Knowing the problem is half the battle

KEN BULLEN* EXPLAINS HOW INSECT RESISTANCE IS BUILDING, AND THE STEPS BEING TAKEN TO KEEP SCIENCE AND ON-FARM PRACTICES ON TOP OF THE PROBLEM

INSECT RESISTANCE TO phosphine and protectant insecticides is emerging as a serious threat to Australia's grains industry.

The GRDC has been sponsoring an Australia-wide program monitoring this resistance to ensure the industry is not caught without adequate means of dealing with storage insects.

The GRDC 'Resistance Monitoring' project is led by Dr Pat Collins, Queensland Department of Primary Industries and Fisheries, Brisbane (northern region), Dr Rob Emery, WA Department of Agriculture (western region), and Dr Joanne Holloway, NSW Department of Primary Industries, Wagga Wagga (southern region).

The project covers Australia's grain regions in a cooperative program that is resistance-testing insect populations in grain storages on farms, in merchants' premises and in bulk-handling facilities.

Dr Collins says the development of insect resistance has been caused by several factors:

- Fumigating in unsealed silos, resulting in under-dosing with phosphine, in farm, merchant and bulk-handling storages. This results in frequent exposure of insect populations to sub-lethal dosages, allowing individuals with a new resistance gene to survive treatment and continue breeding, passing on their resistance. Repeat fumigations favour the insects that have the resistance gene by allowing them to survive, but kill normal susceptible insects.
- Repeat treatments with protectant insecticides in the same chemical family, such as organophosphates (for example, fenitrothion, methyl-chlorpyrifos, pirimiphos-methyl, dichlorvos) or synthetic pyrethroids (for example, bioresmethrin).
- Under-use of other important insect control measures, such as maintaining strict hygiene in and around all grain handling and storage facilities and moisture and temperature management in stored grains to reduce insect populations.

Each year, researchers visit hundreds of farms, grain merchants and bulk-handling sites in each grain region. Insect specimens are taken at each site and the insects are then bred under controlled conditions in a laboratory. These insects are then exposed to a battery of protectant insecticide and phosphine tests. The program has been running since the early 1990s.

THE TRENDS THAT HAVE EMERGED ARE:

- Phosphine resistance: the frequency of strong resistance to phosphine is increasing in four of the five major insect pest species. This resistance was first detected in 1997. About five per cent of insect populations contain individuals with this strong resistance, which occurs throughout eastern Australia but has not yet been detected in the western grain region. The highest level of resistance occurs in the lesser grain borer (LGB) *Rhyzopertha dominica,* and we have based our new recommendation for use of phosphine on this LGB resistance.
- Protectant insecticides resistance: frequency of strong resistance to protectant insecticides is increasing. The current status of pest resistance to protectants is summarised in the table below.

MANAGING RESISTANCES 'ON-FARM'

- Adopt an Integrated Pest Management (IPM) approach to grain insect control, by close management of moisture content and temperature of grain in storage – the cooler and drier the grain, the less insects like it.
- By maintaining strict hygiene standards in grain handling equipment and storage facilities. These non-chemical pest management components greatly reduce the threat from insects and take pressure off protectant insecticides and fumigants in the overall pest management program.
- Use phosphine appropriately. It is simply impossible with an unsealed storage to ensure adequate phosphine concentration and exposure time for killing all stages of the insect pest's lifecycle. Some of these are concealed within the individual grains and are thus less susceptible to phosphine, unless it is used properly. There is also no chance of killing resistant insects. Even though the grain industry has to cope with strong phosphine resistance, Australian research has shown that resistant insect populations can be controlled in sealed storages.

Investment in sealed, aeratable storages is essential for today's graingrower who is storing more grain for longer periods on-farm.

- Researchers must strive to identify and test new chemical treatments.
- Limit insect populations by appropriate management of grain moisture and temperature using aeration and/or hot air drying while in storage.

The frequency of strong resistance to phosphine is increasing in four of the five major insect species throughout eastern Australia

Phillip Taylor carries out laboratory testing of grain storage insects for pesticide resistance from hundreds of sites, as part of a GRDC-funded project 'Resistance Monitoring'.

THE FUTURE

Based on Australian and overseas experience, resistances can be expected to become more serious and widespread. Scientists are trying to improve their understanding of the mechanism of resistance development using the latest biotechnology. With grains industry support through GRDC, the University of Queensland's Dr Paul Ebert ('Markers for Phosphine Resistance' project UQ00010) is searching for a 'rapid test' for phosphine resistance.

We would like to retain phosphine as a principal fumigant for the foreseeable future because of its low cost, its ease of use and its acceptance by all markets. There is no ready alternative. We will see wider investment by the grains industry in sealed, aeratable silos to improve the effectiveness of phosphine use.

The Australian grains industry will adopt a 'Food Production' ethos in the management of grain production and marketing. There is a already a widespread trend overseas towards 'identity preservation' and Quality Assurance. We will continue to investigate and develop new fumigants and protectant insecticides for industry adoption. For example, the biological insecticide compound spinosad has been recently researched and developed as a new 'green' protectant insecticide for the control of LGB. A new fumigant, 'Vapormate' (ethyl formate and CO^2 mix) is under development by BOC and CSIRO. Other fumigants are also being investigated, but are expected to be more expensive and more complex to apply than phosphine products.

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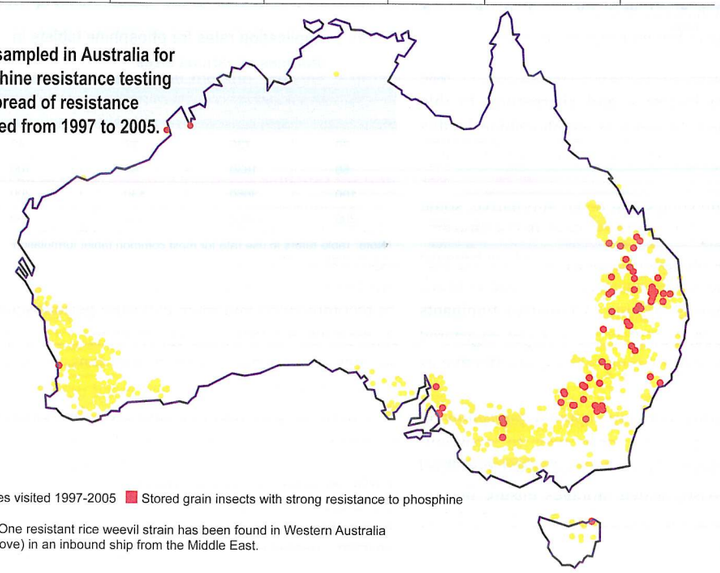
Occurrence of resistance to commonly-used protectant insecticides in Australia

Protectant Insecticide	Sawtooth grain beetle	Lesser grain borer	Rice weevil	Rust-red flour beetle	Moths
Pirimiphos-methyl (eg, Actellic 900)	Resistance common	Not effective	Rare	Rare	None
Fenitrothion (eg, Fenitrothion 1000)	Resistance common	Not effective	Rare	Rare	None
Chlorpyrifos-methyl (eg, Reldan)	Resistance common	Not effective	Rare	Rare	None
Methoprene (eg, IGR, Diacon)	None	Increasing	Not effective	None	Not effective
Dichlorvos (eg, Dichlorvos 500, DDVP)	None	Common	None	None	None
Spinosad (eg, Conserve® Grain Protectant Insecticide to be released 2006-07)	Not effective	None	Not effective	None	None

Sites sampled in Australia for phosphine resistance testing and spread of resistance detected from 1997 to 2005.



Sites visited 1997-2005 Stored grain insects with strong resistance to phosphine

Note: One resistant rice weevil strain has been found in Western Australia (as above) in an inbound ship from the Middle East.

PHOTOS: DEPARTMENT OF AGRICULTURE WA

From top, rust-red flour beetle, lesser grain borer and sawtooth grain beetle.