Sound storage eliminates post-harvest blues

CSIRO Entomology stored grain expert Len Caddick reminds grain producers to get in early and plan a strategy to ensure insect-free storage this harvest. The rewards of a well-managed grain crop deserve effective storage to allow maximum profits at point-of-sale.

Grain producers can maintain grain quality in storage by encouraging a harsh environment for insect pests and ensuring an effective grain treatment strategy.

Infestation of grain stores can result from insects flying in 'en masse' from off site but it is more likely that grain conditions in the store have favoured the rapid development of an existing insect population.

Take time to clean equipment and machinery thoroughly immediately after harvest, and ensure good hygiene around the storage area, as the first step in controlling insects in stored grain.

If insects have no refuge to hide in during the time that grain stores are empty, the risk of infestation of freshly harvested grain in store is reduced.

Remove residues from silos following out-loading, wash down the silo and apply a treatment of an inert dust prepared as a slurry or contact insecticide prepared for use on silos and sheds.

Treatment of storage structures is essential where insects have been detected in grain during the previous season. But it is wise to apply a structural treatment on a routine basis following cleaning and wash down.

Grain condition

Temperature, moisture content and initial condition of the grain influence the rate that insects multiply in stored grain.

Leaving grain to dry on the crop to achieve low moisture contents at harvest results in reduced yields due to loss of moisture and shattering of ripe kernels. Delays in harvesting ripe seed also result in weathering and loss of quality.

The exposed germ of weathered grain and higher screenings, containing broken and split kernels, provide a readily accessible food source for insects. Remove screenings from weathered grain to reduce the rate of insect development during storage.

Early harvesting the ripe crop at a higher moisture level, followed by cooling and in-store drying (where necessary), removes much of the risk associated with reduced yield due to shattering and loss of quality due to weathering.

Apart from the premiums that high-quality grain attracts, sound grain is more storable and less prone to insect attack compared with weathered grain stored under similar conditions.

Some insects can survive at low temperatures and seed moisture contents (see Figure 1). The lesser grain borer (*Rhyzopertha dominca*) and saw-toothed grain beetle (*Oryzaephilus surinamensis*) can survive and reproduce in grain stored at nine per cent moisture content when temperatures are favourable.

Grain weevils (*Sitophilus* spp.) can breed at lower temperatures compared with the other major beetle pests of stored grain. Various grain conditions favour the development of different grain weevils: the lesser grain borer, rice weevil (*Sitophilus oryzae*) and saw-toothed grain beetle (see Figure 1, page 51).

The lesser grain borer is the most adaptable of the major stored grain pests found in Australia, and can breed both in dry and moist grain, and at temperatures between 20–35°C. The versatility of this pest to survive and breed in grain has resulted in the lesser grain borer being difficult to control.

Insects produce heat and water when they are moving and feeding in grain, and during their development. Grain weevils in particular produce a substantial amount of heat and water during their development.

Insects can modify their immediate environment, creating their own micro-environment in which conditions are more favourable for development. A large increase in insect numbers can lead to the formation of 'hot spots' in grain.

Insects can also find other individuals of the same species in a grain bulk by using pheromones, a group of chemical attractants. A gathering of insects in grain provides a greater opportunity for them to modify their environment at a faster rate.

Cooling using aeration

Grain temperatures of about 30°C favour insect survival and development, especially when grain moisture content exceeds 11 per cent.

Grain producers can use aeration to manipulate both temperature and grain moisture content during storage to create a less favourable environment for insect development. Grain temperatures less

Beth Field

The first step to ensuring insect-free grain during storage, is to maintain good hygiene around the storage area. By removing grain residues, there are few refuges for insects during the period before grain enters the silos.

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Sound grain placed in a dry, cool and sealed environment can maintain its quality and insect free status with little risk of downgrading.

in brief

- Clean stores and harvesting and handling equipment are essential to maintain an insect-free environment on the farm.
- Sound, dry and cool grain can be readily stored for prolonged periods.
- Harvest grain early where facilities are available to cool rapidly and where necessary, dry grain to a safe moisture level.
- Combine phosphine with cooling using ambient aeration in properly sealed silos to store grain insect-free and maintain harvest quality.

than 20°C curb the development of beetle and moth pests. At 15°C or less, insect development ceases or takes places slowly.

A well-controlled aeration system will help achieve and maintain lower grain temperatures. Grain cooling can be achieved using an efficiently designed aeration system, comprising a suitable fan, rated to deliver the required airflow rate (litres per second per tonne), and the necessary arrangement of ducting and vents to enable efficient distribution and flow of air through the grain bulk. There is a specific and correct size aeration system for each size and shape of storage. A local supplier of aeration systems can provide information on the design best suited to each particular storage setup.

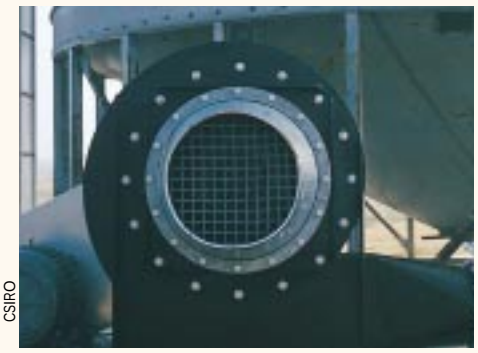
Where cooling alone is required, an airflow rate of up to 2.5L/s/t would suffice. Aeration cooling aims to maintain a uniform temperature in the grain and to keep that temperature as low as practicable.

Drying using aeration

Aeration systems which effectively dry and cool grain during storage provide greater flexibility for harvest.

An aeration system which can deliver an airflow rate of up to 20L/s/t is well suited to reducing moisture levels in early harvested grain where moisture contents of up to 16% can be expected. Airflow rates needed for grain aeration-drying are typically 10 times higher than that needed for aeration-cooling, with modified control regimes. Existing air conditions and type of grain will influence the rate that moisture can be removed. Inspect damp grain daily for signs of deterioration during storage.

The aim of the drying process is to prevent mould development and loss of quality. Moulds require a much higher level of moisture to develop compared with insects. Aeration-drying cannot achieve a level of grain dryness that would prevent development of insects, but combined with cooling, grain conditions can be made less favourable.



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Large capacity (7.5 kilowatt) aeration fans which can deliver an airflow rate of up to 20 litres per second per tonne, are well suited to reducing moisture levels of early harvested grain in storage.

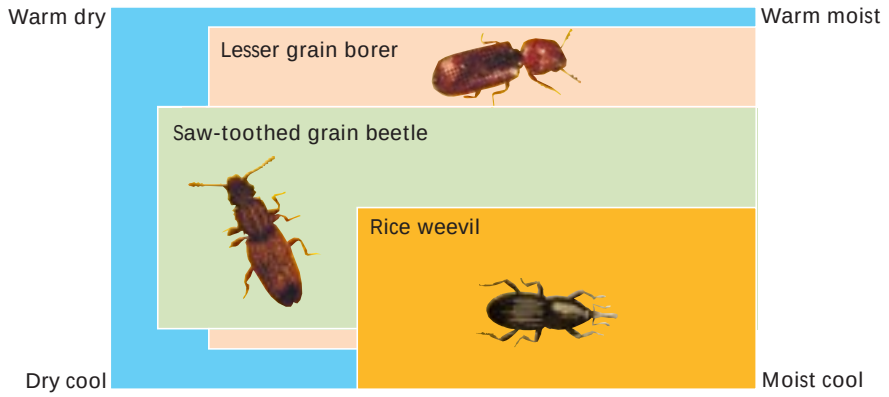
In silos without aeration, turning grain during storage can even out grain temperature and moisture content, and also disrupt the formation of potential 'hot spots' by insects.

Moisture movement in stored grain largely results from fluctuating temperatures at the peak and adjacent to the walls and hopper of the silo, compared with more stable temperature in the core of the bulk. Heat-reflective white-painted silos will help passive cooling and reduce heating by sunlight.

A major benefit of aeration is the evening out of grain temperature during storage which minimises the movement of moisture in the bulk. In stores without aeration, moisture can move rapidly from warm to cool regions of the bulk. Condensation often occurs on the inside of the roof of a silo, resulting in moisture damage and moulding at the surface. The peak region of a stored bulk is particularly prone to moisture damage and insects are often detected in this region because of favourable moisture levels.

Regularly sample the surface of a grain bulk to check for insects, rising moisture levels, and possible mould damage. Take caution when sampling grain in-store. Do not enter filled bin-type stores to carry out an inspection as this can prove unsafe.

FIGURE 1 Effect of grain condition on the development of stored grain insects



Heat, and particularly moisture, provides the ideal conditions for development of the major stored grain insect pests. By keeping grain dry and cool, insect development is retarded, keeping grain protected. Insects are not to scale.

Source: CSIRO Entomology

Regular monitoring

Monitor insect levels using traps and sampling devices to ensure potential infestations are readily detected and controlled using an approved treatment. It is likely that grain held in storage without the use of a fumigant or chemical protective treatment will become infested within weeks of harvest.

Sealed silos maintained to manufacturer specifications offer a significant barrier to the entry of insects. But without complementary hygiene around the storage and insect-free grain placed into the silo, infestations are likely to occur. Cooling alone using ambient air is not an efficient way of killing insects since they can adjust to cold conditions and then start to multiply again if the grain becomes warmer.

If live insects are detected as the silo is emptied, delays of at least two weeks are likely before moving the grain. Infested grain at this stage will need treatment and venting for fumigants, and an even longer withholding period for chemical protectants. Such a delay may result in the loss of a profitable sale.

Phosphine management

In adequately sealed silos, fumigation treatment using phosphine is recommended. Adhere to the safety procedures, dosage rate, and exposure time specified on the label when using phosphine. Phosphine does not control insects effectively when grain temperatures are less than 15°C. An initial fumigation using phosphine soon after harvest, followed by cooling using ambient aeration, is a useful management method to maintain insect-free grain and harvest quality.

In unsealed or partially sealed silos, the options are limited to use of an inert dust as an admixture (for use on grain destined for seed or livestock feed) or residual chemical protectant registered for use on the grain type in question. Grain already in storage would need to be turned into an adjoining silo while the dust or chemical protectant is admixed with the grain.

An easier approach is to apply the treatment to grain during loading at harvest. Adhere to the safety procedures, application rate and withholding time specified on the product label. Investigate the limitations associated with the sale of grain treated with inert dusts and chemical protectants. Where inert dusts are used as an admixture for treatment, grain will probably not be accepted into the commercial handling system. The registered use of different chemical protectants can vary between States, and some registered chemicals are still not acceptable for use on specific grades of cereal grain due to their intended end-product use.

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