Such a system would actively move the fumigant through the grain, ensuring good distribution and removing the reliance on passive distribution, which can be inadequate in stores greater than 200t, even if fully sealed. Aeration provides the ability to control grain temperature so fumigation is applied to warm grain, which is then cooled. Reducing grain temperature after fumigation suppresses insect development, provided temperatures of less than 20°C, and finally less than 15°C, are achieved. As with fumigant distribution, all the grain within the store needs to be cooled to such temperatures for insect suppression to be effective.

It is expected that an integrated aeration and fumigation system will significantly reduce the variation in fumigant concentrations and temperatures, helping to ensure that all grain within the store receives the correct exposure time to the fumigant.

A feasibility study on developing an integrated aeration-fumigation system was completed in 2005. The benefits of such a system are detailed below. This study compared the cost of an integrated fumigation and aeration system against existing systems, mainly sealed or unsealed silos with aeration or systems with separate aeration and fumigation systems. The study established that an integrated system would cost between $0.50 and $1.50 per tonne of grain, if the total cost is amortised over the 10-year life of the system.

FOR PHOSPHINE TO REMAIN EFFECTIVE, BETTER APPLICATION TECHNIQUES ARE REQUIRED

BENEFITS OF THE INTEGRATED SYSTEM OVER THE STANDARD PASSIVE DISTRIBUTION OF PHOSPHINE IN SEALED STORES, OR STORES SOLELY FITTED WITH AERATION

- Fumigate effectively in the range of sealed silos typical of industry
- Faster complete fumigation (not partially fumigated leaving eggs etc)
- Can accommodate any initial grain temperatures
- Improves predictability and reliability
- Provides cooling after fumigation to prevent routine repeat fumigations
- Actual disinfestation of grain, not solely suppressing infestations

In 2006 the GRDC commissioned a project to develop an integrated aeration-fumigation system. This project now is being undertaken by the Cooperative Research Centre for National Plant Biosecurity (CRCNPB). The initial two years of the project focused on modelling the four 'rate' components of the fumigation process using phosphine and three other gaseous fumigation products. The four rate components are insect population mortality, fumigant distribution, grain temperature and fumigant sorption.

A key component was to define the mortality response of grain-storage insects exposed to phosphine under varying and non-continuous doses. This was partly done from the literature, but additional data was required and further experiments were conducted.

Based on the modelled data, an industrial-scale prototype integrated aeration-fumigation system is being developed and constructed in collaboration with an equipment manufacturer. It is planned to trial this prototype with 2008 winter crop wheat.

The developed system will enable phosphine to be applied according to label rates, allowing for differing grain temperatures and the required periods for purging grain of intergranular and desorbed phosphine. The phosphine label recommends treatment exposures of seven days for grain temperature "above 25°C", "10 days for 15°C to 25°C", and not fumigating when the temperature is less than 15°C. Following the exposure period ventilation is required to purge air and remove desorbed phosphine. Aeration systems reduce the ventilation period to one day, as described on the label. □

GRDC Research Code CRC50059
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Robots could keep resistance at bay

New tools are being developed to reduce reliance on prophylactic pesticide treatments, which provide short-term risk mitigation but increase resistance

BY DARRYL HARDIE

THE AUSTRALIAN GRAINS industry is highly reliant on the prophylactic use of phosphine and other grain protectants in bulk and farm grain stores to control insects. Inevitably this type of use results in more applications than may be required and multiple applications of the same product to the same parcel of grain. Such practices generate resistant populations of storage pest species.

The main reason for the prophylactic use of these products has been the inability, at numerous levels within the industry, to accurately determine the presence and population size of the target species within stored grains.

The current systems of manual sampling and visual detection of adult pests provides a very limited view of the whole storage. Coupled with ineffective and/or often inherently dangerous wired monitoring systems to measure fumigation levels in storages, the problem has been further compounded.

To address the use of prophylactic treatments as a means of risk mitigation, a new project has been initiated by the Cooperative Research Centre for National Plant Biosecurity (CRCNPB). The aim of this project is to develop wireless hardware systems and technology to monitor the presence of grain insects and fumigation levels within grain stores.

Acoustic, light, reflectance, temperature and pheromone sensors will be investigated. Embedded sensor networks and robotic samplers, which are potentially more cost-effective and likely to be able to penetrate large grain bulks, will also be investigated.

All these systems are innovative for the post-harvest grains industry and have the potential to remotely deliver accurate and safe information on the presence of grain storage pests and fumigant levels within grain bulks. The project runs until 2010 and progress will regularly be reported back to industry.

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Support for successful storage

Management of insect resistance to phosphine, the most widely used chemical associated with insect control, is a looming biosecurity and grain-hygiene issue for the industry. If the Australian grains industry is not able to control the spread of phosphine resistance to many of the common pests of stored grain, it runs the risk of damaging its reputation as an exporter of high-quality, insect-free grain, effectively reducing bargaining power for our produce.

The Grains Knowledge Network project is a new initiative from the Cooperative Research Centre for National Plant Biosecurity to develop a strategy to improve awareness of this issue and contribute to the management of phosphine resistance. This two-year project, which started in August 2008, aims to assess methods for delivering information to growers, including the impact this work has on changing the way growers manage phosphine resistance.

"In order to retain market access, in many situations on-farm practice needs to change and improve," says Plant Health Australia program manager Dr Sharyn Taylor.

"This project aims to quantify adoption of best management practice in relation to grain storage to identify if there are limitations in current knowledge-delivery programs and help demonstrate to the market that the Australian grains industry takes the issue of grain hygiene very seriously through the whole value chain."

This project will link with another new initiative from Plant Health Australia and the Grains Council of Australia called the Grains On-Farm Biosecurity Program. Within this program, grains biosecurity officers based in Western Australia, South Australia, Victoria and Queensland will deliver information to growers on the risks associated with the introduction and spread of new pests. These officers will also provide information on practical methods for improving farm biosecurity.

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Delivering information to growers on managing all aspects of grain storage is part of the objectives of the Grains Knowledge Network project.