IT'S ALL IN THE SEAL

By **Gio Braidotti**

PHOTO: NICOLE BAXTER

Doug Clarke, Lake Grace, WA, checks the oxygen content of his silos using a handheld meter.

REPLACING OXYGEN IN grain storage silos with nitrogen has proven an effective way to remove insects at all stages of their life cycle, leaving stored grain – be it wheat or canola – preserved, residue-free and subject to no withholding periods.

Nitrogen is also the preferred storage option, says Western Australia grower Doug Clarke, who is the earliest adopter of the technology in its on-farm form.

Mr Clarke made the switch five years ago on his Lake Grace property, and has made his silos available to Murdoch University researchers led by stored-grain expert Professor YongLin Ren, with support from the GRDC.

Mr Clarke has hosted visitors over the years, including overseas buyers, and says he has learnt the extent to which insecticide-free grain is preferred by buyers.

While he says the system is performing well, he is committed to continuous improvement.

However, one challenge is that there is currently no price signal favouring residue-free grain to compensate for the investment and the extra work associated with nitrogen-based storage.

In relation to the technology itself, Mr Clarke has no issue with existing oxygen-purging systems. He says the nitrogen generator needed to purify nitrogen from the atmosphere and pump it into a silo is a machine developed by the oil industry, which is widely available.

"At a rate of 30 cubic metres an hour, it costs about $5 worth of diesel to purge a silo of oxygen all the way down to 0.05 per cent total content," he says. "Best of all, insects never acquire resistance."

Another challenge relates to infrastructure: silos leaking.

"The standards for sealed silos are too low for nitrogen storage of grain," Mr Clarke explains. "The accepted level on the seals for a silo is the loss of half an inch (12.7 millimetres) of water pressure in three minutes."

The oxygen in the silo needs to be purged long enough to kill all insects. Mr Clarke has identified a relationship between eradication time (for all stages in an insect's life cycle) under nitrogen and grain temperature.

The eradication time is as low as one week at high temperatures, at 20ºC it blows out to three weeks, and below that temperature he says it does not work.

It is these circumstances that have created resistance to insecticides and an interest in the latest sealing technology.

"What I am saying is that the better the seal, the better control you have under any fumigant. We need to be looking to the latest sealing technology, including polymers and 3D printers," he says. "The area that now needs improving is the silo manufacturing." □

GRDC Research Code NPB00013

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RESEARCH TESTED

By **Rebecca Jennings**

GRDC-FUNDED RESEARCH THOUGH the Plant Biosecurity Cooperative Research Centre (CRC) is being put to the test by growers and bulk handlers at five sites across Australia.

Plant Biosecurity CRC grains coordinator Dr David Eagling says the impact sites are a partnership with industry to work through implementation issues. Each site has different industry partnerships and a different focus:

- in central New South Wales, the impact site at the GrainCorp facility in Temora focuses on testing a new paint-based product to control storage pests;
- in southern Australia, research at the Viterra facility at Bowmans, South Australia, includes insect monitoring to complement Plant Biosecurity CRC investments in grain insect ecology;
- in the west, the focus has been at the CBH facilities at the grain port of Kwinana, where the team has been putting low-oxygen/nitrogen technology through its paces;
- in the northern Western Australian grain region, the impact site is a partnership with the Mingenew–Irwin Group (MIG), with various activities located directly on grower's farms (a particular focus over the past 18 months has been the deployment of aeration technology developed jointly by the GRDC and the Plant Biosecurity CRC); and
- in southern Queensland, the site has been a partnership with GrainCorp with an assessment of sulfuryl fluoride across various locations.

"The Plant Biosecurity CRC is conscious that research needs to be implemented into existing grower and bulk-handler processes and management to be successful," Dr Eagling says.

"We are working on the best way to do this, as well as looking at the benefits of bringing together multiple research findings that can be integrated in a systems approach, rather than each one in isolation.

"The industry impact sites assess how a range of research outcomes fit together in the day-to-day operations on-farm, at ports and in bulk-handling facilities."

He says the impact sites provide researchers with a central point for field testing and involve growers and bulk-handlers in deciding what research to test and how to go about evaluating the research findings.

SEARCH CONTINUES FOR PHOSPHINE ALTERNATIVES

By **Catherine Norwood**

IT SEEMS UNLIKELY there will be a single solution to replace the highly effective phosphine. Rather, a suite of alternatives will be required, applied with tactical precision to extend the life of phosphine and maintain Australia's export commitment of nil live insects in grain shipments. Nitrogen seems likely to play a major role as a phosphine alternative, with field trials at bulk storages and on-farm underway this year (see page 3). Another controlled-atmosphere strategy being investigated is the use of ozone.

OZONE APPROACH

As with nitrogen, ozone – or O_3 (as compared to oxygen gas O_2) – has been recognised for decades as an effective way to kill stored-grain insects. Although Murdoch University's Professor YongLin Ren, who leads several phosphine-alternative research projects for the Plant Biosecurity Cooperative Research Centre (CRC), says the technology is not new. Technical advances mean it could be an accessible and viable treatment.

The ozone research is being undertaken through the Plant Biosecurity CRC's partner Kansas State University in the US.

When O_3 is applied at a rate of 200 parts per million in laboratory trials, it kills all stages of strongly resistant stored-grain insects within two days.

Professor Ren says field trials using O_3 as a treatment in small-scale farm storages are likely to be held within the next six months. Other trials are planned to evaluate ozone in combination with nitrogen.

SULFURYL FLUORIDE

GRDC-supported research through the Plant Biosecurity CRC and led by Associate Professor Paul Ebert at the University of Queensland is focusing on the synergistic or additive effects of various chemical combinations.

Sulfuryl fluoride is an alternative that provides a resistance-breaker effect in the bulk-grain-handling system for the treatment of strongly resistant rusty grain beetles (*Cryptolestes ferrugineus*). However, it is more expensive than phosphine and has restrictions on its use to prevent residue issues. Professor Ebert says the combination of phosphine and sulfuryl fluoride is showing promise as a way to control insects in a suitable timeframe at reduced cost. He says 100 per cent control of all life stages of rusty grain beetle has been achieved with one-third of the concentration of phosphine combined with half the dose of sulfuryl fluoride needed when either is used alone.

A sublethal dose of the botanical pesticide dimethyl disulphide (DMDS) makes phosphine 10 times more effective against strongly resistant lesser grain borer.

Several other gases and volatile compounds that enhance the activity of phosphine in a variety of ways are also being investigated. Victorian researcher Dr Ross Mann is examining the potential of volatiles from fungi as part of the Plant Biosecurity CRC work. Endophytic fungi live symbiotically with their host plants and emit volatiles to protect the plants from insect pests. Strains of fungi have been identified that produce volatile chemicals capable of killing the lesser grain borer, red flour beetle and rusty grain beetle.

SILICA POTENTIAL

The Plant Biosecurity CRC is investigating silica as a contact protectant for stored-grain insect control. Several synthetic silica compounds are being assessed and initial laboratory trials have identified compounds that provide strong control against key grain pests within 10 days. Field validation is now underway, with results showing possible competitive advantages for the silica compounds in price and efficacy.

The Plant Biosecurity CRC is also working on two possible market opportunities. One is the use of silica compounds as an admixture in grain flows. The other is as a structural treatment where the silica product acts as a barrier to insect movement when applied to both external and internal surfaces of structures used for the bulk storage of grains. □

GRDC Research Code NPB00013
Plant Biosecurity CRC Codes 3114, 3099
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"This allows the researchers, as well as the end users of the research, to see how different strategies or technologies interact with other activities and to identify any barriers to adoption, such as time or cost."

BULK-HANDLER

GrainCorp grain protection manager Robin Reid says the bulk-handler has been involved in trials to assess the impact of phosphine and sulfuryl fluoride when applied at different concentrations and over different fumigation periods as part of the industry impact work.

"If the grains industry is to maintain the use of phosphine, we need to look for alternative products and think carefully about the destination of grain to ensure delivery into markets is below the maximum residue limits," he says.

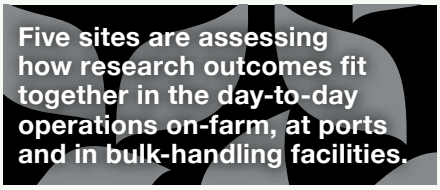
"It's important to support this research, as the industry relies on scientific data for products to be registered and accepted in the marketplace. Without research which responds to challenges facing the industry we would run out of pest-control options."

GROWERS

Growers involved in the Mingenew–Irwin industry impact site are accessing research tailored to their challenges, such as managing residue and resistance.

MIG executive officer Sheila Charlesworth says the benefits to growers from participating in an impact site are enormous.

"It ensures the end users of research can play a part in how this research is delivered, for maximum impact on-farm. Our growers are experiencing the research outcomes firsthand," Mrs Charlesworth says. "It has also given our growers access to the Plant Biosecurity CRC's extensive collaborative network of researchers and organisations around Australia and overseas.



"As a result of this research, we are seeing growers extend power to their storage sites for aeration and show increasing interest in alternative non-chemical pest-control products such as nitrogen." □

GRDC Research Code NPB00013
Plant Biosecurity CRC Code 3076
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