# ETHYL FORMATE: A FUMIGANT WITH POTENTIAL FOR RAPID ACTION

Peter C. Annis* and Jan E. van S. Graver.

Stored Grain Research Laboratory, CSIRO Entomology, GPO Box 1700 Canberra, ACT 2601, Australia

## 1 Introduction

In Australia materials previously shown to have potential for fumigation have been re-evaluated. The research has been driven by the need to i) find alternatives for methyl bromide and ii) relieve selection pressure for resistance on phosphine. Ethyl formate (EtF) is a chemical in this category. It is a liquid at normal ambient temperatures, boils at 55°C, and vaporises readily at normal grain temperatures. The vapour was shown to be toxic to stored product insects by Muthu et al. (1984), who reviewed the literature on this chemical.

## 2 Research since 1984

This paper summarises the status of research on EtF undertaken at the Stored Grain Research Laboratory (SGRL) since 1984.

### 2.1 Dried fruit

Interest in EtF was renewed through its use as a disinfestant of dried fruit. Hilton and Banks (1996) conducted studies on insect mortality and sorption to verify and, if possible, improve the efficacy of EtF for insect control when applied to dried fruit during packing. They concluded that EtF is not only a good fumigant of dried fruit but that it had some potential as a fumigant of durable commodities. Continued research with EtF has indicated some promise of disinfesting dried fruit in shipping containers.

### 2.2 Grains and similar commodities

Considerable work has been carried out to investigate the potential to use of EtF on durable commodities. This can be summarised as, effects on insects, interactions with commodities and field trials:

#### *2.2.1 Insects*

A range of test exposures to insects, plus data from the literature have been used to characterise immature *Sitophilus oryzae* as one of the most tolerant species to EtF. Studies with this species have been used as a benchmark against which to compare other insects. The most important findings to date indicate that, i) an application rate of around 80g $m^{-3}$ is efficacious for most species tested but marginal for immature *S. oryzae*, ii) the application rate provides a better indicator of efficacy than estimated, as opposed to measured C × t products (Ct).

Laboratory exposures seem to indicate this to be a function of very rapid insect kill and rapid breakdown of EtF on cereal commodities (Damcevski and Annis 1998). This means that i) the concentration changes rapidly and a large proportion of insect death occurs before a meaningful Ct can be assessed, and ii) a substantial portion of the Ct is accumulated after the insects die.

### 2.2.2 *Commodity*

A method has been developed to determine natural and residual levels of EtF in a range of granular and non-granular commodities. Natural background levels have been estimated over a range of commodities including, wheat, barley, oats, canola, rice, faba beans cottonseed, and chickpeas. Field trials and laboratory investigations have shown that wheat, oats, barley, canola, paddy rice and rice products can be aired easily to a stage at which levels of residual EtF are indistinguishable from natural levels. End user assessment (milling, baking, malting and brewing) of these commodities treated under field trial conditions has shown no detectable effects.

### 2.2.3 *Field studies*

So far field trials with ethyl formate have mainly been opportunistic rather than planned. They have included successful disinfestation of plant and machinery, disinfestation of sampling systems, and surface disinfestation of grain. Closely monitored small-scale field trials (~50t) have been carried out on dried fruit, wheat, barley, canola and oats. All have been satisfactory in that no problems were found in terms of application method, operator safety, insect control, commodity damage, ventilation or residues at outloading.

## 3 Application methods

Three methods for applying EtF have been developed and investigated. Each has advantages and disadvantages and appears to be feasible at the small-scale trial level:

- *Direct admixture with grain during grain movement*. An aqueous ethyl formate mixture is sprayed directly onto grain as it enters storage. This method provides good distribution, and appears to be suited to prophylactic treatments and rapid disinfestation. The results to date suggest that a high degree of sealing is not required with this application.
- *Volatilisation with recirculation*. A pre-determined amount of pure EtF applied to a sealed system is allowed to mix by natural or forced air movement. However, the flammability of EtF demands careful planning and operation of this method to ensure sources of ignition are not present during the application procedure.
- *Direct application in water*. Aqueous EtF is sprayed directly onto the material requiring surface disinfestation. This is the least tried method and more experimentation is required before the extent of its application can be established.

The scale-up and conversion of these experimental application methods to robust commercial procedures has yet to be undertaken.

## 4 Conclusions

Despite the limited scope of the research so far undertaken, it is conservatively concluded that EtF could play a useful role in the Australian grain industry. However, further laboratory and field studies are required to ascertain the true applicability of this chemical.

## 5 Acknowledgments

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## 6 References

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