MONITORING OF CHLOROPICRIN FIELD EMISSIONS FROM SHANK APPLICATIONS AT SHALLOW AND DEEP INJECTION DEPTHS

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Introduction

Chloropicrin is a preplant soil fumigant used throughout the world for its broad biocidal and fungicidal properties primarily in high value terrestrial crops such as strawberries, peppers, onions, potatoes, tobacco, flowers, tomatoes, forest seedlings and nursery crops. Chloropicrin is a lachrymator and has a strong, sharp, onion-like odor. Chloropicrin is an important component in many methyl bromide alternatives and may be formulated with methyl bromide, 1,3-dichloropropene or iodomethane or it may be applied alone as a sole active ingredient. For shank applications, chloropicrin is injected into the soil using tractor-mounted injection shanks fourteen days or more before planting. More recently, chloropicrin also has been applied by drip fumigation. Drip applications typically have lower emissions than shank applications. Quantitative data on airborne concentrations of chloropicrin resulting from applications are used to predict the potential for exposure to handlers and persons near treated fields. These data are used by regulatory agencies in preparing risk assessments and in evaluating volatile organic compound emissions reductions efforts.

In this study, our objective was to generate comparative emissions data from four shank application methods of chloropicrin in four fields located in close proximity to each other. This was done to ensure that meteorological conditions, soil type, and soil temperature at each of the four fields were similar. Soil moisture at all fields was adjusted prior to application to provide for optimum application conditions. All applications were conducted on the same day and air monitoring was conducted concurrently at each field. Our research evaluated the use of two methods of tarping in addition to deep injection to reduce emissions of chloropicrin for the shank (broadcast and strip) applications of this fumigant.

Methods

The field portion of the study was conducted May 28-June 11, 2008 near Wasco (Bakersfield), California. Four agricultural fields with sandy loam soil were selected for the study. Each of the four fields was one acre and the fields were separated by at least 2,000 ft to prevent cross-contamination. The four shank applications were: (1) shank, broadcast, tarped, 12” deep, (2) shank, strip (flatfume), tarped, 12” deep, (3) shank, broadcast, non-tarped, 12” deep, and (4) shank, broadcast, non-tarped, 18” deep. Maximum practical application rates for each method were used in this study. A certified commercial applicator applied the chloropicrin using a closed, pressurized, direct shank injection system at rates of 358 lb/acre (Field 1), 165 lb/gross acre (Field 2), 197 lb/acre (Field 3), and 351 lb/acre (Field 4). The tarped fields utilized a standard low density polyethylene tarp. Non-tarped applications were sealed with a disc and ring roller following fumigant injection. Pre-application soil samples (approx. 1 lb) were collected with a corer at 0-6, 6-12, 12-18, 18-24, and 24-30 inches deep at two random locations across each field. Soil samples were analyzed for texture, bulk density, organic matter and moisture.

Chloropicrin emission levels from the treated fields were determined by measuring air concentrations above the field at regular intervals during and following the application for a total of fourteen days. Chloropicrin volatilizing from the soil was collected on solid sorbent tubes (XAD sampling tubes) at 1, 2, 3, 6, and 10 ft heights at the center of the field. Chloropicrin was extracted from the tubes by hexane and was analyzed by gas chromatography using an Electron Capture detector. Chloropicrin flux values were determined using the CALPUFF6 air model.

Results

Preliminary chloropicrin flux analyses from Fields 1-3 are shown in Figure 1. Background samples indicated that no cross-contamination occurred during the monitoring. For Fields 1-3, the chloropicrin emission rate rapidly increased within the first 24 h (up to 82 µg m^{-2} s^{-1}) and reached a maximum within 30 hours for tarped applications and within 36 hours for the non-tarped applications.

Based on the amounts applied, the mass loss of chloropicrin for Field 1 was 46% (tarped, broadcast), 49% for Field 2 (tarped strip flatfume), and 51% for Field 3 (non-tarped, shallow broadcast). Emission rates and mass loss for Field 4 (non-tarped, deep broadcast) are being calculated.

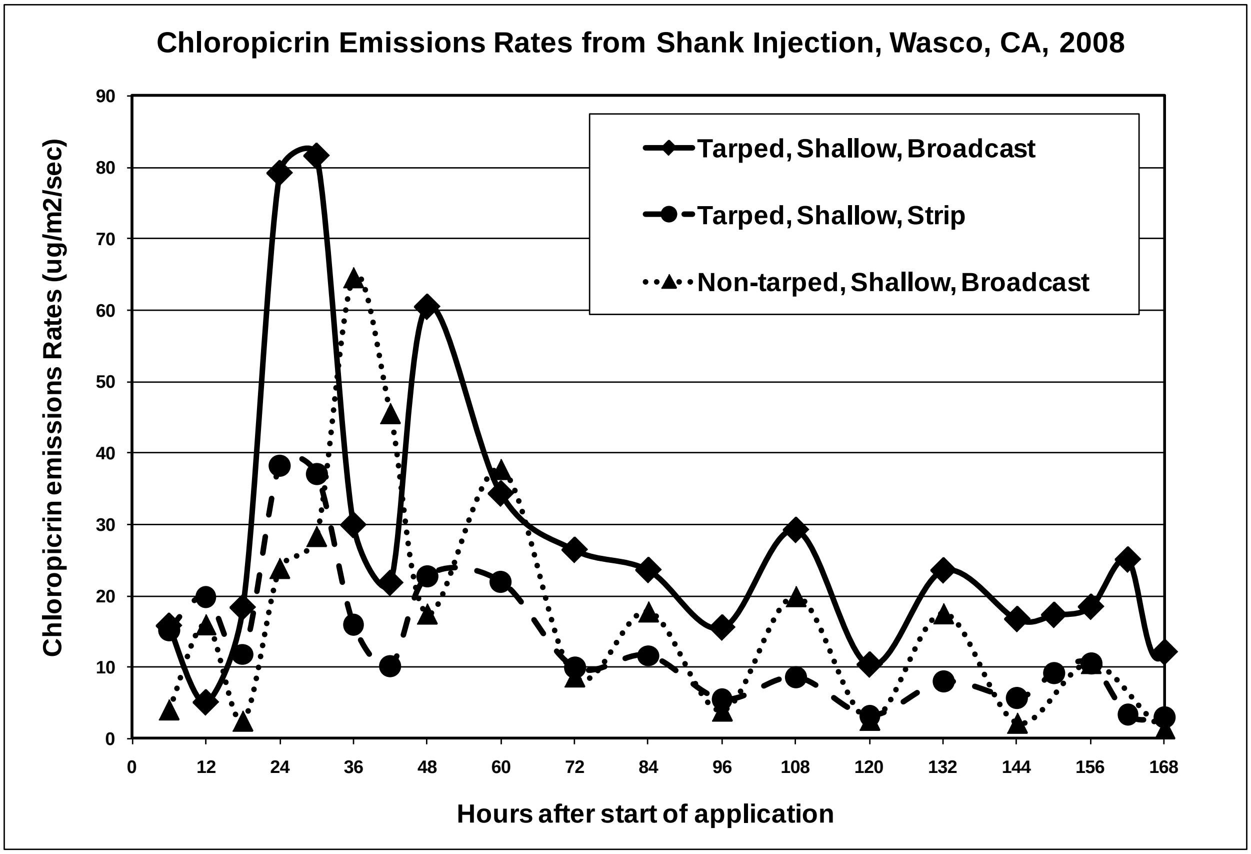

Figure 1. Chloropicrin emission rates (ug m^{-2} sec^{-1}) from tarped fields (broadcast and strip) and non-tarped shallow shank applications.

Percent mass loss appeared to be largely independent of application method. However, actual mass loss varied with each method due to the differing application rates. Peak chloropicrin flux rates varied with application method/rate. Peak emission rates for the tarped broadcast application were substantially lower (>2.5 fold lower) than those reported for a tarped broadcast application near Phoenix, Arizona, conducted at the same application rate (Beard et al, 1996). Since the soil and application conditions were similar at the Phoenix and Wasco study sites, the reduction in peak flux from Field 1 of the Wasco study (82 ug/m^2/sec) versus the Phoenix study (211 ug/m^2/sec) was due to improved application practices, such as incorporating proper pre-application moisture.

Literature Cited

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