

## Phosphine resistance in stored grain pests – Teachers

### Background

After harvest, grains are stored in large stockpiles. During storage, grains are susceptible to attack from several species of insects. The most common insect pests of stored cereal grains (wheat, barley, oats, triticale, sorghum and millets) in Australia are:

- Weevils: (*Sitophilus* spp.). Rice weevil is the most common weevil in wheat in Australia
- Lesser Grain Borer: (*Rhyzopertha dominica*)
- Rust Red Flour Beetle: (*Tribolium* spp.)
- Sawtooth Grain Beetle: (*Oryzaephilus* spp.)
- Flat Grain Beetle: (*Cryptolestes* spp.)
- Indian Meal Moth (*Plodia interpunctella*)
- Angoumois Grain Moth (*Sitotroga cerealella*)

Another dozen or so beetles, psocids (booklice), and mites are sometimes present as pests in stored cereal grain.

If insects in grain are left untreated, the grain will, be unsaleable to most buyers, be reduced to dust by the insects feeding on it and go mouldy because of the heat and moisture released by the insects.

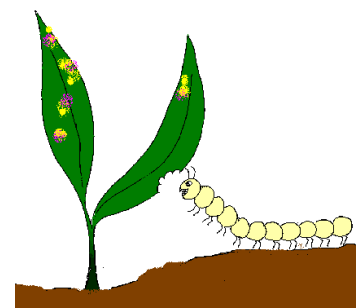
The grain industry in Australia is reliant on fumigants to protect stored grain from insect infestations. Methyl bromide is one such fumigant however, due to the Montreal Protocol it has slowly been phased out since 2005. The Montreal Protocol on Substances that Deplete the Ozone Layer is an international treaty designed to help protect the ozone layer by phasing out a number of chemicals thought to be contributing to ozone depletion.

Since the phasing out of methyl bromide, phosphine (PH<sub>3</sub>) has become the most important fumigant for the grain industry in Australia. Phosphine is a highly toxic gas that, when used properly, kills off insect populations without affecting the viability of stored grains. It is also toxic to humans and other mammals but when used properly there is minimal residue left on the grain. One advantage of using phosphine is that it is accepted by international markets as leaving grain 'residue-free', which can be important for trade. Contact insecticides do not have this same 'residue-free' status and so, farmers who use such insecticides have difficulty in selling grain.

Another advantage of using phosphine is that the grain does not have to be moved to be treated. Instead, phosphine tablets can be placed into the silo. The tablets are placed into the silo or grain storage area and react with the moisture in the air to produce phosphine gas. This process can take between 1 to 4 days depending on the temperature. The gas moves around by diffusion and air currents inside the silo or container.

Susceptible adult insects are killed quickly, usually within a day, but immature eggs and pupal stages are tolerant of phosphine and can survive short exposures to phosphine, even in high concentrations. To kill all stages of the insects' life cycles, the phosphine gas must be present in high enough concentrations for approximately 7 days.

As phosphine gas moves around, it leaks rapidly from silos that are not sealed (air-tight). Fumigation in an unsealed silo exposes the insects to a sub-lethal dose of phosphine. Resistant adult insects, eggs and pupae will survive the fumigation treatment and continue breeding, passing on their resistance. Repeated fumigations favour the insects that carry the resistance gene and kill normal, susceptible insects.



High levels of phosphine resistance have been identified in several species of stored grain pests in Australia.

## Relevance to plant biosecurity

The frequency of strong resistance to phosphine is increasing in four of the five major grain insect pest species. About 5% of insect populations contain individuals with this strong resistance. Weak resistance in insect species is common across Australia. This is a problem as phosphine fumigation is the mainstay of insect control in grain and other stored food products. Over 80% of stored grain is currently treated with phosphine. Strong insect resistance threatens the continued use of phosphine in Australia and lowers the chance of good insect control in silos.

Researchers are currently working with growers and grain handlers to monitor the levels of phosphine resistance in insects, provide advice about phosphine dosage rates and effective use and most importantly, trying to find alternative methods of insect control.

## Activities for students

- Complete 'Understanding phosphine resistance in insect pests of stored grain'
- Complete activity 'phosphine resistance genetics'

## More information

<http://www.crcplantbiosecurity.com.au/program/post-harvest-integrity>

[http://www.dpi.qld.gov.au/26\\_5990.htm](http://www.dpi.qld.gov.au/26_5990.htm)

[http://www.dpi.qld.gov.au/cps/rde/dpi/hs.xsl/26\\_6467\\_ENA\\_HTML.htm](http://www.dpi.qld.gov.au/cps/rde/dpi/hs.xsl/26_6467_ENA_HTML.htm)

[http://www.dpi.qld.gov.au/cps/rde/dpi/hs.xsl/26\\_4801\\_ENA\\_HTML.htm](http://www.dpi.qld.gov.au/cps/rde/dpi/hs.xsl/26_4801_ENA_HTML.htm)

<http://www.csiro.au/resources/Phosphine.html>

