UPDATE ON ETHYL FORMATE: NEW TOXICITY DATA AND APPLICATION PROCEDURE

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Ethyl formate (EtF) is an old fumigant being re-evaluated by the Stored Grain Research Laboratory in Australia as an alternative to methyl bromide for use against stored product insects. EtF has some inherent advantages as a fumigant that make it interesting to investigate further. It is a rapid acting fumigant (<2 days). It is routinely used for dried fruit in various parts of the world, including Australia. It is registered as a food additive. It has wide natural occurrence in a range of foods at levels of 0.05-1.0 mg/kg. It has an Australian MRL for dried fruit of 1.0 mg/kg. It breaks down on the commodity after fumigation rather than being desorbed, but its breakdown products are also naturally occurring components of the foodstuffs. Fumigation with EtF does not adversely affect product quality or seed germination. It is a volatile liquid at ambient temperatures and special measures are needed to manage flammability.

Further work has been undertaken to define the dosage required for control of the most tolerant species – in the case of EtF, the late larval/early pupal stage of *Sitophilus oryzae*. A measured (C×T) of at least 660 mg h/L at 25ºC, 30-50% rh, was required for complete control of these insects in a minimal grain situation (where sorption was limited). Ethyl formate toxicity was increased by raising temperature, relative humidity or carbon dioxide (CO_2) level. Because water vapour and CO_2 are synergists for EtF, these results will be beneficial in designing a formulation and application system that can minimise the dosage of EtF and reduce flammability and residues.

Movement of EtF through a grain mass was studied using a 75 L capacity PVC cylinder containing 52 kg of wheat. Without recirculation, a single dose (5 mL or 80 mg/L – just below the flammability limit of 84 mg/L) of EtF applied at either top or bottom of the cylinder did not move to the other end of the cylinder before it was sorbed by the grain and then broken down. Recirculation (1 gas change/hr) was then tested using the same apparatus and 10 min after application, the fumigant was evenly distributed through the cylinder, although due to sorption and rapid breakdown on grain, the C×T was insufficient to control the test insects that were dispersed through the grain.

To address the problem of insufficient C×T, EtF was applied by double injection or pulsed application (5 mL or 80 mg/L of EtF for each injection) or controlled release (10 mL of EtF dosed for a 4 hour period) in the recirculatory system. All

tested insects were completely controlled by the 48 hr exposure. The EtF residues were also evenly distributed through the cylinder. After 5 days (without forced aeration), the levels of EtF in wheat had declined to 0.5 mg/kg, which is similar to the natural levels found in grain.

These results show that EF will need to be used in a recirculatory system and that the challenge to its successful use as a fumigant of bulk commodities is to be able to achieve the required C×T product in the face of a relatively low flammability limit and the very fast rate of sorption and breakdown on grain. The next steps in our research will be to further develop possible synergists, formulations, and application methodologies to get around these problems.