

Understanding Phosphine resistance in insect pests of stored grain – Students

Insect pests of stored grains

After harvesting, grains and seeds are stored in large stockpiles, ready to be shipped to international or domestic markets. The grains are often stored for long periods of time. During storage, the grains are susceptible to attack from various insect species. If these insects are left untreated, the grain may be reduced to dust by feeding and go mouldy due to the heat and moisture released by the insects. This renders the grain unsaleable.

Insect pests of stored grains include:

- 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*)

To find out more about these insect pests, go to http://www.dpi.qld.gov.au/26_5990.htm

What is phosphine?

Phosphine is a toxic chemical that is used to fumigate stored grain and kill insect pests. Phosphine is classified as being 'residue-free', this means that it does not leave a toxic residue on the grain and that the treated grain is safe for human consumption.

Phosphine is introduced into silos and other grain storage facilities via tablets. These tablets react with moisture in the air to produce phosphine gas, which kills the insects. Phosphine fumigation is the mainstay of grain insect control in Australia. It has remained effective for the past 40 years and currently over 80 percent of grain is treated using this method.

Phosphine fumigation and resistance

Phosphine 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.

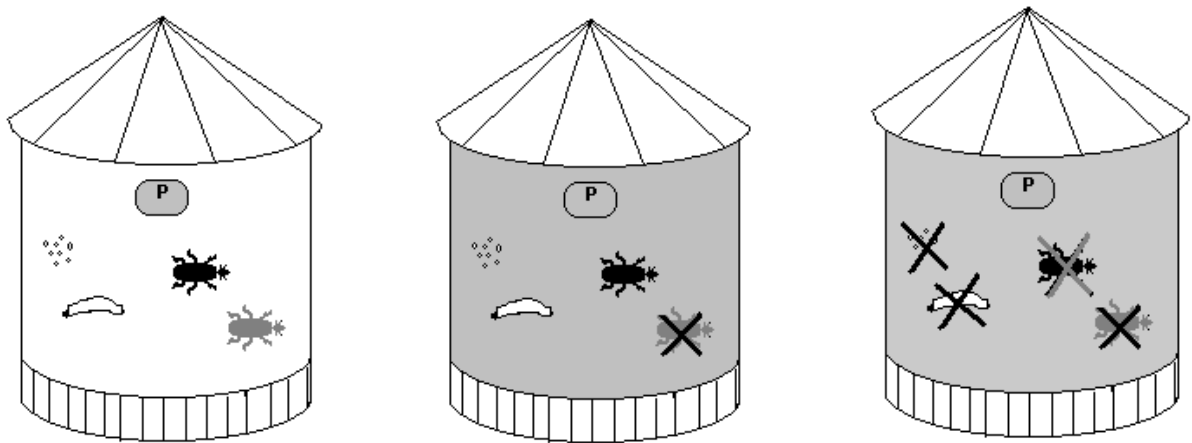
As phosphine gas moves around, it can leak rapidly from silos that are not sealed to be air-tight. Fumigation in an unsealed silo exposes the insects to a sub-lethal dose of phosphine. Resistant adult insects, eggs and pupae will survive the fumigation treatment and continue breeding, passing on their 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.

Questions

1. Why is grain treated with phosphine?
2. What are the effects of insect infestation in stored grains?
3. What does 'residue-free' mean?
4. The diagram below shows how a weevil infestation in a sealed grain silo is treated with phosphine. Match the labels to the correct stages by drawing a line from the description to the matching picture.

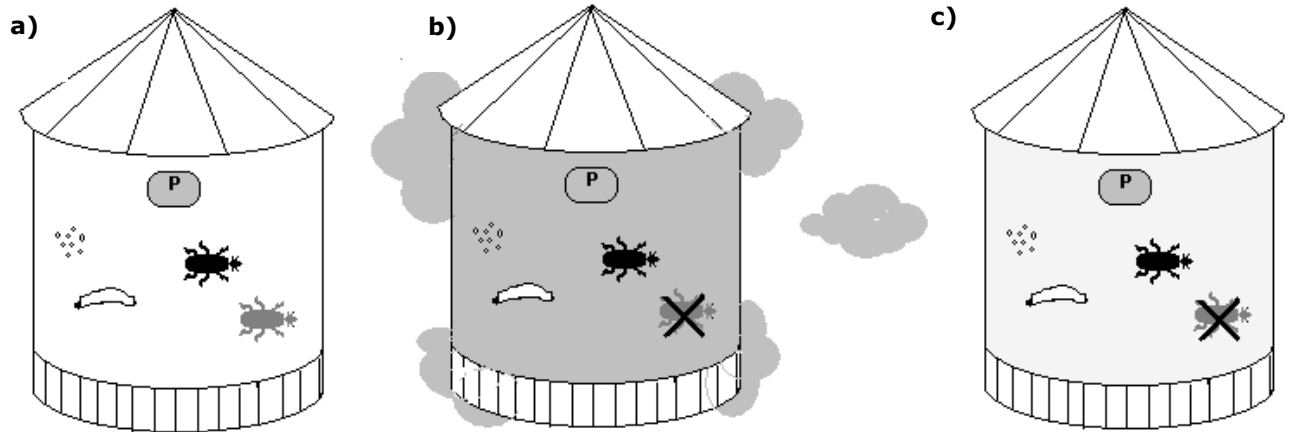
Figure 1: phosphine fumigation in a sealed silo



- After 7 days, the phosphine remains at a high enough concentration to kill the immature weevils and resistant adult weevils.
- Phosphine tablets are applied to a silo with live adult weevils and immature weevils (eggs, larvae and pupae) inside the grains.
- During the first few days, the tablets react to release phosphine gas that kills susceptible adult weevils (grey) quickly but not the immature weevils or resistant adults.

5. Use the diagram below to complete the blanks in the descriptions.

Figure 2. phosphine fumigation in an unsealed silo



- a) Application of _____ tablets in a silo with live adult weevils and _____ weevils (eggs, larvae and pupae) inside the grains.
- b) During the first few days, tablets react to release phosphine gas that kills _____ adult weevils (grey) quickly but not the immature weevils or _____ adults and the gas _____ out of the silo.
- c) After 7 days, little phosphine remains and the _____, larvae, _____ and resistant adults survive.

6. If phosphine is our main insect control strategy, what are some of the possible implications of strong insect resistance becoming common across Australia?