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PHOSCARD® PHOSPHINE FUMIGATION DETECTOR CARDS FOR FARMERS

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ABSTRACT

Western Australia exports around 80% of its annual grain harvest to markets that are becoming more discerning with respect to insect infestation and chemical residues. The state is well placed to meet these markets through its extensive use of phosphine (PH_3) fumigation both on-farm and in the central handling system. This marketing advantage is threatened by PH_3 resistance and safety issues attributable to ineffective on-farm fumigations.

Monitoring gas concentrations should be an important part of effective farm fumigation. Unfortunately currently available detection equipment is expensive to buy and maintain, requires calibration and is too sensitive for day-to-day farmer use. Recommendations that farmers pressure test storages to confirm gastightness are rarely carried out as it is considered difficult and, from a farmer perspective, bears little relationship to the actual fumigation.

Agriculture Western Australia have developed an extension tool, known as the Phoscard®, in the form of a credit-card style farm fumigation card which outlines key points for safe and effective PH_3 fumigation. The card has a copper indicator strip that corrodes and discolours after extended exposure to PH_3 concentrations of over 100 ppm.

These indicator cards will not replace accurate detection equipment; rather they are an extension tool outlining the key points to ensure a successful farm fumigation and "good/poor" means of evaluating the fumigation. Production cost is about US$ 0.70 each for runs of 10,000. Co-operative Bulk Handling (WA) have funded the initial run of 10,000 cards for free distribution to Western Australian grain growers. More information on the Phoscard is available from the Agriculture Western Australia Grain Pest Management website at:

http://www.agric.wa.gov.au:7000/ento/grain1.htm

INTRODUCTION

Demand for grain that is completely free of grain insects and chemical residues has been steadily increasing in international grain markets. Australia is well placed to meet this demand through its extensive use of fumigation in sealed storages and flow-through systems both on the farm and in the central handling system. In

Western Australia, sealed storage with phosphine (PH_3) fumigation has been widely adopted with over 60% of bulk handler storages sealed (6.4 million tonnes) (Burton, 1998). A similar percentage of farms are committed to this technology (Newman, 1994). This universal approach has enabled the entire Western Australian grain harvest to be exported since 1990 without the use of contact insecticides at any stage during storage.

There is, however, a serious element of risk. Western Australian research during the late 1970's identified the farm as being the source of most insecticide resistant strains and that these strains will eventually infest central storages (Dean, 1994). The widespread use of PH_3 on-farm in both sealed and unsealed storages could result in development of malignant strains that could subsequently find their way into central storages.

Phosphine resistance monitoring has been carried out in Western Australia since 1984 so that resistant strains can be detected and eradicated before control failures occur. This work has shown a slow but steady increase in the frequency of PH_3 resistance on farms, particularly in strains collected from unsealed and poorly maintained sealed storages. Clearly ineffective fumigations are selecting for widespread low-level PH_3 resistance on farms.

Extension campaigns have been implemented over the years to encourage farmers both to purchase sealed storages and to adequately maintain them. The former has been very successful to the point where all silo manufacturers in Western Australia exclusively produce sealed storages, however maintenance of those storages continues to be a problem along with continued fumigation in old unsealed units.

The current recommendation that farmers pressure-test storages to ensure gastightness is, unfortunately, rarely carried out because of the difficulty of getting pressurised air to storages, particularly field bins. Also we believe that, from a farmer perspective, the pressure-testing bears little relationship to the actual fumigation. There is an urgent need for farmers to begin to regularly measure gas concentrations so as to assure themselves that they have successfully controlled infestations. The GRDC supported National Phosphine Awareness project provides a unique opportunity to change the fumigation culture on farms and promote gas monitoring by farmers.

There is a wide range of mechanical and digital PH_3 detection equipment available, which provide the mainstay of the fumigation industry, however they have proved unsuitable for use by farmers. Currently available tube and hand-pump detectors are expensive for farmers to buy given the occasional use and ongoing need to purchase tubes. There is also some confusion regarding which end of the tube to insert, the number of pumps required, pumping technique and interpreting the scale on the tubes. Small amounts of dust entering the pump will adversely affect its operation.

Digital electrochemical detection equipment has simplified monitoring of PH_3 concentrations for bulk handlers, savvy farmers and researchers but they are

unsuitable to the average farmer because of their cost, sensitivity and need for regular calibration.

We saw a need for a simple PH_3 fumigation indicator suitable for farmers which would provide a "litmus paper like" assessment post-fumigation.

The corrosive effect of PH_3 on copper is well known with most fumigation manuals warning of the need to protect electrical equipment. Yokoyama *et al.*, (1993) used copper plates to evaluate fumigation of hay in freight containers.

We decided to develop a farm fumigation detector card based on a copper strip which would be simple to use, easy to read and, most importantly, cheap.

MATERIALS AND METHODS

Field trials were conducted in typically sealed and unsealed field silos of around 50 tonne capacity. These trials were conducted informally, in some cases by farmers, in an attempt to replicate characteristic use by non-technical workers.

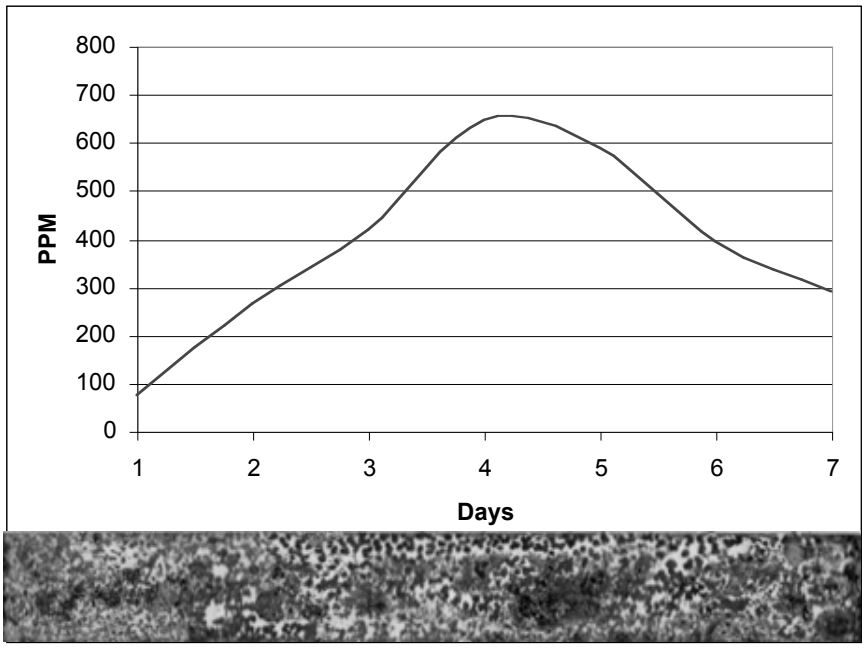

Fig. 1. Phosphine fumigation in Avondale sealed silo No. 2, (10 sec pressure decay half-life), lower band showing degree of corrosion on copper strip detector card.

Cards were located as far as practical away from the tablets, which were placed in aluminium oven trays on the grain surface. The cards were removed post-fumigation and the degree of corrosion on the copper strips photographed with a digital camera.

Copper strips were applied to plastic cards with printed instructions and background information making the detector-card a single unit.

Cards were manufactured from white polystyrene 85.5mm x 54.5mm x 1mm. The copper strip was 10 mm wide and covered with a transparent plastic tape to protect the copper from tarnishing during storage. The words "peel off" were printed on the protective tape. The front side of the card was printed in a two-colour process to save production costs while the back side was printed with a four-colour process to give an accurate representation of degrees of copper corrosion on the comparison strip adjacent to the copper. The 3 mm hole in the corner facilitates attachment of string for retrieval of the card.

RESULTS

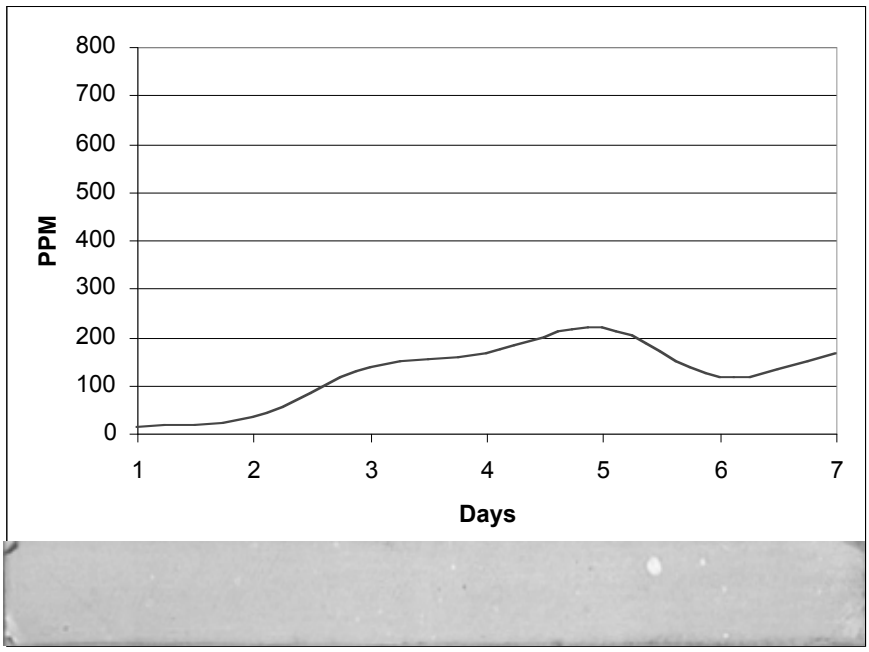

Fig. 2. Phosphine fumigation in Avondale sealed silo No.16, (0 sec pressure decay half-life), lower band showing degree of corrosion on copper strip detector card.

Fig. 3. Front side of the phosphine detector card.

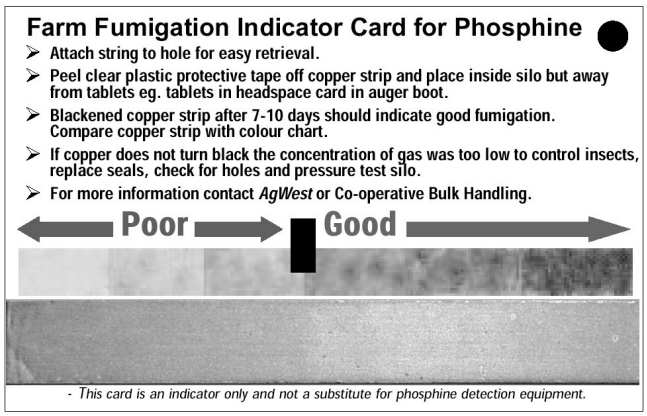

Fig. 4. Rear side of the phosphine detector card.

DISCUSSION

It is important to note that Phoscard® farm fumigation detector cards are intended as an extension aid targeting farmers, not a means of measuring fumigations. They will not replace existing gas detection equipment. The cards provide an *indication* of the quality of farm fumigations shown as "good" or "poor". They are of little use in the grain handling or pest control industry.

Phoscard® has been evaluated in over 20 different storages (Emery and Kostas, 2001). Typical results of a successful and an unsuccessful fumigation can be seen in Figs. 1 and 2 respectively.

The "Directions for Use" on the PH_3 label is well known for its complexity. The detector cards provide the means to distil those directions to five points and facilitate wide distribution of key messages in an eye-catching form.

Given our intention that the cards be used as an extension aid, the most prominent instructions on the card are how to conduct safe, effective farm fumigations (Fig. 3). Instructions for the use of the gas detection facet of the card are secondary (Fig. 4) but provide information regarding corrective action that can be taken when poor fumigations occur.

The detector cards have been manufactured to the same dimensions of a credit card. There is a copper strip along the bottom of the backside of the card to give the look and feel of a credit card. This gives a sense of familiarity and convenience to the cards, encouraging their use. They appear to remain in good condition indefinitely provided the protective tape remains intact. Phoscard's durability enables ease of storage so farmers can keep them in vehicle glove compartments or even their work-clothing pocket for ready use. If nothing more, the cards will generate discussion among farmers about fumigation issues and possibly encourage farmers to make contact with experts when the cards show that storages fail to give “good” fumigations.

Production costs are US$ 0.70 per card for a run of 10,000. Additional colours add around one to two cents per card. Co-operative Bulk Handling (WA) funded initial production of 10,000 Phoscard® which have been distributed to Western Australian grain growers throughout the state.

ACKNOWLEDGEMENTS

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