Insects a pest in harvest bags

Although harvest bags offer flexible, cost-effective storage, questions have arisen about grain hygiene and quality at out-turn By James Darby

POLYMER-MEMBRANE-BASED HARVEST BAGS provide a cost-effective grain-storage option. However, serious concerns have been raised over grain spoilage, contamination and out-turned processing quality. In response the GRDC and CSIRO undertook a project to evaluate the limitations and risk of this technology under Australian conditions.

The evaluation consisted of four elements: a detailed literature review, field studies in Australia, a review of harvest bag trials in Argentina (where more than 20 million tonnes of grain a year is stored in this system), and a comparison with the performance of grain-bunker storage in Australia.

Harvest bags have been promoted as providing non-chemical insect control and grain-quality management. This is based on the premise that the bag is sealed to achieve gas-tightness for the duration of the storage – that is, more than five minutes half-life pressure decay time – and that hermetic conditions are created.

A hermetic atmosphere refers to an atmosphere with raised carbon dioxide (CO_2) and low oxygen (O_2) concentrations relative to the natural air. In such an atmosphere insect life is less easily sustained and can be killed depending on the ratio of the gases at a certain temperature. For example, research has shown that atmospheres containing two per cent O_2 and 15 per cent CO_2 at 26˚C were far more effective against adults and eggs of certain grain storage pests, than atmospheres with five per cent O_2 and 15 per cent CO_2.

HERMETIC EFFECTS IN THE FIELD WERE UNRELIABLE

The change in the atmospheric composition within a sealed harvest bag can be generated by the pests. As the pests respire they will use up O_2 and expire CO_2, altering the balance of the gases, but only if the bag is gas-tight.

While the hermetic effects can be proven in controlled conditions, in the field the situation was found to be unreliable.

If a hermetic atmosphere is to be created in a harvest bag unacceptably high numbers of insects have to be present. It is estimated that fewer than 10 live insects per kilogram of grain are required to achieve hermetic conditions in a well-sealed bag. However, even half this amount is unacceptable to the industry. So this system is seen as a fragile insect-control approach in Australia.

The second limitation relates to achieving sufficient gas-tightness and then sustaining this throughout the storage period. If gas-tightness is not achieved in the first place a hermetic atmosphere can never occur. If it is achieved, but oxygen is allowed to enter at a later date, due to physical damage to the bag, insect populations may flare.

The field studies found that appropriate levels of gas-tightness were not being achieved on-farm. It is recommended that pressure testing is carried out regularly throughout the storage period.

At present there is no appropriate dispensing arrangement for the use of phosphine in harvest bags. The insertion of phosphine tablets directly into the grain results in the membrane being penetrated, is not permitted according to the phosphine label and will result in phosphine-tablet residue being left on the grain.

A mechanism for introducing phosphine into harvest bags is needed. Pressure testing is well known and should be used to prove the seal of harvest bags. Reliable distribution of phosphine is needed to ensure disinfestation of the large proportion of the grain held in the surface layer where grain experiences large changes in temperature and moisture accumulation. This large fluctuation of conditions also makes harvest bags unsuitable for the longer-term storage of malting barley (longer than four months).

Growers considering the use of harvest bags as a cost-effective storage option should consider how they might address the following limitations and grain-hygiene-related issues identified by this study:

- a reliable insect disinfestation capability with harvest bags is not available;
- insects detected at out-turn pose considerable logistical problems;
- mixing of solid phosphine preparations with grain breaches label requirements;
- use of residual chemicals to control insect infestation is limited to where sufficient permanent storage capacity is available to turn and treat grain; and
- bags are difficult to sample for insect infestation. □

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More information: download a copy of the full study from http://cms.csiro.au/resources/HarvestBagReport.html

The field studies found that appropriate levels of gas-tightness were not being achieved in harvest bags on-farm, thus not achieving the hermetic conditions that can kill insect pests.

PHOTOS: NEIL MCALPINE

Improved storage technology to slow resistance

Poor application techniques, even in sealed silos, are resulting in ineffective fumigation and increasing phosphine resistance. Integrated fumigation and aeration systems offer a solution By James Darby

PHOSPHINE, THE MOST widely used fumigant on-farm and in bulk storage, kills insects slowly. Insects require a minimum time to acquire a sufficient quantity of fumigant to die. Higher phosphine concentrations can reduce this time, but only if well distributed throughout the grain stack. This time period is affected by temperature – cool bugs take up phosphine more slowly as they are less active. Higher concentrations have been shown to kill all insects, irrespective of their resistance status.

It has been established that a wide variety of fumigant concentrations and exposure periods occur throughout grain stores and between different types of fumigation systems. Therefore, for phosphine to remain effective, better application techniques are required. Consistent increased concentrations will be very effective.

Research has shown that the time taken for fumigants to move by passive distribution into grain masses in well-sealed stores ranges from two to 15 days. The size and shape of the store, pressure relief details, weather incurred, filling extent, grain conditions and amount of fumigant applied all influence this distribution period. Generally, distribution times are longer the greater the distance that the fumigant has to penetrate into the grain mass.

Other work has established that a wide range of grain temperatures can occur at harvest across Australia, depending on weather, although 25˚C to 35˚C is common for winter crops harvested in summer. Once stored, grain will slowly change temperature over weeks in response to external weather, warming in summer and cooling in winter. Substantial temperature gradients occur between the perimeter and centre of a store. Insects thrive at 25˚C to 30˚C, which is the ideal temperature for fumigation, while temperatures of 15˚C or less effectively stop insect populations growing.

Another factor that could contribute to variation in insect kill is sorption. This is the process whereby grains slowly remove phosphine from the air. In most cases sorption is negligible, but with certain grains, such as sorghum, paddy rice and canola, sorption may affect doses required for successful fumigation.

The use of a combined fumigation and aeration system is proposed as a method to overcome these problems and improve insect control, particularly for large grain stores, of 200 to 2000 tonnes.