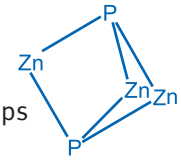
Zinc phosphide

What is zinc phosphide?

Zinc phosphide is used as a rodenticide throughout the world.

The first use of zinc phosphide to control field rodents was during 1911–12 in Italy. Its use increased during World War II and until the 1950s, when sodium fluoroacetate (1080) and the anticoagulants first appeared. In the 1970s there was a renewed interest in zinc phosphide for rodent control in agriculture.

Today, zinc phosphide is used throughout the agricultural world to control a range of animals, including mice, rats, voles, ground squirrels, prairie dogs, nutria, muskrats, rabbits and gophers. Here in Australia, zinc phosphide is used extensively for controlling mouse populations in grain crops and rat populations in cane crops.



Zinc phosphide is an inorganic compound with typically a dark grey crystalline appearance. The molecular formula is shown to the right.

Zinc phosphide is insoluble in water and is a relatively stable molecule. Degradation of zinc phosphide occurs via oxidation of the phosphorus to various phosphorus oxyacids or via reduction of the phosphorus to phosphine gas.

Phosphine gas has a characteristic garlic or onion-like odour, and it is this odour that is often associated with zinc phosphide concentrate and its formulations. Phosphine gas is used extensively throughout the world as an insecticide and rodenticide for the protection of stored food products.

How does zinc phosphide work?

Zinc phosphide is an extremely toxic compound and is a non-specific pesticide for vertebrates. In general, its toxicity across a range of species is similar to that of strychnine. In contact with moisture under acidic conditions (like in the stomach of a mouse), zinc phosphide reduces to phosphine gas, which is the cause of zinc phosphide's acute toxicity.

Phosphine gas causes central nervous system depression, irritation of the lungs and damage to the liver and other organs. Death occurs as a result of heart failure and, more commonly, pulmonary oedema, although there are reports of heart failure accompanied by kidney damage.

Both zinc phosphide and phosphine are readily absorbed via the gastrointestinal tract, although the majority of acute effects are caused by phosphine. Unreacted zinc phosphide contributes to liver and renal damage.

Where to use zinc phosphide?

In Australia, a grain bait formulation containing zinc phosphide is registered for use as an in-crop rodenticide. Zinc phosphide can be used in canola, cereals, crops (stubble), fields (pre-plant) and fallow, legumes, nuts, safflower, sweet potatoes and pasture. It is applied by aircraft or by ground spreading. In addition, there are off label permits for other crops and situation such as in strawberries, visit the Australian Pesticides and Veterinary Medicines Authority (APVMA) website www. apvma.gov.au.

When to use zinc phosphide?

Zinc phosphide bait can be used to reduce mouse numbers at sowing and at any stage of crop development up until two weeks before harvest.

There are no hard and fast rules for when to apply zinc phosphide bait to crops to control mice. Biosecurity Queensland recommends careful monitoring of mouse numbers and, more importantly, mouse damage in crops. If the benefit of mouse control exceeds the cost of the control, baiting may be beneficial. It is very important not to let mouse numbers build up, because no poison or control method is fully effective when the mouse population is large.

The ideal time for rat control in sugar crops is from early ratoon (when the new shoots appear) stage to canopy closure, which for Australia is any time between October and March.

The aim is to try to reduce the population of breeders before the population explodes. This has the added advantage of reducing damage to ratoon cane by ground rats.

Why use zinc phosphide?

Zinc phosphide not only provides good control of mice in crops, but it also has a good storage and environmental record.

Storage stability

The zinc phosphide content of zinc phosphide grain bait remains stable for at least two years when stored in original containers at temperatures up to and including 40°C. Storage temperatures in excess of 50°C have been shown to cause significant deterioration of the bait.

Crop residues

Zinc phosphide has no solubility in water and has little or no mobility in the environment. It breaks down to form phosphine gas and zinc, a trace element required by plants.

Any traces of zinc phosphide found in plants would most likely be due to baits lodged in the leaf axils of plants. Residues found in a broad range of crops have been well below the permitted maximum residue level (MRL).

Remaining bait in crop stubble also needs to be considered for its potential to do harm to grazing animals. However, at the recommended application rate, there should be little chance of harm to grazing animals.

Soil residues

Zinc phosphide cannot be directly incorporated into the soil. Zinc phosphide grain bait undergoes an exponential decline of active ingredient concentration when exposed to dry or wet soil. However, there is no discernible relationship between soil pH and the rate of bait decomposition.

Water residues

When zinc phosphide grain bait is immersed in water very little phosphine is released. The majority of the zinc phosphide degrades into various harmless phosphorus oxyacids.

Weathering

There is no direct relationship between the intensity of rain and zinc phosphide concentration in bait. Therefore, the amount of time in contact with rain/mist/dew, rather than the amount of rain received, determines the overall loss of zinc phosphide from bait. Mould growth may occur after prolonged contact with moisture, but this does not cause acceptability problems with mice.

A change in bait appearance may be observed after rainfall, with the bait taking on the pale yellow appearance of natural wheat, but with a dark groove. This is caused by the loss of the surface coating of zinc phosphide, which gives the bait its characteristic black colour. This does not significantly alter the zinc phosphide concentration and these baits are still quite toxic.

The effective bait life is defined by sufficient active ingredient remaining to still be effective for mouse control. The average effective bait life of material exposed to dry soil is in excess of 100 days, whereas when bait is exposed to wet soil the value is around 20 days.

Non-target impact

Studies investigating the potential secondary poisoning and non-target effects of zinc phosphide grain bait formulations have found that bait posed little hazard to non-targets if applied in-crop when sufficient food was available. To date, evidence shows minimal non-target impact from zinc phosphide grain bait use.

Human exposure

Material Safety Data Sheets (MSDS) are available for zinc phosphide from the products' manufacturers, and should be consulted before using the bait.

Zinc phosphide is not a volatile substance and apart from dust, pure zinc phosphide does not constitute a hazard when stored in dry conditions. It is common for zinc phosphide bait to evolve phosphine in storage.

The most dangerous contact routes are either ingestion (of zinc phosphide) or inhalation (of phosphine). It is therefore recommended that lids of storage containers are removed in open ventilation and every precaution should be made to avoid breathing the phosphine gas trapped in the headspace of the storage container. The generation of phosphine in the presence of acids can lead to dangerous fire and possible explosion hazard.

If poisoning occurs, contact a doctor or the Queensland Poisons Information Centre (13 11 26).

Who benefits from zinc phosphide?

The importance of zinc phosphide is easily displayed in economic terms, with rodents responsible for $10–30 million damage per plague to cropping industries in Queensland alone. Rodents are a fact of life in the rural industry and their numbers can build rapidly, given favourable climate and food supply. Damage can occur at any stage of crop development. Mice can damage equipment, electrical wiring and reduce the performance of intensive livestock such as pigs and poultry. Mice can also ruin stock feed, stored grain fodder and stored wool.

Along with the economic impacts of rodent infestations, there are other important social impacts. Mice transmit disease and are therefore a serious nuisance in homes, businesses, hospitals and schools. Mouse infestations and the effort required to combat plagues are the cause of considerable stress to rural communities.

The availability of zinc phosphide for the protection of crops is just one part of an efficient and effective rodent management strategy aimed to save millions of dollars for Queensland and Australia each year.

Further information

Further information is available from your local government office, or by contacting Biosecurity Queensland on 13 25 23 or visit biosecurity.qld.gov.au.

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