



Fumigating with phosphine

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Fumigating with phosphine gas is a popular stored grain management tool because storage operators can control insects at any time without moving the grain.

Unfortunately most on-farm fumigations do not fully control insects. This information sheet explains how phosphine works, identifies the causes of problems and presents some solutions.

► Gas loss

Most farmers use phosphine generating tablets (for example, Celphide; Fumitoxin; Gastion) when fumigating. These tablets react with moisture in the air to release phosphine gas. Up to two days is needed to release all the gas - longer if the grain is cool or very dry. The gas then moves through the grain, usually within a day in bulks up to a few hundred tonnes.

Phosphine moves readily, so it leaks quickly through holes in silos or sheeting. Wind and large temperature changes accelerate phosphine loss. In many on-farm fumigations, most of the phosphine is lost within 4 days.

► Phosphine poisons slowly

Insects are killed slowly by phosphine. A low concentration for a long time may be more effective than a very high concentration for a short time.

Adult insects die at lower concentrations than eggs or pupae. For example, weevil pupae typically need 1200 parts per million (ppm) for 4 days, 230 ppm for 7 days or 30 ppm for 10 days. Adults die from only 30 ppm in 1 day. Lower concentrations and exposure times are needed at higher temperatures.

► Poor fumigation practices

Farmers usually spread tablets over the surface of grain bulks or bag-stacks, push them into the grain, or mix them with grain as it is conveyed into storage. Bag-stacks and bins are then covered with canvas or plastic, but silos are not.

Most farmers believe that these treatments are successful within a few days . . . but what really happens?

Phosphine concentrations typically reach a few hundred ppm in less than a day, then remain there while the tablets continue generating phosphine. Once the tablets are finished, concentrations fall rapidly and little remains in unsealed storages after 4 days.

Many fumigations are done only after adult insects are obvious in grain. But by this time many eggs and pupae are also present. Adult insects usually die in less than two days, even at the low levels reached in poor fumigations. But many eggs and pupae will survive and continue breeding. When adults are seen in a few months, another ineffective fumigation usually follows.

► Insect resistance

Fumigation in leaky silos or under leaky sheeting selects for resistance. Resistant stored product insects in Asia require much higher concentrations or longer exposure periods than are currently needed in Australian grain - but we too could have insects like those.

The costs of repeated fumigation or extra control measures needed by buyers of grain containing hidden eggs and pupae are passed back to the farmer, but are avoidable. cont'd

► Improving fumigation

Fumigation cannot be fully effective unless it is done in a gas-tight enclosure. Silos can be made gas-tight for fumigation, preferably during manufacture. Information on sealed silos is given in GRAINSAFE bulletin GS011.

Gas-tight bag stacks are built by laying a plastic sheet on the floor, building and covering the stack, then tightly rolling and clamping the top and bottom sheets together. Old sheets that have been folded or rolled many times, or roughly handled are unlikely to be gas-tight.

Measuring the phosphine concentration shows you whether the fumigation enclosure is sufficiently gas-tight. Three days after applying phosphine tablets the concentration should be more than 500 ppm, and at the end of a 7 day fumigation above 25°C the concentration should still be at least 100 ppm.

You can measure phosphine concentration with a hand pump and gas detector tube. Buy, beg or borrow a measuring kit to monitor at least some of your fumigations. Several companies sell suitable gear so shop around to find the price and performance that suits you - see the listing at the end of this bulletin.

► Airing

Fumigated grain must be aired before handling to remove toxic gas and to minimise residues. Flow-through ventilation aided by a fan usually allows completion of airing in 24 hours.

Without a fan this could take 5 days. Shorter periods can be used if fumigant levels near the grain are monitored - airing should continue until the concentration drops below 0.3 ppm of phosphine.

► Non-residual effect

Fumigation gives no residual protection to stored grain. In other words, insects flying or walking into the grain after the fumigant concentration has dropped to low levels will begin breeding.

Sealed, gas-tight silos have an advantage - they have no major holes so insects are prevented from entering the grain.

Fumigation should be used only as part of an integrated plan for managing grain insects. Other practices could include sound hygiene to reduce the number of migrating insects, and aeration after fumigation to minimise the rate of population growth. Used together, these methods will increase the period of safe storage.

► Safety

Phosphine is much more toxic to people and farm animals than to insects. Health workers specify a concentration of 0.3 ppm as acceptable in work areas. Gas detector tubes are one method of monitoring workplace concentrations.

Use the following guidelines to stay safe when using phosphine:

- don't inhale phosphine gas;
- ventilate fumigated areas before entering;
- apply fumigant quickly;
- fumigate only in areas where gas can't leak into living or working areas;
- spread tablets thinly to avoid fire risk;
- open tablet containers in open air and away from your face;
- never place tablets in water;
- display a clear warning sign:

'DANGER - POISON GAS - KEEP AWAY'

► Other fumigants

Phosphine is the most convenient fumigant available for use by farmers.

Methyl bromide is quicker than phosphine, taking only 24 hours, but it requires more specialised application equipment. It can reduce the germination of seed. Methyl bromide use is likely to be restricted soon because of effects on the earth's ozone layer.

Carbon bisulphide is a fumigant that is applied as a liquid. It is much more flammable than phosphine, may reduce baking quality of flour from treated grain, and needs high concentrations to be effective.

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Applying Phosphine

✓ **How much?** Effective fumigation of grain usually needs 1.5 grams of phosphine per cubic metre of **total storage capacity**.

- 1.5 grams per cubic metre is:
- 1.5 tablets per cubic metre; or
 - 55 tablets per 1000 bushels; or
 - 2 tablets per tonne capacity (wheat).

Note! Use the same amount of fumigant regardless of whether it is full, partly full or empty. For example, a storage with enough space to hold 100 tonnes of wheat always needs 200 tablets - even if it is only partly full.

✓ **How long?** Phosphine fumigant acts faster on stored grain insects as the grain temperature increases.

- Minimum fumigation times are:
- 7 days at grain temperatures above 25°C;
 - 10 days at 15 to 25°C.

Grain below 15°C should not be fumigated with phosphine - insects are very hard to kill at low temperatures. Fumigant takes longer to distribute in storages with more than a few hundred tonnes capacity, unless forced circulation is used.

✓ **Which grains?** Phosphine is effective against insects in most types of grain. But some commodities (for example, linseed and cottonseed) soak up phosphine very quickly, leaving little to kill insects. Phosphine does not control insects effectively in these materials.

Suppliers

The following list gives suppliers of equipment for measuring phosphine concentration. Other companies may also supply suitable equipment.

- Air-Met Scientific Pty Ltd
(Kitigawa hand pump and detector tubes)
Ph 07-8811360
Fax 07-8812360
- GRAINCO Qld Cooperative Association Ltd
(G.M.E. hand pump and tubes)
Ph 076-32 1088
Fax 076-32-9380
- Drager (Australia) Pty Ltd
(Drager hand pump and detector tubes)
Ph 07-274 2433
Fax 07-274 0062
- MSA (Australia) Pty Ltd
(hand pump and detector tubes)
Ph 07-891 1966
Fax 07-891 6087

