

# Careful phosphine use improves insect control

CSIRO Stored Grain Research Laboratory scientist Peter Annis explains how the correct application of phosphine combined with good hygiene and grain management will help to ensure a complete insect kill in stored grain. But it is important grain growers establish a careful fumigation method to maximise the impact of phosphine.

To achieve complete insect control and reduce the chances of fumigation failure, it is critical to make sure phosphine is sealed in stored grain for long enough.

Safe and effective phosphine fumigation can take about 11–27 days to ensure a total insect kill.

Fumigation is the only readily available method to rectify failures in pest control, which happen during preparation, harvesting and inloading of grain. It is also the sole way of disinfecting obviously infested grain without moving it.

Phosphine is the only fumigant widely available for on-farm fumigation.

CSIRO research studies with phosphine show the fumigant will kill all species and all stages of grain insects (eggs, larvae, pupae and adults). Most adult insects are highly susceptible to phosphine, while pupae and eggs are more difficult to kill than other stages.

## Complete control

Both the phosphine concentration and exposure time are important in killing insects but time is more important than concentration.

To ensure a complete kill, phosphine must be retained in stored grain long enough.

Unless the gas is contained for a specific minimum time, it is unlikely all insects will be killed despite the concentration.

In practice, phosphine will only be retained long enough if the storage is adequately sealed or phosphine is added continuously. Phosphine fumigation takes time. Usually this



Photos: CSIRO Stored Grain

To achieve complete insect control in stored grain, growers must make sure the phosphine fumigant is retained in the grain for up to 27 days. Generally, phosphine fumigation failure is caused by leaky on-farm storage.

involves 7–20 days under fumigation, followed by 2–5 days ventilation and a further two days withholding period.

Phosphine is supplied as a solid preparation under a number of trade names and in a variety of forms such as tablets, pellets, sachets, blankets or plates. These react with moisture in grain and surrounding air gradually releasing phosphine gas, a process which, under Australian conditions, typically takes up to five days.

This means safe, effective phosphine fumigation requires a total of 11–27 days to make sure the preparation has finished releasing gas and any gas present has escaped from the storage.

## Harvesting to storage

Pest control in grain should not be a single action and involves a range of activities:

**Elimination of contaminating insects** — Practise good hygiene in harvesting, transport,

## Plan ahead for safe fumigation

Safe and effective phosphine fumigation is vital. The following guidelines will help to achieve a complete insect kill.

### Preparation

Ensure there is enough time for the fumigation before the grain has to be moved.

- Seal the silo to the pressure test standard.
- Read the preparation label.

### Dosing

Use the correct amount of preparation (see the label).

- Do not enter a silo bin when it has grain in it.
- Do not contaminate grain with phosphine preparation residues.
- Do not heap phosphine producing preparations.
- Do not add water to phosphine producing preparations.
- Reseal the structure after the preparation is added.

- Label the structure as being under fumigation.

### After exposure

Under no circumstances enter any silo bin when it has grain in it.

- Allow the full exposure period plus an airing time before removing the preparation residue or the grain.
- Be careful when handling preparation residues; they are likely to have some unreleased phosphine gas and there may still be significant amounts of unreleased phosphine.
- Correctly dispose of the residues according to label regulations (if not otherwise instructed, bury to about 500 millimetres on-site — do not transport residues in a closed vehicle).

### Records

Keep records for each fumigation by recording storage, commodity, dosing, exposure and post-exposure details.



- CSIRO research shows effective phosphine fumigation will kill all species and all stages of grain insects.
- Phosphine concentration and exposure time are critical in achieving a complete insect kill in stored grain.
- Safe and effective phosphine fumigation takes about 11–27 days.
- Fumigation failure will occur if the phosphine was not retained for long enough, not enough phosphine was added, insects entered the storage after fumigation, the insects were resistant to the treatment or the grain was too cold.

## Pests...

handling and storage equipment and combine with structural treatments using an inert dust or a registered insecticide.

**Making the storage hostile to pests** — use physical processes such as aeration cooling, storage of dry commodity and white painted bins. Combine with grain protectant application and removal of insect refuges around store.

**Killing all insects** — fumigation.

**Keeping new insects out of the store** — sealing of storage and hygiene around storage.

**Early recognition and fixing failures** — trapping and inspection to detect early insect infestation followed by strategic fumigation.

### Fumigation failure

If live insects are found after fumigation, the problem could be caused by:

- The fumigant was not retained for long enough.
- Not enough fumigant was added.
- Insects entered the storage after fumigation.
- The insects were resistant to treatment.
- The grain was too cold.

In most cases phosphine fumigation failures are caused by the fumigant not being retained for long enough.

Application of phosphine according to label instructions and good hygiene and grain management will assist in achieving a complete kill.

But most on-farm storage is too leaky for effective phosphine fumigation. All older and many newer structures were designed to keep the grain in, the rain out, and to allow natural



Laboratory tests are used to determine effective dosage rates for phosphine against the major stored grain insect pests.

ventilation of the grain — not to retain gas. Even in modern sealed silos, fumigation will fail without regular maintenance of the seals, especially for the rubber seals associated with hatches and chutes.

For the best chance of a successful fumigation, the storage must be sealed after filling and meet a three-minute or better pressure test half time. When pressure tests are less than three minutes, the chance of the fumigation being fully effective is reduced.

Fumigation in structures with a pressure test of less than 10 seconds can be no different from fumigation in unsealed structures.

### Phosphine safety

If accidents or dangerous incidents occur, regulations are likely to be tightened and

on-farm use of phosphine will become more restricted. Correct use according to the label will reduce these risks.

But it is not possible to put every potential danger on a label and some general knowledge of the material, along with common sense, can help to reduce unpredictable hazards.

Phosphine-producing compounds are poisonous, they produce the active ingredient phosphine when they react with water and the active agent is poisonous and a potentially explosive gas.

The water they are designed to work with is the moisture present in air between grains. The addition of any extra water is dangerous. When giving off phosphine, the compounds also give off heat — too much compound heaped together may cause fire.

Residual material should be treated as hazardous since further phosphine may be produced after all the readily produced phosphine has been released.

### Phosphine resistance

Phosphine treatment failures due to resistance are rare in Australia, but not uncommon elsewhere in the world. In Australia, low levels of phosphine resistance are common.

But this low level of resistance does not lead to control failure when phosphine treatments are used at the label rate in adequately sealed storages.

To minimise the risk of resistance developing, make sure phosphine is given every chance of killing all insects the first time it is used.

Read the label and apply the correct dose. Make sure the enclosure is sealed and treat the grain before it is swarming with insects.

If fumigation failure occurs, avoid retreating with phosphine if possible. This is especially important where there is no obvious and fixable reason for the failure.

### Avoiding residues

Problems with residues after phosphine fumigation can be avoided if:

- Phosphine-producing products are not mixed with the grain and spent material is removed before moving the grain.
- Full ventilation and withholding periods are followed.
- Preparation is not used higher than the label rate.

A record of the fumigation is useful if any problems occur after fumigation. Ideally, these should record the date of the fumigation, the capacity of the storage, the amount of phosphine added, a rough estimate of the number of insects present at fumigation, and the date (ventilation plus withholding time) grain was cleared for moving.

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## On-farm hygiene helps control

Good on-farm hygiene and early insect detection within handling and storage units will help reduce insect infestations in stored grain.

Insects that have infested freshly harvested grain are likely to have come from grain residues left from the previous season.

### Clean-up grain residues

Grain residues are found in harvesters, augers, field bins, trucks, animal troughs, silos after emptying, rubbish and other clutter.

Make a note of places where residues are found, dispose or redesign facilities to eliminate the problem, or at least inspect and clean these sites before storing new season grain.

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

### Silo treatments

Following outturn of grain from silo bins, the structure should be washed down and a treatment applied using an inert dust or contact insecticide prepared for structural use.

Suitable inert dusts can be either applied as a dry powder or prepared as a slurry.

Structural treatment is essential where insects were 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.

Never add freshly harvested grain to silos retaining the previous seasons grain unless it has been effectively treated.

### Storage inspection

The earlier insects are detected, the sooner they can be removed. This is especially important since insects can multiply at rates up to 100-fold per month if left unchecked.

Insect infestation in cereal grains will become obvious in 2–3 months under most Australian storage conditions unless precautions are taken.

Regular inspection and the use of traps can help detect a potential infestation. The presence of detectable numbers of grain storage insects is a warning a problem is on its way.

