CHLOROPICRIN EMISSIONS REDUCTION BY USING TOTALLY IMPERMEABLE FILM

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Introduction

The use of fumigants to control soil pests has become a common agricultural practice in the US to maximize the yield of various crops. However, fumigants are highly volatile compounds that warrant exceptional safeguards to minimize environmental pollution and to ensure safety through improved application technology. Over the past decade, various efforts have been made by researchers to develop and make available molecules which can successfully be applied to soil fumigation without compromising the quality of the immediate environment. In particular, combinations of methyl bromide with chloropicrin, metam with 1,3-dichloropropene and chloropicrin, and of methyl iodide with chloropicrin applied by drip irrigation, are showing excellent results in mitigating the impact of emissions on outdoor air quality.

In July 2008, the United States Environmental Protection Agency (USEPA) proposed substantial label changes for methyl bromide and chloropicrin to mitigate potential by-stander and occupational (worker) exposure to the fumigants resulting from the application process. Fumigant emissions from treated soil and their corresponding potential exposure risks to by-standers and workers can be significantly reduced though the use of improved application methods, technological advancements in application materials such as tarps, and by taking advantage of specific edaphic and environmental conditions. However, the USEPA does not have sufficient data demonstrating reduced fumigant emissions under the improved application methods and technology and thus are limited in their ability to adjust the proposed exposure mitigation requirements.

In this study, our objective was to generate comparative emissions data from shank applications of chloropicrin under totally impermeable film (TIF) in five fields located in close proximity to each other in the San Joaquin Valley, CA. Air monitoring was conducted concurrently to ensure that meteorological conditions, soil type, and soil temperature at each of the five fields were similar. This presentation will provide information on sealing treatments to reduce chloropicrin emissions after shank (broadcast and strip) applications of a mixture of methyl bromide and chloropicrin.

Methods

The field study was conducted during May 28 – June 11, 2009 in Bakersfield, CA. Five agricultural fields were selected for this study. Each of the five fields measured approximately 1 acre and were separated from each other by at least 1800 ft to minimize cross-contamination.

Pre-application soil samples (about 1 pound wet weight) from 0-3, 3-6, 6-9, 9-12, 12-18, 18-24, and 24-30 inches depths of the experimental fields were collected with a corer at random from two locations across each field and analyzed for texture, bulk density, organic matter and soil moisture. The five shank applications and sealing treatments were: 1) shank, broadcast, tarped, low permeability PE tarp sealing (~ 12' deep); 2) shank, broadcast, tarped, TIF sealing (~ 12" deep); 3) shank, broadcast, tarped, TIF plus potassium thiosulfate soil spray sealing (~ 12" deep); 4) shank, broadcast, tarped, TIF sealing (~ 18" deep), and 5) shank, strip, tarped, TIF sealing (~ 18" deep). A certified commercial applicator applied methyl bromide and chloropicrin using a closed, pressurized, direct shank injection system at rates of 360 (Field 1), 360 (Field 2), 360 (Field 3), 360 (Field 4), and 180 (Field 5) pounds/gross acre. Methyl bromide and chloropicrin emission levels from the treated fields were determined by measuring air concentrations around the field at regular intervals during and following application. Methyl bromide and chloropicrin volatilization rates (flux) were calculated by use of the off-field regression method. The method uses the Industrial Source Complex Short Term (ISCST3) model and an atmospheric dispersion model used by EPA for regulatory purposes to back-calculate the field emission rate. Fumigants volatilizing from the soil were collected on solid sorbent tubes (XAD-4) tubes. Fumigants in the tubes were extracted for GC-ECD determination using hexane.

Results

Background samples indicated that no cross-contamination occurred during the monitoring. For the shallow shank broadcast tarped application using standard polyethylene film (Field #1), the chloropicrin flux peaked at 31.03 µg m^{-2} s^{-1} 6-12 hours after the start of application. For the shallow shank broadcast tarped application using VaporSafe™ film (Field #2), the chloropicrin flux peaked at 25.82 µg m^{-2} s^{-1} 0-6 hours after the start of application. For the shallow shank broadcast tarped application using VaporSafe™ film in combination with the potassium thiosuflate soil spray (Field #3), the chloropicrin flux peaked at 30.97 µg m^{-2} s^{-1} 0-6 hours after the start of application. For the deep shank strip tarped application using VaporSafe™ film (Field #4), the chloropicrin flux peaked at 6.33 µg m^{-2} s^{-1} 24-30 hours after the start of application. For the deep shank tarped broadcast application using VaporSafe™ film (Field #5), the chloropicrin flux peaked at 6.31 µg m^{-2} s^{-1} 30-36 hours after the start of application. The percent mass loss for chloropicrin for Fields 1-5 was 18.29%, 12.8%, 9.77%, 17.92%, and 9.37%, respectively.

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