

Effective phosphine fumigation of grain

Topic Sheet No. 8
Winter 1997



Background

Phosphine has been used for fumigating grain in the UK for more than 40 years. It is the only realistic treatment for grain which has to be disinfested *in situ*. Currently phosphine is available commercially in solid formulations containing aluminium or magnesium phosphide. These release gas on exposure to air.

For successful treatment:

- The seal on the sheeted grain bulk must be good enough to retain gas for several days.
- There must be sufficient air movement to distribute the gas evenly throughout the bulk.

Research findings

Dr Chris Bell at the MAFF Central Science Laboratory at York has led four HGCA-funded studies on phosphine use.

New methods of introducing phosphine into grain have been developed. Using a mixture of 2% phosphine in liquid carbon dioxide, gas can be fed from cylinders into the base of grain silos or into the ventilation system of floor stores. If the bulk has been cooled, natural convection will carry gas up through the grain achieving good distribution. Thereafter, a continuous low volume flow of gas offsets leakage throughout the treatment time. Low power fan-assisted gas circulation will help counter high wind or wide day

and night temperature oscillations. At some stages of their life-cycles insects can tolerate exposure to gas for several days. Pests may succumb when they reach the next stage (Table 1). Some insect species have developed resistance to phosphine at all stages. To

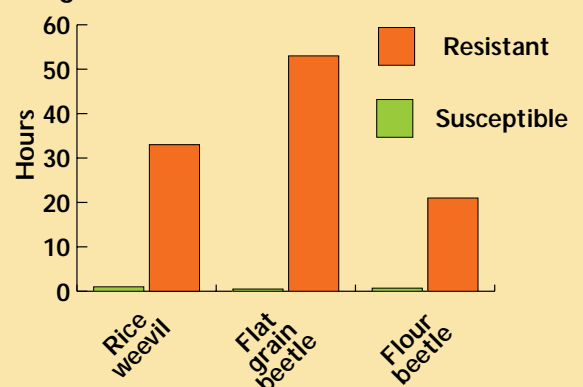
Table 1. Days to kill pupae and adults of grain weevil and flat grain beetle

Temp. (°C)	Phosphine dose (mg/l)	Pupae (in grain)	Adults
15	0.39	16	2
	0.77	16	2
10	0.64	>16	3
	1.35	>16	2
5	0.78	>24	5

control both naturally tolerant and resistant stages, long exposure periods are required (Figure 1). A rapid test to identify resistance within a few hours has been developed based on insect activity.

At low temperatures longer exposure to phosphine is required to kill pests.

Figure 1. Hours to kill 50% of beetles



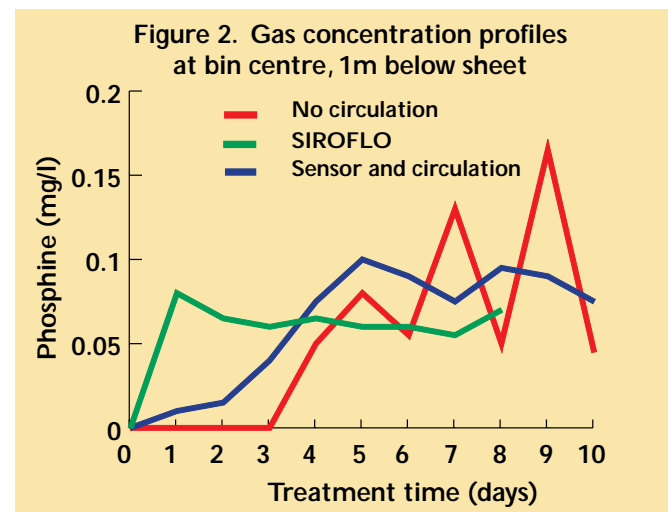
Immature stages cannot develop at 10°C, though fumigation may be needed if adults are present. Adults can be controlled at 5-10°C, temperatures not formerly recommended for fumigation.

An automated dosing system has been developed for controlling cylinder-based phosphine supplies. It monitors gas concentrations at various positions in the bulk. If any reading falls below the set point, a solenoid valve opens and gas is dosed to the area. In bins, only a few sensors are required near the grain

with pesticides. However, efforts should be made to prevent the need for fumigation by employing an integrated grain storage strategy (see Topic Sheet No 7).

Pest populations should be monitored using traps. If numbers rise, the most rapid solution is to fumigate with phosphine using a contractor approved by the British Pest Control Association. Such companies will be aware of the latest developments in fumigation technology.

Improvements in gas application ensure successful



surface. A simple recirculation system can be arranged with a pipe running from under the sheet at the grain surface down the outside of the bin to the base. When used with recirculation, after three days phosphine levels equal those obtained with the recently developed Australian SIROFLO forced air flow phosphine dosing system (Figure 2).

Similar results are being obtained from trials in floor-stored grain.

In your grain store

Insects and mites in stored grain are a persistent and often serious problem. Prophylactic fumigation using low doses at the start of storage may be as cheap as admixture

fumigation, even at the low temperatures resulting after ambient-air cooling. Cooling no longer precludes disinfestation by fumigation. The new rapid resistance test means that more expensive lengthy fumigations will only be used where resistance has been identified.

Looking ahead

Phosphine will become increasingly important. Use of methyl bromide, the only other fumigant approved for use on grain in the UK, is to be strictly controlled. The cylinder-based formulation of phosphine is now undergoing UK registration.

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Action:

- Try to avoid the need to fumigate by cleaning and fabric treatment of the empty store, and drying, cooling and surface insecticide treatment of the grain (see Topic Sheet No 7).
- If there is a history of infestation in the store employ a BPCA-approved contractor to (prophylactically) fumigate the grain with phosphine.
- Monitor the bulk for insects and mites throughout the season.
- If infestation increases, minimise spread using a curative fumigation.
- New application technology means effective fumigation is possible - even of cooled grain.

Further information:
Project Reports 41, 105

Research Review 27

Project 0026/1/94

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