

Methods to Reduce Fumigant Volatilization Losses from Agricultural Fields

Husein Ajwa
Extension Specialist, UC Davis
1636 East Alisal Street, Salinas, CA 93905
Phone (831) 755-2823, FAX (831) 755-2844, haajwa@ucdavis.edu

Suduan Gao, USDA-ARS, Water Management Research Laboratory,
9611 S. Riverbend Avenue, Parlier, CA 93648, sgao@fresno.ars.usda.gov

David Sullivan, Sullivan Environmental, 1900 Elkin Street,
Alexandria, VA 22308, sull_env@ix.netcom.com

Randy Segawa, Department of Pesticide Regulation, Sacramento, CA,
rsegawa@cdpr.ca.gov

Deb Shatley, Dow Agrosiences, Lincoln, CA 95648,
dgshatley@dow.com

Introduction

Fumigants are regulated in part based on air emissions. Predicted emissions (soil surface fluxes) and toxicology of the material are used by the California Department of Pesticide Regulations and the U.S. Environmental Protection Agency to establish application rates, buffer zones, and use limits (township caps). Use of 1,3-dichloropropene (Telone, InLine) in California is currently limited by township caps and buffer zones. Chloropicrin (Pic) and metam sodium are currently under re-registration and preliminary indications are that uses may be limited through the imposition of greater buffer zones. Counties are currently limiting application rates and setting buffers for these materials in anticipation of revised federal and state regulations.

Current methods of soil fumigation can result in unintended fumigant escape into the atmosphere. Inadequate sealing practices will reduce the efficacy of soil fumigants against soil pests and may cause off-site emissions. Tested emission reduction practices include deep injection, drip application (Ajwa et al., 2004), fumigant degraders such as thiosulfate (Wang et al., 2000), and the use of a range of low permeability tarps including virtually impermeable film (VIF) (Nelson et al., 2001). Although VIF has been shown to have extremely low permeability under laboratory conditions, success in reducing emissions and improving efficacy in broadcast shank fumigation has not been successful because the proper glue is not available. High soil water content reduces movement of alternative fumigants that tend to be much less volatile than methyl bromide. Application of a water seal at the soil surface has been shown to reduce emissions of fumigants (Sullivan et al., 2004). Consequently, the use of sprinklers to seal the soil surface can be a practical management option.

Reducing fumigant emissions into the atmosphere has become critical to ensure the continued availability of methyl bromide alternative fumigants. Our goal was to develop management practices that can significantly reduce fumigation emissions while achieving good soil pest control. Our research evaluated the use of VIF, semi-impermeable film (SIF), and sprinkler-applied water plus thiosulfate seal to reduce volatilization losses of 1,3-dichloropropene (1,3-D) and chloropicrin (Pic) after drip application of these fumigants to raised soil beds.

Sealing Treatments and Fumigants

Experiments were conducted in the coastal strawberry production areas. Each experiment was conducted simultaneously on four adjacent fields. Each field was one acre in size, and the four fields were separated from each other by >1000 ft to avoid cross contamination. The four fields contained the same soil type, soil moisture, drip tape, and were prepared following standard strawberry field preparation practices by cooperating growers. The four sealing treatments were: 1) standard high density polyethylene (HDPE), 2) standard HDPE plus 10 mm water seal containing 25 gal potassium thiosulfate, 3) VIF or SIF, and 4) VIF or SIF plus 10 mm water seal containing 25 gal potassium thiosulfate. A sprinkler system was used to apply the water plus thiosulfate seal immediately after drip fumigation with InLine or Pic.

Air Sampling

The Indirect Flux Method was used to estimate fumigant flux from the field. This method uses the Industrial Source Complex Short Term (ISCST3) model and an atmospheric dispersion model used by EPA for regulatory purposes. In this method, the fumigant concentrations in the atmosphere around the field are measured and used with the ISCST3 dispersion model to back-calculate the field emission rate. Volatilization flux measurements were obtained using air samplers (pumps) positioned at eight locations around each field (Figure 1). The air was sampled at a height of 1.5 m above the soil surface at 6 or 12 hour intervals for five days. Air concentration measurements were obtained by collecting fumigant on charcoal or XAD sampling tubes. The tubes were then extracted with solvent (ethyl acetate or hexane) and fumigant analysis was done by using a gas chromatography with an electron capture detector.

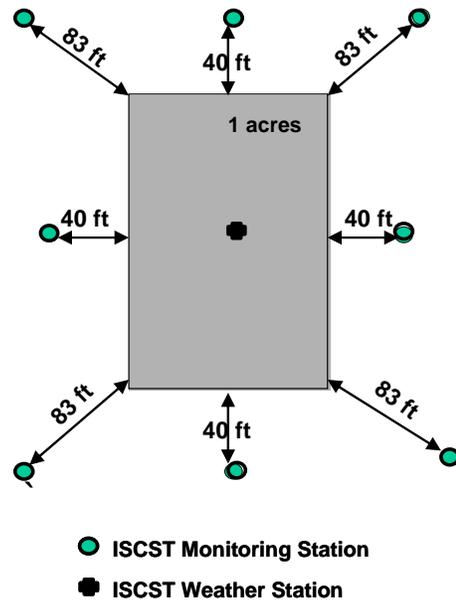


Figure 1. Locations of air sampling pumps (monitoring stations) and meteorological station for each field. The four fields have the same monitoring station set-up.

Emission Rates

Fumigant flux was estimated by using the ISCST3 dispersion method. In this method, the fumigant concentrations in the atmosphere around the field are measured and emission rates are back-calculated. For example, results computed using this dispersion model showed that the use of VIF or HDPE tarp plus thiosulfate seal reduced chloropicrin emissions by more than 40% relative to HDPE tarp alone (Figure 2). This presentation will discuss flux results for InLine applied under SIF plus thiosulfate. In addition, this presentation will compare fumigant emissions computed by using three techniques: 1) off-site indirect method, 2) closed chamber method, and 3) on-site micrometeorological method.

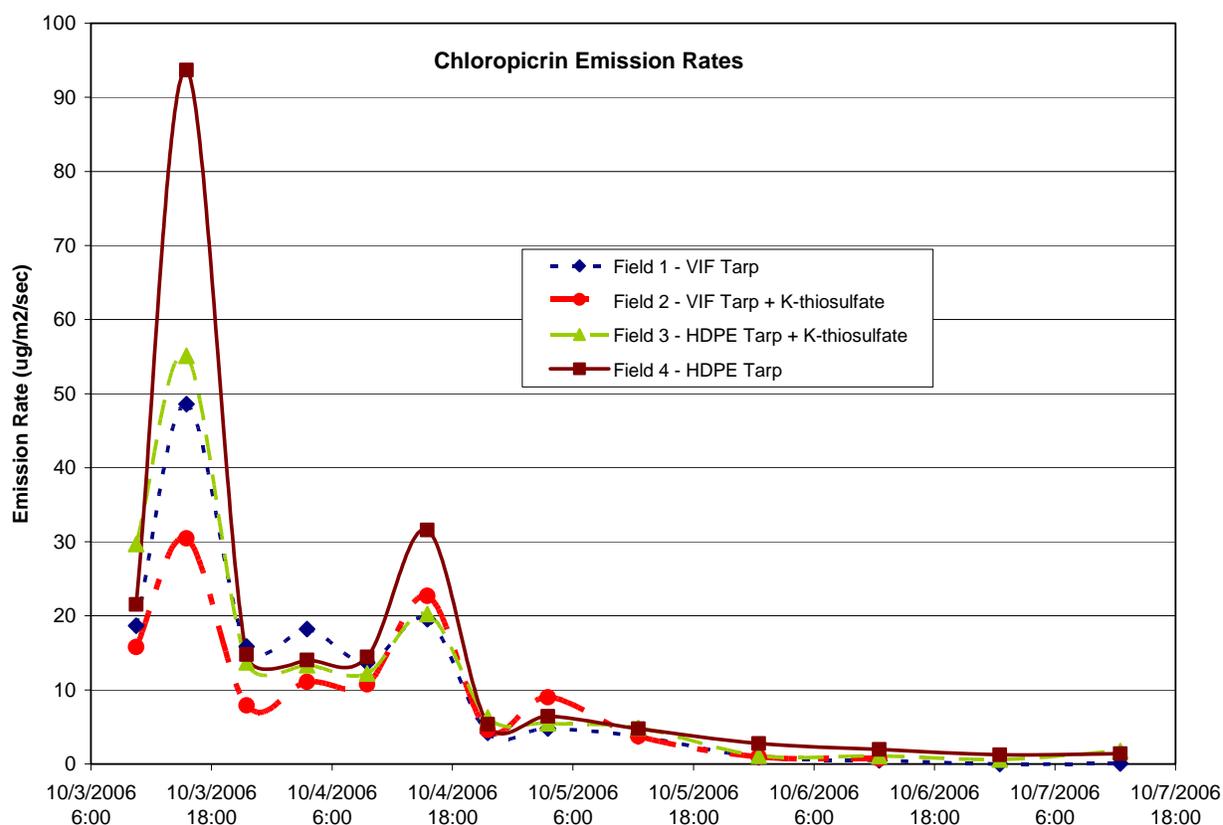


Figure 2. Chloropicrin emission rates ($\text{g m}^{-2} \text{sec}^{-1}$) from four fields after drip application under two types of plastic tarp.

Although the low emission practices might increase application costs, lower emissions can provide an argument for reduced buffer zones or increased township caps. We believe that the proposed low emission practices are practical and affordable, compared to the alternative of not being able to use these fumigants.

Literature Cited

- Ajwa, H.A., and T. Trout. 2004. Drip application of alternative fumigants to methyl bromide for strawberry production. *HortScience* 39:1707-1715.
- Nelson, S.D., C. Riegel, L.H. Allen, Jr, D.W. Dickson, J. Gan, S.J. Locascio, and D.J. Mitchell. 2001. Volatilization of 1,3-dichloropropene in Florida plasticulture and effects on fall squash production. *J. Am. Soc. Hortic. Sci.* 2001; 126: 496-502.
- Sullivan, D.A., M.T. Holdsworth, and D. J. Hlinka. 2004. Control of off-gassing rates of methyl isothiocyanate from the application of metam-sodium by chemigation and shank injection. *Atmos. Environ.* 38:2457-2470.
- Wang, Q., J. Gan, S.K. Papiernik, and S.R. Yates. 2000. Transformation and detoxification of halogenated fumigants by ammonium thiosulfate. *Environ. Sci. Technol.* 34: 3717-3721. 2000.