FUMIGANT EMISSIONS REDUCTION BY USING LOW PERMEABILITY FILM AND THIOSULFATE WATER SEAL

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Introduction

Fumigants are regulated primarily 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 US Environmental Protection Agency to establish application rates, buffer zones, and use limits (township caps). Use of 1,3-dichloropropene (Telone, InLine) in the California is currently limited by township caps and buffer zones. Chloropicrin (Pic) is currently under re-registration and preliminary indications are that uses may be limited by greater buffer zones. Counties are currently limiting rates and setting buffers for these materials in anticipation of revised federal and state regulations. 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), 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, reduced emissions and improved efficacy in broadcast shank fumigation have 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 or 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.

Methods

Sealing Treatments and Fumigants

Experiments were conducted in Oxnard and Salinas. Each experiment was conducted simultaneously on four adjacent fields. Each field was one acre, and the four fields were separated from each other by >1500 ft to avoid cross contamination. The four fields contained the same soil type, soil moisture, drip tape, and were prepared following standard strawberry field practices by cooperating growers. In Oxnard, the four sealing treatments were: 1) standard polyethylene (LDPE), 2) VIF, 3) SIV, and 4) standard LDPE plus 8 mm water seal. In Salinas, the four sealing treatments were: 1) standard polyethylene (LDPE), 2) VIF (five layers), 3) standard LDPE plus thiosulfate water seal, 4) standard LDPE plus 8 mm water seal. A sprinkler system was used to apply the water or 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 (Ross et al., 1996). 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. 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.

Results

Emission Rates

Fumigant flux was estimated by using the ISCST3 air quality dispersion models. For example, the calculated chloropicrin emissions rates showed that the use of VIF (five layers) reduced emissions rates by 73% relative to standard PE tarp (Figure 1). Application of thiosulfate in 8 mm water reduced emissions rates by 50%, but application of 8 mm water alone reduced emissions rates by only 20%. The chloropicrin mass loss relative to the amount applied was 22% for the standard PE tarp, 3% for the VIF, 9% for the thiosulfate/water seal, and 16% for the water seal.

In Oxnard, the use of VIF (three layers) reduced early emissions rates by 35% (first 6 hours) and 80% (second 6 hours) relative to standard PE tarp (Figure 2). Application of 8 mm water reduced emissions rates by 8% (first 6 hours) and 36% (second 6 hours). The chloropicrin mass loss relative to the amount applied was 30% for the standard PE tarp, 17% for the VIF, 24% for the SIF, and 25% for the water seal.

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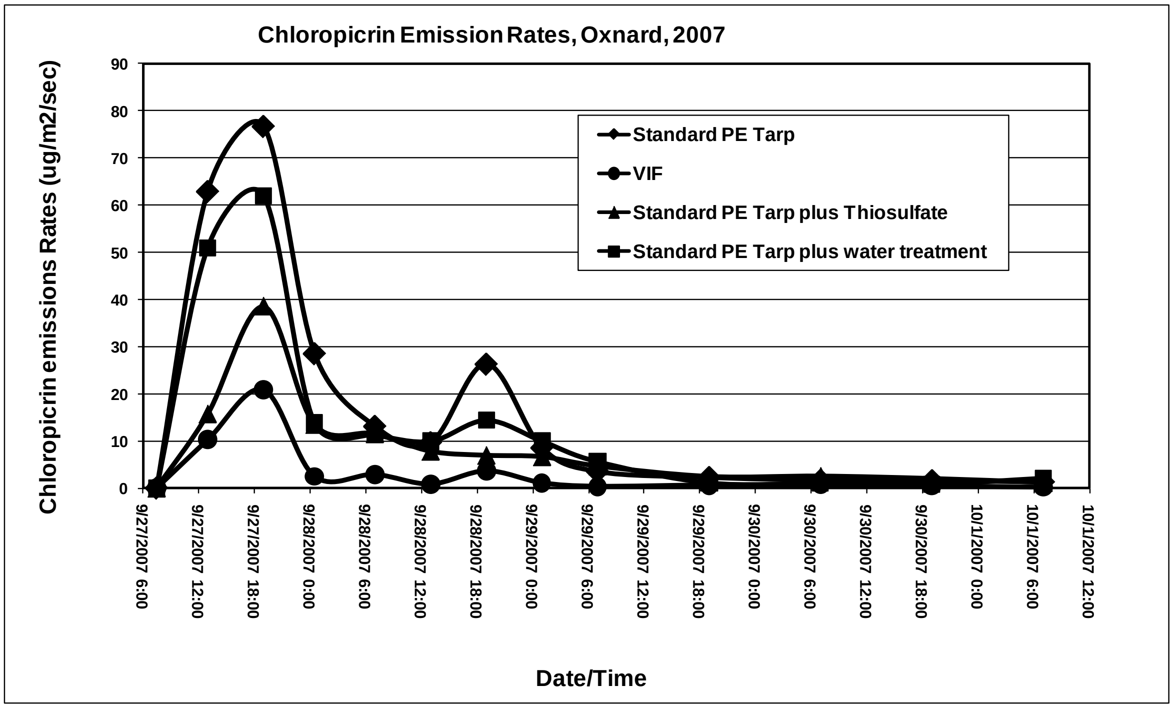

Figure 1. Chloropicrin emission rates (ug m^{-2} sec^{-1}) from four fields after drip application of TriClor EC under two types of films and potassium thiosulfate/water seal.

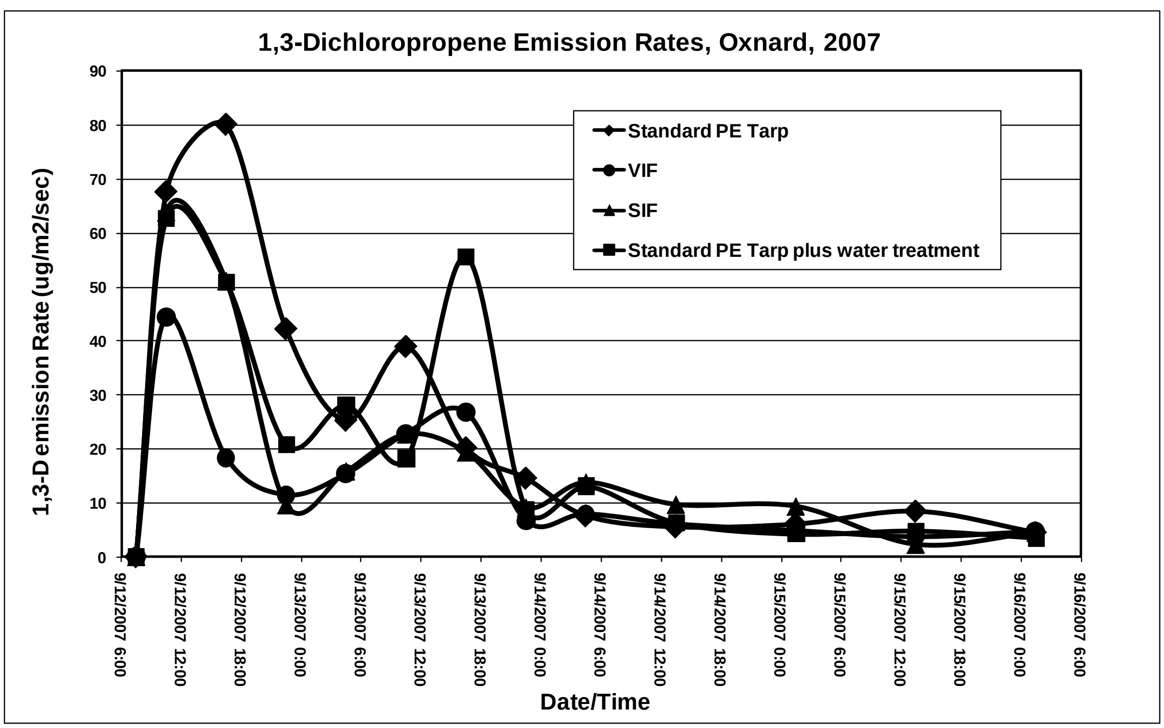

Figure 2. 1,3-Dichloropropene emission rates (ug m^{-2} sec^{-1}) from four fields after drip application of InLine under three types of films.