STORED GRAIN PESTS
FACT SHEET

GRDC Grains Research & Development Corporation

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CAUTION: RESEARCH ON UNREGISTERED PESTICIDE USE

Any research with unregistered pesticides or of unregistered products reported in this document does not constitute a recommendation for that particular use by the authors or the authors' organisations. All pesticide applications must accord with the currently registered label for that particular pesticide, crop, pest and region.

NORTHERN AND SOUTHERN REGIONS

Attention to detail needed for successful grain storage

The tolerance for live storage pests in grain sold off-farm is nil. With more grain being stored on-farm, growers can obtain best results by using a planned, integrated approach to pest control.

KEY POINTS

- To maintain pest-free stored grain in a condition required for feed, processing or seed, growers need to:
  - make full use of good hygiene and aeration cooling;
  - identify pest incursions earlier through monthly monitoring;
  - select the correct storage treatments; and
  - apply stored grain treatments correctly.

Managing grain storage

Generally, the combination of good hygiene plus well-managed aeration cooling, overcomes 85 per cent of storage pest problems. When fumigation is needed it must be done in pressure-tested sealable silos.

For grain storage, three key factors provide significant gains for both insect pest control and grain quality.

Hygiene

The first grain harvested is often at the greatest risk of early infestation due to contamination. One on-farm test found over 1000 lesser grain borers in the first 40 litres of wheat that passed through the harvester. Therefore, cleaning-up grain residues in empty storage and grain handling equipment, including harvesters, field bins, augers and silos provides a safe start for the new season's grain. Clean equipment by blowing or hosing out residues and dust, and then consider a structural treatment (See Table 1, page 2).

Aeration

Freshly harvested grain usually has a temperature around 30°C, which is an ideal breeding temperature for storage pests. Deal with high moisture grain promptly by aerating, blending or drying.

Aeration fans fitted to stores can rapidly reduce grain temperatures. Studies have shown that rust-red flour beetles stop breeding at 20°C, lesser grain borer at 18°C and below 15°C all insects stop breeding. Aim for grain temperatures of less than 23°C in summer and less than 15°C in winter. Aerate grain as soon as it is placed into storage. For reliable results use an automatic controller to run fans.

Storage choices

When buying a new silo, purchase a quality, sealable silo fitted with aeration, and check with the manufacturer that it meets the Australian Standard for sealable silos.

Experience has shown that at least two sealable, aerated silos on farm provide the option for effective fumigation and delivery program.

Fumigation in unsealed or poorly sealed silos leads to the selection of resistant insects in stored grain. Many older silos were not designed to be sealed and cannot be used for fumigation, however fitting them with aeration can reduce insect multiplication through grain cooling.

PHOTO: P. BURRILL

Good hygiene, aeration, silo location and colour can all help minimise the potential for pest infestation of stored grain.

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Storage and treatment notes

Cereal grains

Buyers and bulk handlers are changing their acceptance of grain treated with insecticides. Before using a grain insecticide, always check with your potential grain buyers and bulk handlers (depot) for market acceptability. Identify storage pests before selecting a treatment. Always follow label instructions carefully.

Seed held on farm (cereals - wheat, barley, oats)

Seed that is dry, cool and sound (that is, not weather damaged) will remain viable for longer. In well-managed storage, germination percentage should be above 95 per cent after six months. To achieve this, grain moisture content (mc) should be below 12 per cent.

Grain temperature also has a major impact on germination. Aim for grain temperatures of 20°C and below in seed storage by using aeration (with auto control). Wheat at 12 per cent mc stored at 30°C (too warm) had less than 70 per cent germination after six months. Position small seed silos in the shade or paint them reflective white to assist in keeping grain cool.

For insect control, treating seed with a grain protectant in combination with aeration cooling is recommended.

Pulse and oilseeds

Insect control options are limited for stored pulses and oilseeds. Dichlorvos and grain protectants are not registered for use on these grains. Phosphine fumigation and controlled atmosphere may be an option. The effectiveness of phosphine fumigation on oilseeds is often reduced due to phosphine sorption during treatment.

As limited chemical options are available, use good hygiene in combination with aeration cooling to reduce insect activity. Small seed-size grains like canola may need large-size aeration fans on stores. Always store these grains at their recommended grain moisture content level.

Fumigation

Read labels and only carry out fumigations in suitable gas-tight, pressure-tested grain stores. For effective phosphine fumigation, a minimum of 300 parts per million (ppm) gas concentration for seven days or 200ppm for 10 days is required. Gas will leak out very quickly from unsealed storages, resulting in poor insect control on all life-cycle stages (eggs, larvae, pupae and adults). Poor fumigations also increase the populations of resistant insects.

As a general rule, only keep a silo sealed while conducting the fumigation (for example, one to two weeks). After fumigation has been completed, return to aeration cooling to hold the stored grain.

TABLE 1 RESISTANCE AND EFFICACY GUIDE FOR STORED GRAIN INSECTS 2009 – CEREAL GRAINS SEPTEMBER 2009 (NORTHERN AND SOUTHERN GRAIN PRODUCTION REGIONS). BEFORE APPLYING – CHECK WITH YOUR GRAIN BUYERS / BULK HANDLERS AND READ LABELS CAREFULLY

TREATMENTS	WHP (days)	 Lesser grain borer (*Rhyzopertha dominica*)	 Rust-red flour beetle (*Tribolium castaneum*)	 Rice weevil (*Sitophilus oryzae*)	 Saw-tooth grain beetle (*Oryzaephilus surinamensis*)	 Flat grain beetle (*Cryptolestes ferrugineus*)	 Psocids – Booklice (*Order Psocoptera*)	 Structural treatments
Grain disinfectants – used on infested grain to control full life cycle (adults, eggs, larvae, pupae).								
Phosphine (eg Fumitoxin®)[1,3] when used in gas-tight, sealable stores	2							
Dichlorvos (eg Dichlorvos 1140®)	7–28							[9]
Grain protectants – applied post harvest. Poor adult control if applied to infested grain.								
Pirimiphos-methyl (eg Actellic 900®)	nil							
Fenitrothion (eg Fenitrothion 1000®)[4]	1–90							
Chlorpyrifos-methyl, eg Reldan Grain Protector®)[5]	nil							
Methoprene (Grain Star 50®)	nil[6]		[7]		[7]			
"Combined products" (eg Reldan Plus IGR Grain Protector)	nil[2]							
Diatomaceous earth, Amorphous silica – effective internal structural treatment for storages and equipment. Specific use grain treatments.								
Diatomaceous earth, Amorphous silica (eg Dryacide®)[8]	nil[2]							

KEY

WHP Withholding Period ☐ Not registered for this pest ☐ High-level resistance in flat grain beetle has been identified, send insects for testing if fumigation failures occur ☐ Resistant species likely to survive this structural treatment for storage and equipment ☐ Resistance widespread (unlikely to be effective) ☐ Effective control

1 Unlikely to be effective in unsealed sites and causing resistance, see label for definitions **2** When used as directed on label **3** Total of (Exposure + Ventilation + Withholding) = 10 to 27 days **4** Nufarm label only **5** Stored grains except malting barley and rice/ stored lupins registration for Victoria only/ not on stored maize destined for export **6** When applied as directed, do not move treated grain for 24 hours **7** Periods of 6–9 months storage including mixture in adulticide, eg Fenitrothion at label rate **8** Do not use on stored maize destined for export , or on grain delivered to bulk-handling authorities **9** Dichlorvos 500g/L registration only

Notes: Other grain treatments are restricted to: Licensed fumigators: Ethyl formate eg. Vapormate® fumigant. Trained fumigators: Sulfuryl fluoride eg. Profume® gas fumigant.

SOURCE: Registration information courtesy of Pestgenie, APVMA and InfoPest (QPI&F) websites

GRAIN STORAGE PESTS – IDENTIFICATION

To maintain grain quality and to select the correct treatments, identify pests early by sampling monthly. Sieving samples from the top and bottom of stores is needed to detect insects at low numbers.

Construct or purchase a grain temperature probe (1.8m long), grain spear and grain insect sieve. Sieve onto a white tray to see small insects. Holding the tray in the sunlight warms the insects and encourages movement. (See Useful resources).

Note: Temperatures that influence life cycle and breeding relate to stored grain and not air temperature.

LESSER GRAIN BORER (*Rhyzopertha dominica*)

- A very serious pest of most stored grains.
- Dark brown cylindrical beetle (3mm long) with mouth parts and eyes only visible from the side.
- Adult beetles are strong flyers and live for 2–3 months.
- Females lay 200–400 eggs on grain surface. Breeding ceases below 18°C.
- Young larvae (white with brown heads) initially feed outside then bore into grain.
- Life cycle completed in 4 weeks at 35°C and 7 weeks at 22°C.
- Aeration cooling is effective in reducing activity and breeding.
- Their habit is to remain hidden in grain. Sieving required for detection.

PHOTO: QPI&F

RUST-RED FLOUR BEETLE (*Tribolium castaneum*)

- Common pest of stored cereal grain, processed grain products, oilseeds, nuts and dried fruit.
- Adult beetles reddish-brown (3–4.5mm long) with club-shaped segments on antennae ends.
- Adults live from 200 days to 2 years and fly under warm conditions.
- Will infest sound grain, but breeds more successfully on processed products.
- Up to 1000 eggs/female, loosely scattered through the commodity.
- Cream-coloured larvae feed externally on damaged grain and cereal dust.
- Life cycle completed in 4 weeks at 30°C, 11 weeks at 22°C and stops below 20°C.
- Similar species: *Tribolium confusum* – confused flour beetle, more common in cool, temperate regions.

PHOTO: QPI&F

SAWTOOTH GRAIN BEETLE (*Oryzaephilus surinamensis*)

- Infests cereal grains, oilseeds, processed products, peanuts and dried fruits.
- Fast moving, dark brown-black beetle (3mm long) with characteristic saw-toothed pattern on each side of thorax.
- Adults move rapidly over stored grain and fly under warm conditions. They may live for several months.
- Females lay 300–400 eggs loosely throughout commodity.
- White, flattened larvae feed and develop externally but are hard to see.
- Preference for damaged or processed grain to establish in significant numbers
- Life cycle completed in 3 weeks at 30–33°C, 17 weeks at 20°C, stops below 17.5°C

PHOTO: QPI&F

FLAT GRAIN BEETLE (*Cryptolestes* spp.)

- Infests most stored grain feeding on damaged grain.
- Small, flat and fast moving reddish-brown beetles (2mm long) with long antennae.
- Adults fly readily and can live for several months.
- Females lay up to 300 eggs loosely in commodity.
- Larvae, with characteristic tail and horns, feed and develop externally on damaged grains.
- Life cycle completed in 4 weeks at 30–35°C with moist conditions, 13 weeks at 20°C, stops at 17.5°C.
- There are several closely related *Cryptolestes* species with similar appearance and habits.
- A strain of flat grain beetle has developed high phosphine-resistance. Insects surviving fumigation should be tested for resistance.

PHOTO: QPI&F

RICE WEEVIL (*Sitophilus oryzae*)

- Major pest of whole cereal grains.
- Small (3–4mm long) dark brown-black weevil with a long 'snout' and four light spots on back.
- Adults live 2–3 months, do not readily fly but climb vertical surfaces eg. glass jar.
- White larvae generally not seen as they feed and develop inside single grains.
- Life cycle completed in 4 weeks at 30°C, 15 weeks at 18°C, stops below 15°C.
- Similar species: *Sitophilus zeamais* – maize weevil, and *Sitophilus granarius* – granary weevil.

PHOTO: QPI&F

PSOCIDS (*Liposcelis* spp.), BOOKLICE

- Infests a wide range of grains and commodities.
- Considered a secondary pest, feeding on damaged grain and moulds.
- Very small (1mm long) usually, appears as a 'moving carpet of dust' on grain or storage structures.
- Eggs laid on grain surface, hatching to nymphs that moult through to adult stage.
- Thrives under warm, moist conditions – optimum 25°C and 75% relative humidity. Life cycle 21 days.
- Three main species of Psocids in Australia, often in mixed populations. Some can fly.

Examples of grain sieves

PHOTO: P. BURRILL

- Sieving is the most effective method of collecting grain pests.
- Grain sieves need to hold at least half a litre of grain.
- Collect samples from the top and base of the silo.

EXOTIC PESTS
Be on the lookout for anything unusual

The following pests have the highest potential impact on the value of stored grain if they were to establish in Australia.

If you see anything unusual, report it to your local state department of agriculture or ring the Exotic Plant Pest Hotline.

EXOTIC PLANT PEST HOTLINE
1800 084 881

KARNAL BUNT (*Tilletia indica*)

PHOTO: PaDIL

- Not present in Australia.
- Can infect wheat, durum and triticale.
- Usually only part of each grain is affected. Infected stored grain will have a sooty appearance and will crush easily, leaving a black powder.
- Infected grain often has a rotten fish smell, flour quality is seriously reduced.
- Symptoms are similar to common bunt.

KHAPRA BEETLE (*Trogoderma granarium*)

PHOTO: WWW.FORESTRYIMAGES.ORG

- Not present in Australia.
- Attacks most stored grains.
- Adults have wings but do not fly.
- Larvae are covered in fine hairs.
- Looks identical to the warehouse beetle to the naked eye.
- Causes yield loss through grain consumption.
- Larvae skins contaminate grain and cause allergies on consumption.
- Phosphine fumigation is not very effective.

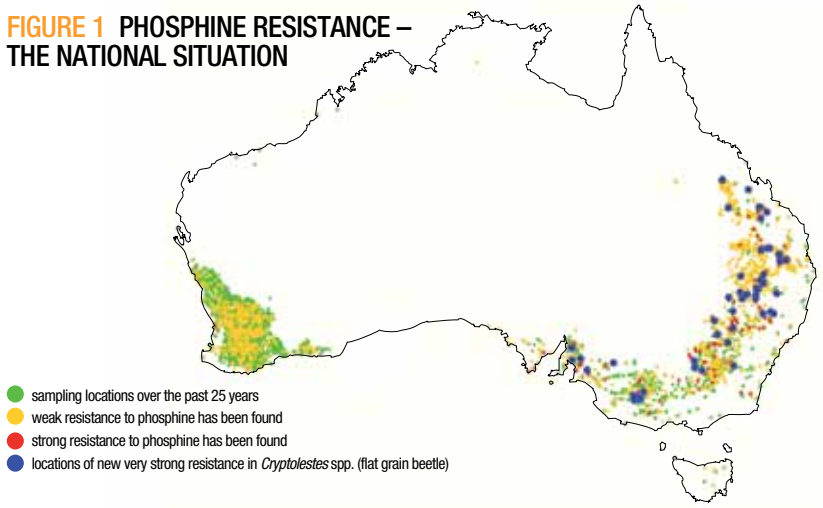
PHOSPHINE-RESISTANT INSECT STRAINS

- A range of stored grain insects are becoming resistant to phosphine fumigations.
- Threatens exports, as live insects remain in grain after fumigation.
- Poor fumigation practices increase resistance.
- Strong phosphine-resistance found in some overseas countries.
- Live insects remaining in storage vessels following fumigation should be tested for resistance.
- Resistant insects can fly between stores or be transported in machinery.

Phosphine resistance is widespread – plan, monitor, control for clean grain

- Dispose of grain residues and seed grading. Clean empty storage, grain handling equipment, including harvesters, field bins and augers.
- Stored grain should be sieved for the presence of insects at least monthly. Also check grain temperature and moisture.
- During winter storage, if grain temperature has been kept at less than 15°C by aeration live insect numbers are likely to be very low.
- Grain should be sampled three weeks prior to sale to allow time for any treatment.
- For effective fumigations, pressure test sealable silos at least once a year to identify any leaks and ensure they are maintained gas-tight.
- Take care when climbing silos to sample grain for insects and wear a safety harness. Sample from the base, and if safe, take a sample from the surface of the grain.
- Sieve a half litre sample onto a white tray. Hold tray out in sunlight to warm for 20 to 30 seconds to encourage insect movement.
- If live insects are found, identify them. Select the appropriate treatment for the grain type and insect. Check labels.
- Phosphine fumigation typically requires 7 to 10 days in a gas-tight sealed silo. When completed, open silo top with care, ventilate using aeration fan for 12 to 24 hours; the withholding period is then two additional days. If not aerated, open silo top and ventilate for five days.

FIGURE 1 PHOSPHINE RESISTANCE – THE NATIONAL SITUATION



Useful resources:

Grain storage specialists	
QLD, Philip Burrill	**07 4660 3620 Email Philip.Burrill@deedi.qld.gov.au**
VIC and TAS, Peter Botta	**0417 501 890 Email peter.botta@nre.vic.gov.au**
WA, Chris Newman	**0428 934 509 Email chris.newman@agric.wa.gov.au**
Grains biosecurity officers	
SA, Judy Bellati	**08 8303 9670 Email Bellati.Judy@sa.gov.au**
QLD, Philip Burrill	**07 4660 3620 Email Philip.Burrill@deedi.qld.gov.au**
VIC and TAS, Jim Moran	**03 5430 4479 Email Jim.Moran@dpi.vic.gov.au**
WA, Lisa Sherriff	**0447 851 801 Email lsherriff@agric.wa.gov.au**
***Crop Insects: the Ute Guide* – southern grain belt edition**	**Ground Cover Direct, 1800 11 00 44**
***Crop Insects: the Ute Guide* – northern grain belt edition**	**Ground Cover Direct, 1800 11 00 44**
Plant Health Australia	**www.planthealthaustralia.com.au**
Grain Trade Australia	**www.nacma.com.au**
Graintec Scientific	**07 4638 7666, www.graintec.com.au**
Insects of stored grain: a pocket reference	**CSIRO publishing, www.publish.csiro.au**

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