. The Australian Wheat Board suggests the following technique.

For long-term storage, adjust equipment to apply 1½ pints of the dilution to one ton of grain. Adjustment will be correct when the output of nozzles in two minutes in fluid ounces is equal to the capacity of the conveyor or auger in tons per hour.

Some nozzles have a constant application rate, but different rates can be gained by varying the concentration of spray.

Grain treated with malathion for long-term storage should be examined periodically to ensure that no insect development has taken place. Incorrect application rates or technique, especially when carried out for the first time, give insects the opportunity to survive. If insects are present, fumigation should be promptly carried out.

When coarse grains stored over summer are not required for stock feed, they should be fumigated with Phostoxin before late delivery to country sidings.

**Resistance to pesticides**

Farmers should not use insecticides as an alternative to hygiene for the control of grain insects in silos, barns and farm machinery. The widespread and indiscriminate use of insecticides can induce resistance in grain pests in just the same way as dieldrin resistance was developed in the sheep blowfly.

Unfortunately, once an insect population has developed resistance to a certain chemical, the resistance factor does not disappear when the particular material is no longer used. If an insect possesses the genetic capacity to develop resistance, the speed with which resistance appears depends largely upon the rapidity with which the insect can breed (number of generations a year), and the frequency with which insecticides are applied.

For this reason farmers should give more attention to mechanical aids such as compressed air, vacuum cleaners or just a broom for cleaning bins and machinery rather than the indiscriminate use of malathion. The widespread occurrence of malathion resistant insects in Australian wheat could have serious effects upon the export trade, and all farmers should recognise their responsibility to deliver clean new season’s wheat to the bin.