Heat — an alternative method to control grain insects

Heat provides a rapid, non-chemical alternative to fumigation for control of stored-grain insects. The concept of heating grain to control insect pests is not new. During the First World War, stored wheat was heated to 58–60°C for at least 3 minutes as an insect control strategy. A continuous-flow machine was used and wheat was circulated over steam-filled pipes. The mean residence time within the machine was 15 minutes at an average throughput of 28 t/h. In the early 1900s, several food-processing companies in the United States used heat to control pests.

The Australian grain industry needs to develop alternatives to chemical methods of grain preservation and pest control. Fumigation and grain protectant applications are the most common and immediately available methods for insect control. More than 80% of the Australian cereal, oilseeds and pulse crop is treated with the fumigant phosphine to control infestations. A declining proportion is treated with residual chemical protectants. Increasing market preference for residue-free grain, development of high-level insect resistance to phosphine, and the current phase-out of methyl bromide (MeBr), currently used for rapid disinfestation of grain, are all reasons supporting the need for research and development in heating technology.

It is worth asking: "What technology will be available for rapid grain disinfestation when MeBr is phased out in 2005?" Heat disinfestation, in one or more forms, is likely to be widely used in the grain industry within the next 10 years, particularly in an integrated approach to grain protection. Three different approaches to insect disinfestation using heating technology are described in this article.

Using a steam generator to add water vapour into hot air steam during thermal disinfestation.

Photo: Julie Cassells

Fluid-bed heat disinfestation

Hot-air convection heating in a fluidised bed was first studied in Australia in 1978. The disinfestation process involved rapid heating followed by rapid cooling to safe handling and storage temperatures. In a fluidised bed, the grain passes at a predetermined flow rate across a sloping metal plate perforated with holes of specified diameter and orientation. During flow of grain across the fluidised bed, the grain is heated to a predetermined temperature that kills all developmental insect stages, including the larval and pupal stages of those species that develop inside grain kernels.

The effectiveness of different heat treatment regimes is influenced by the target temperature, exposure time, insect species and their age-structure, and initial grain temperature and moisture content. The lesser grain borer and grain weevils are the most heat-tolerant species of stored-grain pests. Studies show that grain flowing at 360–500 kg/h at a depth of 100–250 mm across a fluidised bed, with an inlet air temperature of 80–90°C, is completely disinfested within 3 minutes.

Susceptibility of grain to heat damage varies considerably, and is influenced by grain type and by moisture content at the time of heat treatment. Both physical and biochemical damage of the grain can result from rapid heating. It is important to choose a disinfestation strategy that will achieve control of the insect pests without reducing grain quality. Dry grain is more tolerant of the effects of rapid heating. The majority of grain harvested and delivered into central storage in Australia is received at moisture contents below 12.5%. The dryness of grain at the time of harvest makes an in-line rapid disinfestation technique, such as fluidised-bed technology, a feasible option for the Australian grain industry.

In-situ heat disinfestation

In-situ heating of grain is a technology that shows promise for use in small capacity (up to 50 t) farm silos. It is currently being investigated at SGRL with funding from GRDC. This process involves slowly heating the infested bulk by moving a heating front through the grain. Ambient air is heated to the required temperature and fan forced into the grain. The concept is similar to that used for rapid cooling of grain using aeration. There is a workable window between heat dosages that kill insect pests and those that cause significant damage to product quality. SGRL is evaluating suitable heat-disinfestation systems and heating/cooling regimes. Grain temperatures in the range 48–50°C are being evaluated. The system currently being evaluated at SGRL comprises a high-capacity fan, a heating unit with variable output, and four perforated ducts inside the silo. The addition of a steam generator improves the performance of the system. Typically,

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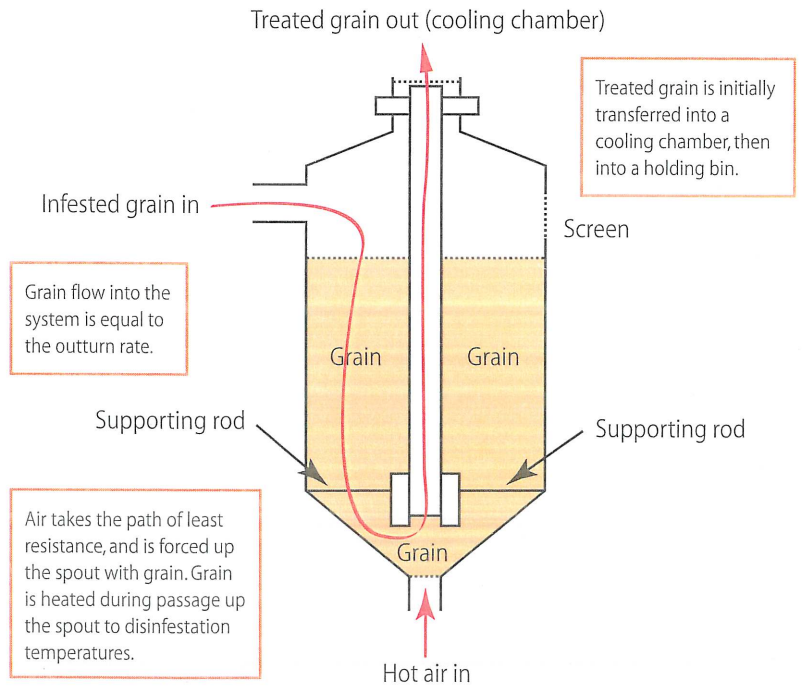

Spouted-bed heat disinfestation