

# Sealed silos increase fumigation success

Insect pests of stored grain are slowly becoming resistant to Australia's most widely used fumigant, phosphine. This article explains how to use phosphine effectively and in doing so prolong the fumigant's useful life.

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When phosphine is used according to label directions in a sealed grain bin the fumigant is extremely toxic to all species of grain insects.

While most adult insects are highly susceptible to phosphine, pupae and eggs are more difficult to kill.

Poor phosphine fumigation will kill most insects present but could leave some less-visible stages alive and within a short time a new generation of pests will emerge.

Effective fumigation occurs when the phosphine gas is held in a sealed farm silo or bulk bin for long enough to kill the target insect pests.

Increasing the concentration of phosphine will not make up for an inadequate fumigation time.

Phosphine treatment involves 7–10 days under fumigation, followed by 2–5 days ventilation and a further two days withholding period. Fumigated grain must be vented for the required time before it can be transported legally.

## Preparing for fumigation

Fumigation will be more successful if the following steps are taken before starting the fumigation process:

- Read the preparation label and the Material Data Safety Sheet (MSDS).
- Ensure fumigant can be applied according to label directions.
- Ensure there is enough time to complete the fumigation before the grain has to be moved.
- Determine the volume of the silo or bulk bin to be fumigated.
- Check that all silo openings such as valves, hatches, fans and chutes are sealed.
- Carry out a pressure test to ensure the silo is sealed to a satisfactory standard.
- Locate and seal leaks where silos fail to meet the required gas-tight standard.

## Performing the fumigation

Apply the amount of fumigant recommended on the label, taking into account silo volume, grain type and potential insects.

If in doubt, use the maximum recommended dose.



Successful fumigation of stored grain will help to prolong the useful life of Australia's most widely used fumigant, phosphine.

For a safe and effective fumigation remember the following:

- Under no circumstances enter a silo bin when it is filled or partially filled with grain.
- Avoid contaminating grain with phosphine preparation residues.
- Do not heap phosphine-producing preparations.
- Reseal the structure after the phosphine preparation has been added.
- Ensure the proper exposure time is allowed (remember this is temperature-dependent).
- Label the structure as 'under fumigation'.
- Prevent unauthorised access to the structure.

## After the fumigation

Allow the full exposure period plus a venting time before removing the preparation residue or the grain.

### At a glance

- **Phosphine is the major fumigant used to kill insect pests in grain storage structures.**
- **Fumigation will be most successful in well-sealed grain storage structures.**
- **The length of time that insects are exposed to phosphine gas and the concentration of phosphine used are important to successful fumigation.**
- **Temperature will affect the fumigation length.**

Be very careful when handling preparation residues, as they are likely to have some un-released phosphine gas.

Correctly dispose of the residues according to label or local regulations. If not otherwise instructed, bury to about 0.5 metres on-site. Do not transport residues in a closed vehicle.

## Dosage rates

Phosphine dosage is calculated on the volume of the storage structure not the amount of grain in the silo or bulk bin.

For normal, sealed, permanent storage structures, the dosage rate is 1.5 grams of phosphine per cubic metre of internal storage volume. This is equivalent to 1.5 standard tablets or 7.5 standard pellets. Refer to the label for dosage rates of chains, sachets, blankets and plates.

## Exposure period

The moisture content of the grain and the temperature in the storage structure affect the rate at which phosphine gas is generated from the dry formulation.

Grain stored at 15–25 degrees Celsius needs to remain under fumigation for 10 days. Grain above 25°C requires an exposure period of seven days.

Phosphine is less effective at controlling insects at low temperatures and fumigation should not be undertaken at temperatures below 15°C.

The specified exposure time is critical to the success of the fumigation in an adequately sealed store. It is important to note that increasing the phosphine dosage will not enable the exposure time to be shortened.

A longer exposure time will not harm the grain and maintaining the seal will stop insects from re-invading the grain store.

### Sealing farm silos

A well-sealed silo ensures that minimal gas leaks out and air does not leak in. Silos bought from a reputable manufacturer need to be sealed to an adequate standard of gas-tightness at the time of purchase.

Regular maintenance to seals of hatches, chutes and sampling points will maintain the required level of gas-tightness and provide a barrier to insect invasion into the grain.

Storage silos not manufactured as sealed will have to be sealed. To seal a silo to a high level of gas-tightness, it is necessary to ensure that the fabric, hatches and chutes are well sealed or sealable.

It can be expensive and difficult to seal a silo made of steel sheeting bolted or rivetted together and with open eaves at the junction of the roof and sides. Consider buying a new sealed bin.

### Common leakage points

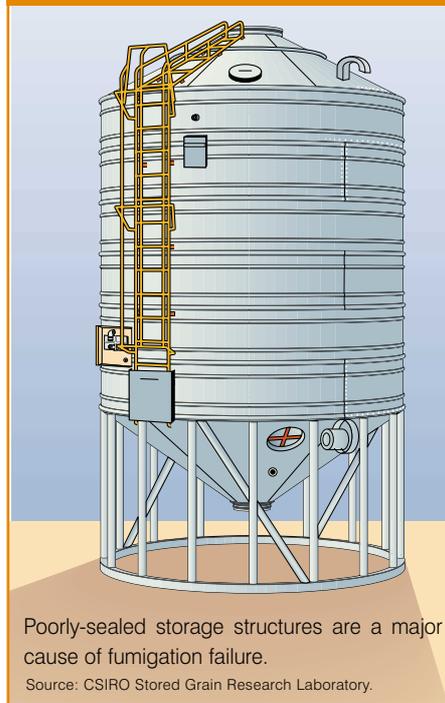
Silos that have been retro-sealed are also more likely to fail than factory-sealed units.

Common failure points on retro-sealed silos are roof panel joints, roof and wall junctions, filling hatches and grain outlets.

Potential leakage points in factory-sealed or retro-sealed silos are highlighted in Figure 1.

Leakage at panel and structural junctions will be more of a problem in retro-sealed silos or bulk bins.

FIGURE 1 Potential leakage points



Performing a pressure test will determine whether the storage structure is sealed effectively. In a silo, a pressure test consists of blowing air into the enclosure using an air compressor, hand-held blower or vacuum

cleaner until a small positive pressure is created. The airflow is then turned off and the time taken for the pressure to halve is recorded using an oil-filled pressure relief valve or U-tube manometer.

A full, well-sealed silo is considered sufficiently sealed if the pressure halving-time exceeds three-minutes.

In an empty silo, a five-minute halving-time is recommended. The chances of fumigation failure increase as the pressure halving-time drops below these time limits.

The real measure of a successful fumigation is that insects are effectively excluded while the silo is sealed.

Sealed silos must be fitted with relief valves to protect the structure from damage due to the excessive positive or negative pressure that can build up in response to changes in environmental conditions during fumigation.

For example, changes in ambient temperature and atmospheric pressure can lead to pressure differences across the walls of a sealed silo or bulk bin to a level where it becomes structurally dangerous or over-stresses the seal.

The better sealed a silo is, the more prone it will be to such problems. The most likely source of pressure-related damage in a sealed silo is caused by implosion due to low-pressure levels within the storage structure.

## Fumigation failure

The failure of phosphine fumigation to control insect pests is generally caused by the fumigant not being retained for long enough.

In practice, phosphine only will be retained at the required concentration when the store is sealed to an adequate standard of gas-tightness.

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 rainfall out, and to allow natural 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.

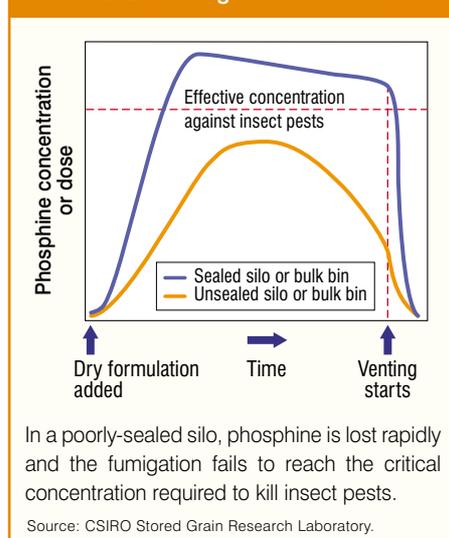
In a poorly sealed silo, phosphine is lost rapidly and the fumigation fails to reach the critical concentration required for complete insect control.

If live insects are found after fumigation, it is likely that: the fumigant was not retained for long enough or not enough fumigant was added; insects entered the storage after fumigation; the insects were resistant to treatment; or the grain was too cold.

## Record of fumigation

Fumigation records help to explain fumigation failures. They also could have value in documenting grain treatment for

FIGURE 2 Fumigation failure



meticulous buyers such as those who want to be sure that specific chemicals have or have not been used to treat the grain.

The following list indicates the type of information that could be usefully recorded:

**Storage details** — silo identification, silo volume and capacity, date and results of pressure test.

**Commodity details** — tonnes of commodity, commodity type, harvest year and commodity.

**Temperature** — grain moisture content, previous fumigation and treatment history and infestation.

**Insect status at fumigation** — none, few or many insects.

**Dosing details** — fumigant used, name of fumigant preparation, dose applied and date applied.

**Exposure details** — defined exposure period and fumigant concentration during exposure period and at end of the exposure (where measurement device is available).

**Post-exposure details** — date cleared of fumigant, date outloaded, results of outloading inspection (insects present or absent).

## Avoid problems with residues

The fine powder residues remaining after phosphine fumigation should be regarded as toxic and problems can be avoided if phosphine-producing products are not mixed with the grain and spent material is removed before moving the grain.

Ensure full ventilation and withholding periods are followed.

Multiple doses and over-dosing may lead to the grain exceeding the maximum residue limit (MRL) for phosphide. The MRL also could be exceeded if the post-application holding period is less than recommended.

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