CHLOROPICRIN AND 1,3-DICHLOROPROPENE EMISSIONS REDUCTION BY USING TOTALLY IMPERMEABLE FILM

Husein Ajwa[1], Mike Stanghellini[2], David Sullivan[3], William Ntow[1], and Jonathan Hunzie[1]

[1]University of California-Davis, [2]TriCal, Inc, [3]Sullivan Environmental Consulting

Chloropicrin and 1,3-Dichloropropene (1,3-D) are preplant soil fumigants registered for use in the United States for the control of soil-borne pests in agricultural croplands. Various registered co-formulations (ratios) of these two active ingredients are injected into the soil at depths of 8 to 24 inches using tractor-mounted injection shanks, or are applied via drip application. 1,3-D is often combined with chloropicrin to enhance the control of fungal pathogens. Chloropicrin is applied as the sole active ingredient for some crops, but most use is in combination with other fumigants. Combination of 1,3-D and chloropicrin are a leading alternative to the use of methyl bromide products.

Fumigant emissions from treated soil and their corresponding potential exposure risks to by-standers and workers can be significantly reduced through the use of improved application methods, technological advancements in tarp composition, 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 its ability to adjust the proper exposure mitigation requirements. Also, California's Volatile Organic Compound (VOC) emissions regulations will continue to limit fumigant use in Non-Attainment Areas unless improvements in application methods, refined Good Application Practices ("GAPs"), and technological advancements in tarps are developed to allow for reductions in total emissions and reductions in application rates without sacrificing fumigant efficacy.

This study provides the basis for USEPA to refine buffer zones and buffer zone reduction credits for the application methods, technology, and cultural practices employed in this study. This study also provides the basis for CDPR to develop refined mitigation requirements for chloropicrin and 1,3-D as part of its in-state chloropicrin risk characterization, and will provide new data that can be considered for VOC regulations. The objective of this study was to generate comparative emissions from two broadcast tarped applications of chloropicrin and 1,3-D.

Methods

Two fields located near each other were chosen to ensure that meteorological conditions, soil type, and soil temperature were similar in each field. Both applications were conducted on the same day using the same application rig. Air monitoring was conducted concurrently at each field starting with the beginning of application and continuing for thirteen days.

The applications were made to two one-acre fields located near Oxnard, California (Ventura County), on September 10, 2009. Fields were separated by several miles to prevent cross-contamination. Air sampling was conducted starting with the beginning of each application and continued though September 23, 2009. An experimental 50/50 mixture of chloropicrin and 1,3-D was used on both fields. The application method, injection depth and target application rates were: (Field #1) shank, broadcast, tarped (10.5-foot wide, 1-mil, standard polyethylene film); 12-inch injection, 280 lbs/acre; and (Field #2) shank, broadcast, tarped (10.5-foot wide, 1-mil, EVAL-resin barrier film), 12-inch injection, 280 lbs/acre. The EVAL-resin barrier film (also called Totally Impermeable Film "TIF") registered under the trade name of VaporSafe™.

Chloropicrin and 1,3-D emission levels from each field were determined by measuring air concentrations in ten directions surrounding the field for six hour periods for the first two days, then every 12 hours for the remainder of the study, except for during tarp splitting/removal in which the intervals were reverted to every 6 hours for this 24-hr period.

Quantitative data on airborne concentrations of chloropicrin and 1,3-D resulting from applications were used to estimate emissions (Flux values) by using the Industrial Source Complex Short Term (ISCST3) model.

Results

Background samples indicated that no cross-contamination occurred during the monitoring. For Field # 1 (polyethylene tarp), the chloropicrin peak flux rate was 8.31 $\mu g\ m^{-2}\ s^{-1}$ at 162-168 hours after the start of application. For Field #2 (EVAL-resin barrier tarp), the chloropicrin peak flux rate was 4.62 $\mu g\ m^{-2}\ s^{-1}$ at 0-6 hours after the start of application. Total mass loss of chloropicrin was 10.8% (Field #1, polyethylene tarp) and 14.1% (Field #2, EVAL-resin barrier tarp).

The interval-specific peak and highest 24-hour average concentration for 1,3-D are summarized below for each field, where the latter (24-hour average) is commonly used by regulatory agencies for assessing bystander exposure risk to 1,3-D. For Field # 1 (polyethylene tarp), the 1,3-D peak flux rate was 38.28 $\mu g\ m^{-2}\ s^{-1}$ at 30-36 hours after the start of application, and the highest 24-hour average concentration was 23.86 $\mu g\ m^{-2}\ s^{-1}$ at 12-36 hours after the start of the application. For Field #2 (EVAL-resin barrier tarp), the 1,3-D peak flux rate was 28.53 $\mu g\ m^{-2}\ s^{-1}$ at 144-150 hours after the start of application, and the highest 24-hour average concentration was 15.46 $\mu g\ m^{-2}\ s^{-1}$ at 144-168 hours after the start of the application Total mass loss of 1,3-D was 43.24% (Field #1, polyethylene tarp) and 42.9% (Field #2, EVAL-resin barrier tarp).

Acknowledgments:

This project was funded by the USDA-ARS Area-Wide Pest Management Program for Methyl Bromide Alternatives. Additional support was provided by Kuraray and TriCal. We wish to thank the California Department of Pesticide Regulation for field sampling.