ETHYL FORMATE REFORMULATED
A POTENTIAL FUMIGANT FOR THE GRAIN INDUSTRY

Yonglin Ren, Tristan van Emmerik, Daphne Mahon,
and J.E. van Someren Graver*
CSIRO Entomology, GPO Box 1700, ACT 2601, Canberra, Australia

Introduction

CSIRO Entomology has been investigating fumigant alternatives for methyl bromide for the past 15 years. One of the chemicals that attracted our attention was the 'old' fumigant ethyl formate. A new formulation of this fumigant, Vapormate, was registered for use in Australia during April 2005 (BOC, Haritos et al. 2006).

Our research with ethyl formate has continued and we recently patented a new formulation (GLO2) containing 95% ethyl formate (EF) and 5% methyl isothiocyanate (MITC) (Ren et al. 2006). GLO2 is intended for use by the grains industry because it has demonstrated a high level of kill against all life stages of the major grain insect pests. It is fast acting (less than 24 hrs) and requires a short witholding period, about 8 days, but much less with aeration.

Stability of formulation

The stability of the formulation (EF:MITC = 95:5%) was tested under laboratory conditions at 25, 30 and 45°C over a 2, 3, and 4 month storage period. No significant decrease in the level of MITC or EF was found at any of the temperatures and storage intervals. There was also no presence of inter-conversion, or breakdown products (e.g. methylamine, formic acid, and ethanol) whose bands are associated with EF, and MITC (aliphatic, carboxylic, and MITC functionalities) at the temperatures and times studied.

Sorption and desorption on wheat

Sorption of both components of GLO2 onto wheat increases with increasing moisture content of wheat (Figs. 1 and 2). Irrespective of moisture content, almost 70% of the applied formulation is absorbed by the grain within the first 3 hours of application.

Desorption of GLO2 is influenced by grain moisture content, exposure time, and witholding period. The rate of desorption decreases with increasing moisture content (Fig. 3), and desorption is more rapid after treatments with short exposure periods with the greatest (approx 70-80%) desorption occurring during the first day.

In all cases the levels of both EF and MITC remaining in grain at the end of the witholding period were significantly below (i) the 300 ppm TLV for EF and (ii) the 0.1 ppm for MITC.

Residues of GLO2 in wheat

During the exposure period, both EF and MITC declined in headspace analysis, e.g. MITC residue levels of 0.6, 0.5, 0.2 and 0.1mg kg^{-1} in wheat (12.5% mc and 25°C) after 1, 3, 8 and 14 days fumigation (Fig. 4).

During period of holding, both EF and MITC were further reduced, e.g. 12.5% mc wheat fumigated for 1 day, MITC residue levels were 0.5, 0.1 and 0.07 mg kg^{-1} respectively after 1, 8 and 14 days holding. Increasing moisture content appears to accelerate the decrease in both EF and MITC residues. After 8 days, residues of EF though above those in the control grain sample were below the experimental permit level of 0.2 mg kg^{-1}. The levels of the MITC in the same samples of wheat had also declined to marginal or below the experimental permit level of 0.1 mg kg^{-1} without the need to use forced aeration. These results are consistent with previous commercial-scale trials with EF on wheat, barley, oats and peas.

Acknowledgments

The research reported here was supported with the financial support of the participants of the CSIRO Entomology Stored Grain Research Laboratory Agreement, and the Grains Research and Development Corporation (GRDC).

References

BOC Australia. Vapormate Material Safety Data sheet # 184. Accessed (on 31 August 2008) at:
https://boc.com.au/boc_sp/au/downloads/msds/184.pdf

Haritos, V.S., Damcevski, K. A., and Dojchinov, G. 2006. Improved efficacy of ethyl formate against stored grain insects by combination with carbon dioxide in a 'dynamic' application. Pest management Science 62, 325-333.

Ren, Y. L., Waterford, C., and Lee Byung Ho 2006. World Intellectual Property Organization. IPO Number WO 2006/066308 A1.

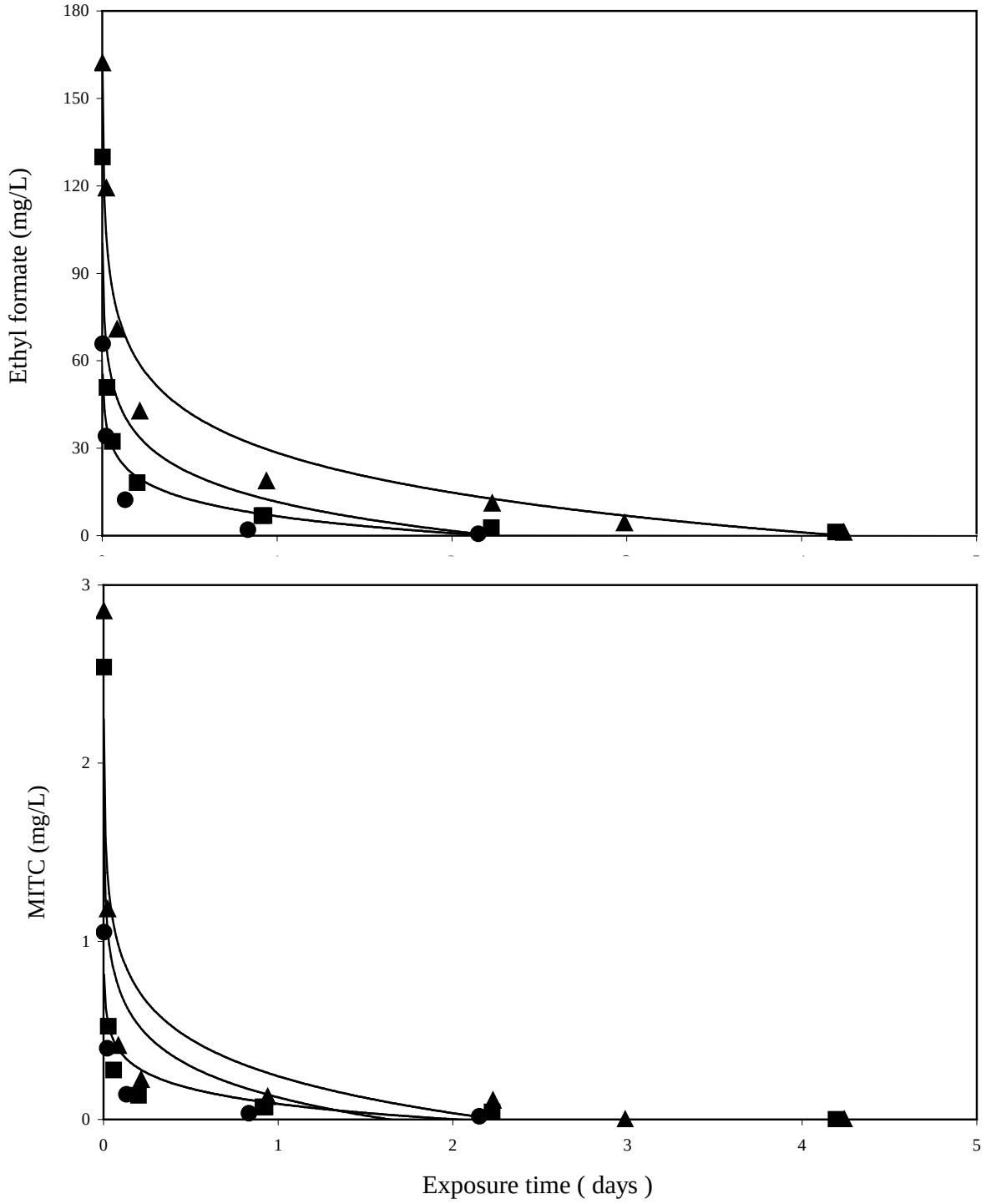

Figure 1(top) Sorption of MITC by wheat at 25ºC

Figure 2 (bottom) Sorption of EF by wheat at 25ºC

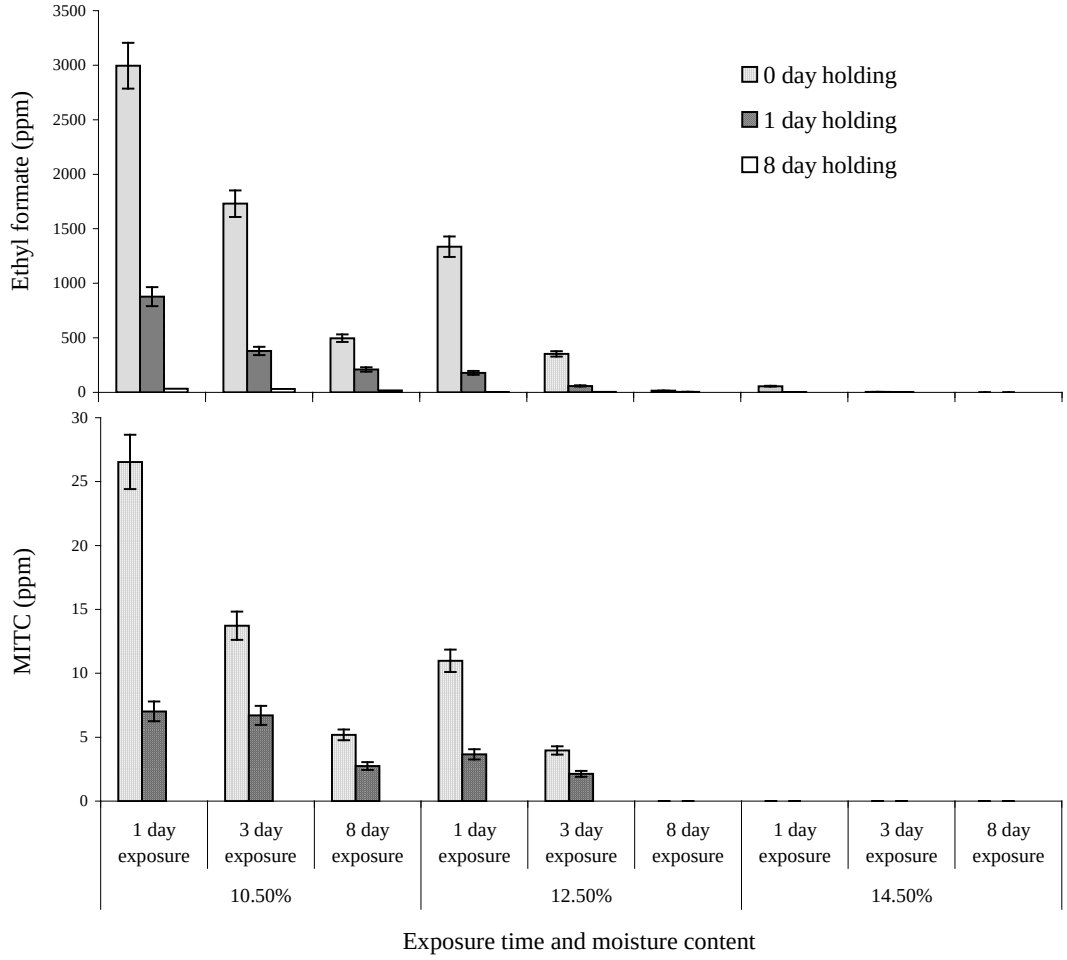

Figure 3 Desorption of EF and MITC from wheat at 25ºC

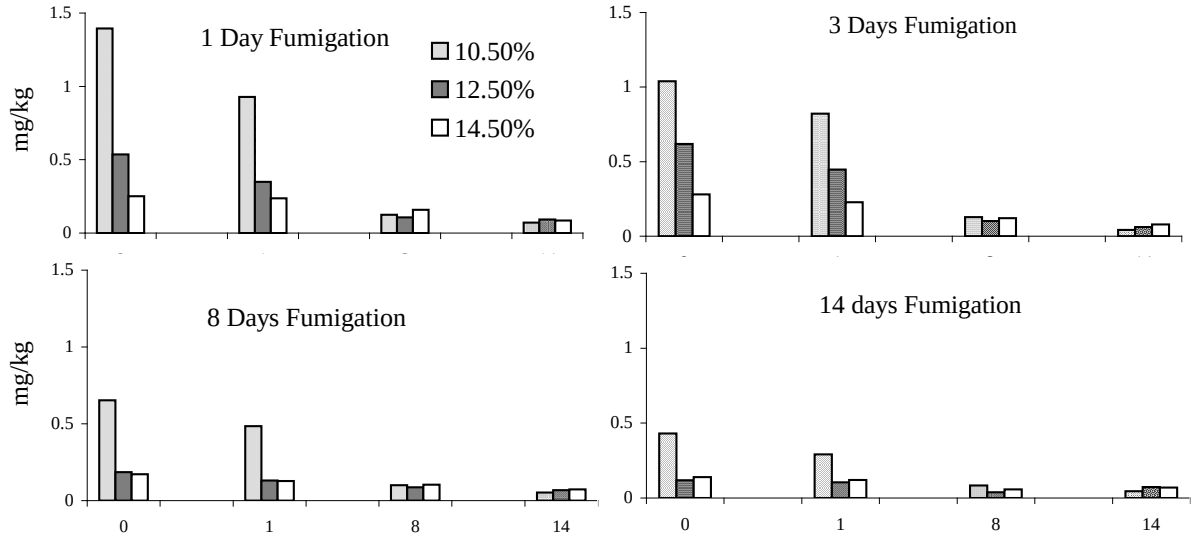

Figure 4 Desorption of EF and MITC from wheat at 25ºC