DEVELOPMENT OF ETHYL FORMATE FORMULATION FOR GRAIN STORAGE

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Executive Summary. Ethyl formare (EF) formulation is a new candidate fumigant, which is 95% EF+5% natural compound, developed and patented by CSIRO Entomology as a fast fumigant for grain storage in farm bins. The EF+X is stable stored at 25°C for over 2 months. The laboratory data shown that the toxicity of EF+X was > 2 times higher than EF alone to adults (Fig. 1a) and mixed aged cultures (Fig. 1b) of *Sitophilus oryzae* (L.). The treatment with formulation did not affect on the wheat moisture content and seed colour compared to untreated controls.

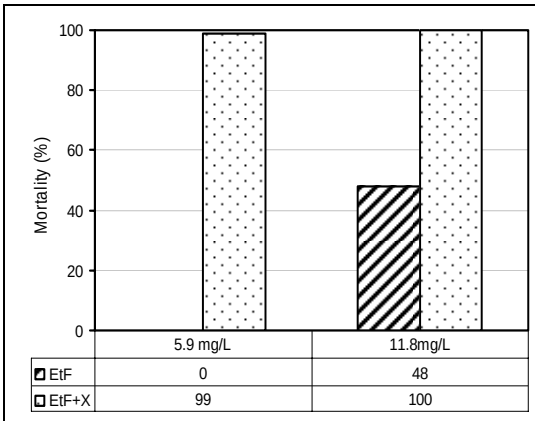

Fig 1a. Compassion of toxicity of EF alone and EF+X to adults of *Sitophilus oryzae* at 25°C and 24h fumigation.

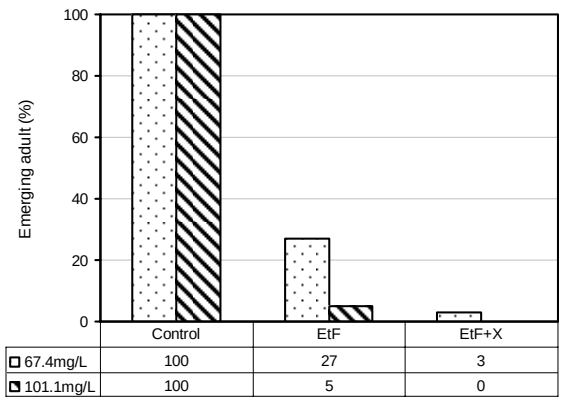

Fig 1b. Compassion of toxicity of EF alone and EF+X to mixed aged cultures (egg, larvae and pupae) of *S. oryzae* at 25°C, 6h fumigation

52kg wheat cylinder trial. Dose of formulation was 80g t^{-1} with a low rate of recirculated air (1 gas change/hour) (Fig. 2).
EF was strongly absorbed by the wheat, 60-65% of EF disappeared during the first 5h of fumigation. Sorption of liquid EF on wheat was higher than that of gaseous EF (Fig. 2). EF and X penetrated through the cylinder of wheat and achieved even distribution. EF and X residue were also evenly distributed through the cylinder of wheat. EF and X residues were reduced to 37 & 0.06mg kg^{-1} after 7 days fumigation without aeration (Fig. 3). Bioassay shown that all stages of three species of tested insect were completely killed.

50 tonne bin trial. Wheat (Australian Standard White) with moisture content of 12.6%, was fumigated with EF+X at a calculated application rate of 80g m^{-3}, in a sealed metal vertical silo (capacity of 50 t) (Fig. 4) located at Fisherman Island QLD. The application rate was in accordance with the requirement of the National Registration Authority for Agricultural and Veterinary Chemicals, and calculated from the mass of applied fumigant divided by the empty silo volume of 60m^3. The formulation was poured onto wheat at the top of the silo. The application was completed within few minutes.

With 2 hours of recirculation using a 0.5kw fan, the in-bin concentrations of EF achieved equilibrium with a concentration variation less than 7%. During the first day exposure period, the EF concentration in the bin remained above 10g m^{-3} in both bins I and 2. The concentration of EF by time product (*Ct*) achieved was 790 and 650g h m^{-3} in bins 1 and 2 respectively. In bin 1, the formulation was sufficient to kill all life stages of mixed age cultures of *S. oryzae*, *Rhyzopertha dominica* (F.) and *Tribolium castaneum* (Herbst). In bin 2, all adults of *S. oryzae*, *R. dominica* and *T. castaneum* were completely killed, but control was achieved 98% for internal stages of the insects. If the synergist was not to add, using EF alone, the *Ct* products should be > 2100g h m^{-3} to kill all life stages of mixed age cultures of *Sitophilus oryzae* (L.), *Rhyzopertha dominica* (F.) and *Tribolium castaneum* (Herbst).

After 5 days fumigation, the silo was opened but without forced aeration. The in-bin concentration of EF was lower than the Australian Experimental Threshold Limit Value (TLV) of 100 ppm. The EF and synergist residues declined to below the Australian Experimental Maximum Residue Limit (MRL) of 0.2 and 0.1mg kg^{-1} respectiverly. The workspace and environmental levels of EF and synergist were monitored during application and fumigation. The levels of EF and synergist were less than the detection limit of 0.1 ppm.

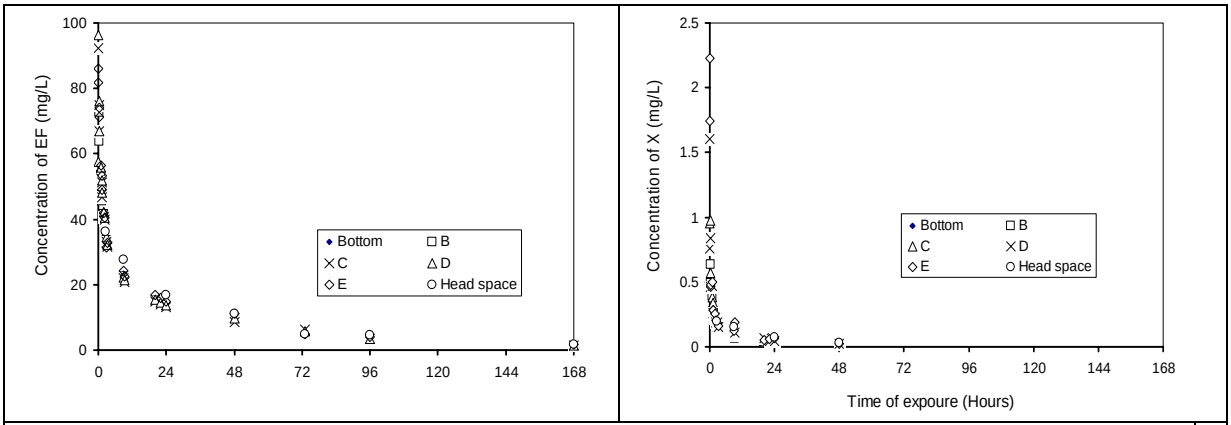

Figure 2. Concentrations of EF and X during 7 days fumigation in cylinder of wheat (95% filling ratio) at room temperature (25°C).

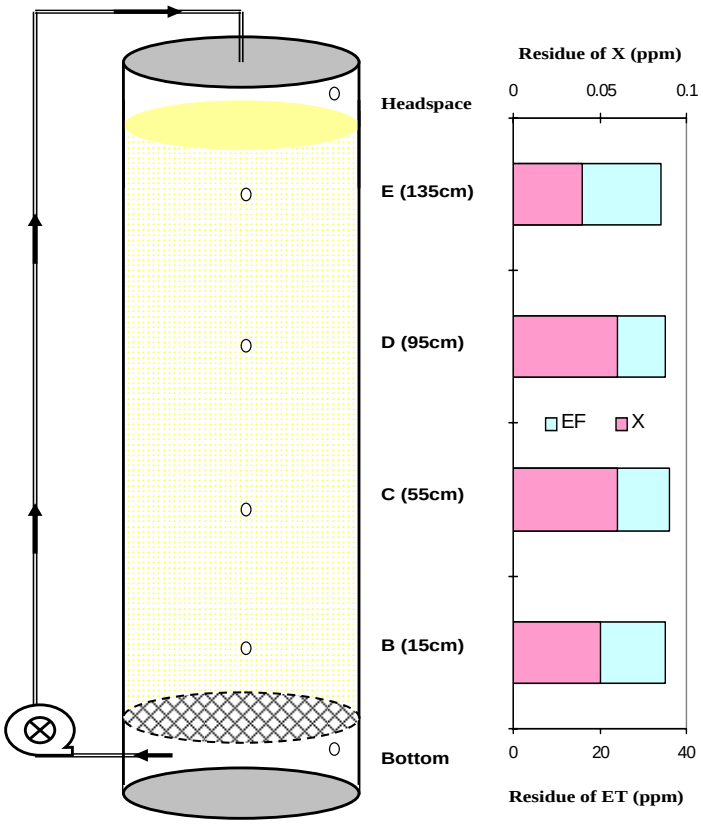

Figure 3. Schematic representation of EF and X residues in fumigated wheat at the different locations of cylinder after 7 days fumigation without aeration

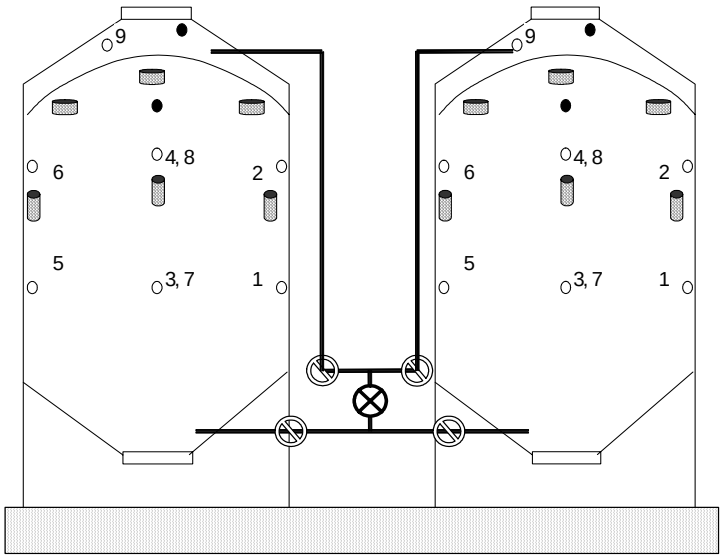

Figure 4. Schematic representation of the 60 m^3 welded steel, self-outloading silo with gas sampling ports (1-11) situated at Fisherman Is Qld.

Gas sampling ports
Temperature and RH sensors
Insect cages
Insect mash bags