Department of Pesticide Regulation

Brian R. Leahy
Director

MEMORANDUM

Edmund G. Brown Jr.
Governor

TO: Randy Segawa
Environmental Program Manager I
Environmental Monitoring Branch

FROM: Pam Wofford
Senior Environmental Scientist
Environmental Monitoring Branch
916-324-4297

Original Signed by

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SUBJECT: CALCULATIONS OF USE ADJUSTMENT FACTORS FOR 1,3-DICHLOROPROPENE WITH THE USE OF TOTALLY IMPERMEABLE FILM FOR STRIP SHANK APPLICATIONS

Summary
Use adjustment factors for 1,3-D were determined for Totally Impermeable Film (TIF) tarped strip applications. These factors were based on a broadcast TIF study conducted in Lost Hills and results from the HYDRUS 2D/3D simulation model, which was used to simulate both the broadcast TIF study and the TIF strip application.

Discussion
In 2002, the Department of Pesticide Regulation (DPR) developed a California Management Plan (DPR, 2002) for 1,3-Dichloropropene (1,3-D) due to concerns over chronic exposure of ambient air concentrations. The plan restricts the yearly use of 1,3-D within townships to 90,250 'adjusted pounds'. Use factors were developed starting in the mid-1990s for shallow, deep, and drip applications to adjust the pounds of 1,3-D applied relative to an original untarped deep shank application volatilization study conducted in Salinas in the fall (Knuteson et al. 1992). The original deep shank application method was given a factor of 1.0 for all months except December and January. This factor of 1.0 was equivalent to a 35% volatilization estimated for the method (Johnson, 2013). Factors were also constructed to account for meteorological impacts on air concentrations. The factors are multiplied by the actual use pounds to calculate adjusted use pounds.

Johnson (2013) describes the steps that were taken to determine the current use adjustment factors. DPR has relied on monitored application studies to determine the emission potential of an application type. The emission ratios have been compared to the original Salinas study where the adjustment factor of 1.0 corresponded to 35% cumulative volatilization. In 2011, Ajwa et al. (Ajwa and Sullivan, 2012) monitored a broadcast shank Totally Impermeable Film (TIF) application in Lost Hills with extensive soil characterization sampling (Tuli, 2011). The study was conducted to measure the emission reduction from a TIF application, to study the effect of different tarp removal times on flux and to validate a model (HYDRUS 2D/3D) that DPR has been assessing for use with soil fumigants. The Lost Hills study results were used to estimate a use adjustment factor for the broadcast shank TIF application method (Johnson, 2013).

The use of TIF in a broadcast tarp application resulted in cumulative emissions of about 10.5% when the holding period was 10 days (Ajwa and Sullivan 2012, Johnson 2012). Based on 10.5% cumulative volatilization, Johnson (2013) calculated an adjustment factor of 0.3 for the broadcast TIF tarp application during the months of February through November. Since the Lost Hills study was a shallow broadcast, the same factor was used for a deep TIF broadcast application (≥ 18 inches), where presumably volatilization would actually be less. During the months of December and January the factor was increased to 0.6 to account for meteorological effects which may increase air concentrations. The factors calculated for the TIF shank applications will be used as the basis for the factors determined for the use of TIF with strip shank method.

Soil and environmental data from the Lost Hills TIF shank fumigation study (Tuli, 2011) were also used to calibrate TIF and fumigant properties from HYDRUS 2D/3D model simulations for a specific field (Spurlock et al., 2013a). Certain properties, such as effective field tarp permeability (also called mass transfer coefficient), adsorption and degradation are difficult to determine in the laboratory for field situations. After the HYDRUS 2D/3D model was calibrated based on a several variables measured at the single field during the Lost Hills study, it was used with no additional calibration to estimate volatilization losses from two other fields monitored. Based on these independent simulations, Spurlock et al. (2013b) concluded that HYDRUS reasonably simulated the emission process and estimated 1,3-D cumulative flux and maximum discrete time-average flux densities that were similar to flux densities estimated by the conventional inverse ISCST3 modeling that DPR has used in the past. In other words, the model was validated for broadcast applications.

Orchard pre-plant fumigations are often made to “strips” of fields where rows of trees will be planted for control of nematodes and Replant Disorder. The strip application is made with equipment that consists of five to seven shanks spaced 20 to 24 inches apart, at a depth of 18 to 24 inches (Stanghellini, personal communication). The TIF tarp is laid down immediately following the injection equipment in an approximate 11 foot wide strip which is separated from adjacent strips by an untreated area. The amount of untreated area varies with the type of tree crop planted. The treated area of an orchard can vary from 35 to 65 percent (Stanghellini, 2014).

Using the HYDRUS 2D/3D model calibrated to the Lost Hills TIF tarp scenario, Spurlock (2014) modeled three scenarios; deep broadcast untarped, deep broadcast with

TIF tarp, and deep strip application (seven shank) with TIF tarp and each scenario was modeled at three soil moisture conditions: wet, moist, and minimum moisture field conditions. The emission ratio (cumulative flux ÷ total fumigant applied) was estimated at 15 days after application with a tarp cut occurring at 9 days after application, consistent with DPR permit conditions for TIF tarp applications. The emission ratios (ER) for the deep broadcast with TIF tarp ranged from 0.023 to 0.033. The emission ratios for the three strip scenarios varied from 0.029 to 0.067. The scenario with the greatest relative difference occurred with soil moisture at label minimum which understandably also had the highest individual emission ratios. For the strip application the ER was 0.067 and for the broadcast tarp the ER was 0.033. The strip to broadcast ER ratio was 2.0.

The proposed use adjustment factors for a broadcast TIF tarp application (Johnson, 2013) were used as the basis for the calculation of the strip TIF tarp applications (Johnson, 2014). Since the use adjustment factor for the broadcast TIF tarp applications is 0.3 for applications from February through November (Table 1), the proposed use adjustment factor for a strip TIF tarp application is 2.0x0.3=0.6. The use adjustment factor for the strip TIF tarp application during December and January is 2.0x0.6=1.2

Table 1. Proposed 1,3-D township cap use adjustment factors for totally impermeable film (TIF) application methods. *SJV=San Joaquin Valley*

Existing Broadcast Tarp TIF Shank Application Adjustment Factors									
					Expressed as percent offgass, base is 35%				
	Jan or Dec		Feb - Nov			Jan or Dec		Feb - Nov	
	Deep	Shallow	Deep	Shallow		Deep	Shallow	Deep	Shallow
In SJV	0.6	0.6	0.3	0.3	In SJV	21.0	21.0	10.5	10.5
Outside SJV	0.6	0.6	0.3	0.3	Outside SJV	21.0	21.0	10.5	10.5
Proposed Strip Tarp TIF Shank Application Adjustment Factors									
	Jan or Dec		Feb - Nov			Jan or Dec		Feb - Nov	
	Deep	Shallow	Deep	Shallow		Deep	Shallow	Deep	Shallow
In SJV	1.2	1.2	0.6	0.6	In SJV	42.0	42.0	21.0	21.0
Outside SJV	1.2	1.2	0.6	0.6	Outside SJV	42.0	42.0	21.0	21.0

References

Ajwa, Husein and David Sullivan. 2012. Soil fumigant emissions reduction using EVAL barrier resin film (VaporSafe) and Evaluation of Tarping Duration Needed to Minimize Fumigant total Mass Loss. Sponsors USDA-ARS Pacific Area-Wide Project, California Department of Pesticide Regulation. Performing Laboratory Department of Plant Sciences, University of California, Davis 1636 East Alisal Street, Salinas, California 93905, Field Testing Laboratory Sullivan Environmental Consulting, Inc. 1900 Elkin Street, Suite 200, Alexandria, Virginia 22308 Laboratory Study ID HA2011A Study Location Lost Hills, California. DPR 50046-0198 [251539].

DPR. 2002. California Management Plan: 1,3-Dichloropropene. Department of Pesticide Regulation. January 30, 2002. Online at: http://www.cdpr.ca.gov/docs/emon/methbrom/telone/mgmtplan.pdf

Johnson, Bruce. 2012. Memorandum to Randy Segawa on Reanalysis of Lost Hills Data for Consistency and Error Detection dated December 4, 2012. Online at: http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis_memos/2410_segawa.pdf

Johnson, Bruce. 2013. Memorandum to Randy Segawa on Calculation of Use Adjustment Factors for 1,3-Dichloropropene With the Use of Totally Impermeable Film for Broadcast Shank Applications dated April 26, 2013. Online at: http://www.cdpr.ca.gov/docs/emon/pubs/analysmemos.htm

Johnson, Bruce. 2014. Memorandum to Randy Segawa on How to Calculate the Application Factor for New 1,3-Dichloropropene Application Methods dated May 8, 201. Online at: http://www.cdpr.ca.gov/docs/emon/pubs/analysmemos.htm

Knuteson, James A., David G. Petty, and Bradley A. Shurdet. 1992. Field volatility of 1,3-dichloropropene in Salinas Valley, California. DowElanco, Midland, Michigan.

Spurlock, Frank, Bruce Johnson and Atac Tuli. 2013a. Memorandum to Randy Segawa on HYDRUS Simulation Of Chloropicrin And 1,3-Dichloropropene Transport And Volatilization In The Lost Hills Fumigation Trials dated February 8, 2013. Online at: http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis_memos/2420-segawa_final.pdf

Spurlock, F., B. Johnson, A. Tuli, S. Gao, J. Tao, F. Sartori, R. Qin, D. Sullivan, M. Stanghellini and H. Ajwa. 2013b. Simulation of Fumigant Transport and Volatilization from Tarped Broadcast Applications. Vadose Zone Journal. doi:10.2136/vzj2013.03.0056.

Spurlock, Frank. 2014. Memorandum to Randy Segawa on HYDRUS Estimates of Cumulative 1,3-Dichlororpropene and Chloropicrin Emissions from Low Permeability Tarp Strip Applications dated June 3, 2014. Online at: http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis_memos/.pdf

Stanghellini, Mike. 2014. Request for Approval of Reduced VOC Emission Field Fumigation Method: Non-Tarped Deep Broadcast Applications of Chloropicrin to Brian R. Leahy, Director California Department of Pesticide Regulation. TriCal, Inc., Hollister, CA.

Tuli, A., 2011. Modeling and Monitoring Field Emissions of Fumigants Under Totally Impermeable Films (TIF). Environmental Monitoring Protocol for Study 273. On-line: http://www.cdpr.ca.gov/docs/emon/pubs/protocol/study273protocol.pdf