APPLICATION OF LOW PERMEABILITY TARP IN PERENNIAL FIELD FUMIGATION

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Successful orchard replanting in many situations still depends on soil fumigation for control of soil borne pests and replanting diseases in California. Additionally, to meet Nursery Stock Nematode Control Program requirements, perennial tree and grapevine nursery growers also depend on soil fumigation. The main alternatives in orchards and nurseries to the phased-out methyl bromide include 1,3-dichloropropene (1,3-D) and chloropicrin (CP). These alternatives are highly regulated because of their toxicity and contribution of volatile organic compounds (VOCs) to the deterioration of air quality. In the last five years, this project has determined various emission reduction methods under field conditions. Among these methods, low permeability tarps, especially the totally impermeable film (TIF), has been promising in effective emission reduction. TIF tarp has shown improvement on efficacy with the potential to use lower rates than currently used under standard polyethylene (PE) tarp. However, a surge in emissions when the TIF tarp was cut presented an exposure risk problem that must be addressed before adoption of the technology. For the last two years, this project has been addressing issues associated with TIF tarp use to reduce emissions and potentially reduce fumigation rates. This report covers emission and fumigant concentration under tarp and in soil profile from recent field trials. Efficacy data are in a separate report by Cabrera et al. (2011).

Project Objectives: 1) Determine the effectiveness of TIF to reduce emission and improve fumigant distribution in soil from broadcast application of Telone C35 in perennial field fumigation; 2) Determine the potential of using reduced fumigant application rates in achieving good efficacy under TIF tarp; 3) Determine fumigant persistence under the TIF tarp over time and evaluate the effects on waiting period for tarp-cutting.

Study Methods: Since October 2009, three field trials have been conducted and a fourth trial is planned for October 2011 at the USDA-ARS station near Parlier, CA. The soil is Hanford sandy loam (coarse-loamy, mixed, superactive, nonacid, thermic Typic Xerorthents), a typical soil type for perennial crops in the region. Brief information about these trials is given in Table 1. For all trials, Telone C35 was shank-applied 18 inch deep with a 20 inch shank spacing (injection nozzle spacing) using a conventional Telone rig. The first trial in fall 2009 tested three fumigation rates (full rate at 48 gallons or 540 lb. per acre, 3/4 full rate, and 1/2 full rate) plus a non-fumigated control and two types of plastic tarps, standard PE and TIF (VaporSafe^{TM}, 1-mil thickness, clear, Raven Industries, Sioux Falls, SD, USA). For all trials, 3 replicates were used for testing each treatment. TIF used

was 10.5-ft wide for the first trial and 13-ft wide for the other two trials. Two sheets of TIF were joined by gluing for the 1st trial, a single sheet for the 2nd trial and three sheets for the 3rd trial in each treatment plot corresponding to two, one and three fumigation passes, respectively. Field measurement and monitoring are also described in Table 1. During the 1st trial, over-application of the 3/4 rate occurred, which resulted in little difference from the full rate. Problems with clogged emitters led to failure in collection of soil-gas data and calculation of total emission loss as percent of total applied. The second trial conducted in summer 2010 on the same soil focused on monitoring fumigant distribution in soil profile and air under the TIF tarp at the full and half rate compared to standard PE at the full rate. The third trial conducted in fall 2010 tested full (540 lb per acre), 1/2 and 1/4 fumigation rates under both PE and TIF tarps. Soil gas concentration data at surface locations with pest bags were collected in the 3rd trial to closely monitor fumigant concentration time (CT) exposure indices and correlate with efficacy data of nematodes, pathogens and weeds.

For all the trials, air fumigant concentrations immediately under the tarps (above soil surface) were monitored to evaluate the potential impact on the waiting period determination for TIF-tarp cutting.

Results and Conclusions: The TIF is proven to effectively reduce fumigant emissions by retaining fumigants under the tarp. Emission measurement in the fall 2009 trial showed that the TIF tarp resulted in >95% emission reductions in both flux and cumulative loss compared to that from standard PE tarp during tarp-covering of two weeks. However, a surge of emission following tarp-cutting was still observed with much higher rates from the TIF than the PE plots. This surge of emission was much smaller than that observed when the tarp was cut within one week of application (Qin et al., 2011) and also was generally lower for CP than 1,3-D because of CP's shorter half-life. Thus, TIF tarp should remain in the field for a sufficiently longer period of time than standard tarp to minimize significant surge of emissions to minimize exposure risks. The surge of emission is highly correlated to the fumigant concentrations retained under the tarp. Figure 2 shows average of 1,3-D concentrations under the tarp. At the same application rate (1/2 rate) the TIF tarp held at least twice the concentrations under the PE tarp. The concentration at the full rate was proportionally higher than the half rate under TIF. The other two trials showed similar trends (data not shown).

Gaseous fumigant data from the summer and fall 2010 field trials showed that generally higher fumigant concentrations were observed under TIF than that under standard PE film in soil profile. Under TIF tarp, soil gas concentration increase corresponded to fumigant application rate. As a result, TIF resulted in higher concentration and time (CT) exposure indices in soil profile that benefit better pest control than standard tarp. Reduced fumigant rates showed good efficacy although differences between the tarps are not evident due to 100% kill of nematode and variation among pests (Cabrera et al., 2011). Field research continues for conclusions on reducing rate effects on efficacy in perennial fields.

References Cited:

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Qin, R., S. Gao, H. Ajwa, D. Sullivan, D., Wang, and B.D. Hanson. 2011. Field evaluation of a new plastic film (Vapor Safe™) to reduce fumigant emissions and improve distribution in soil. J. Environ. Qual. 40:1195–1203.

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Table 1. Summary of fumigation field trials: treatment, monitoring and efficacy study component.

Field Trial	*Treatment*†	*Field Measurement*	*Efficacy*
Fall 2009 (Oct. 27−Nov. 9)	Rate: Full rate (48 gallon/acre), 3/4 and 1/2 full rate; Tarp: PE, TIF	Emission Air under tarp Residual fumigants	Nematodes weeds
Summer 2010 (June 9 - July 1)	Full rate and 1/2 rate under TIF and full rate under PE	Air under tarp Gas fumigant distribution in soil	None
Fall 2010 (Sept. 8 – Oct. 13)	Rate: Full rate, 1/2 and 1/4 full rate Tarp: PE, TIF	Air under tarp Gas fumigant distribution in soil Fumigant concentration in soil air where pest bags buried	Nematodes pathogens weeds

† Telone C35 was used for fumigation for all trials and the full was the maximum allowable 1,3-D rate in CA, 48 gal or 540 lbs of Telone C35 per acre.
‡ The 3/4 rate was over applied to full rate and data from this treatment were integrated to the full rate.

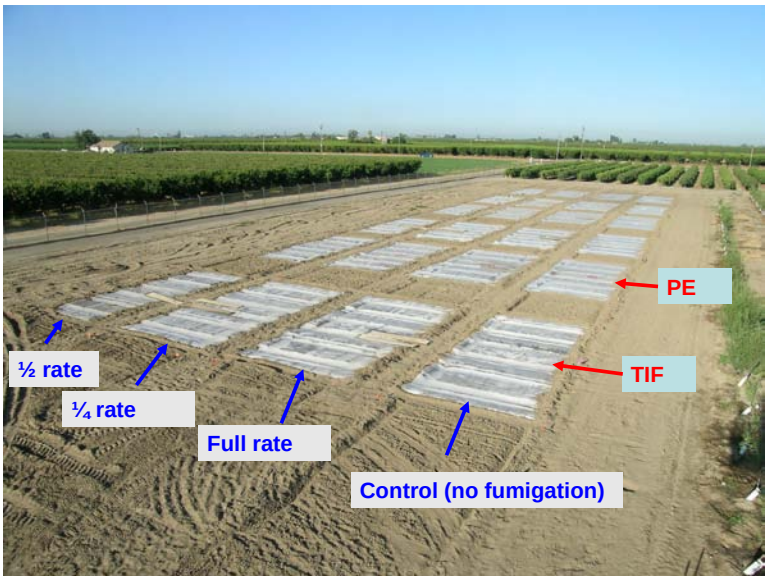

Figure 1. Fall 2010 fumigation trial layout testing the effect of reduced fumigation rate with Telone C35 on gaseous fumigant concentration changes in soil profile and efficacy in USDA-ARS, Parlier, CA. The full rate was the maximum allowable rate of Telone in CA (48 gal or ~540 lbs of Telone C35 per acre). PE, polyethylene; TIF, totally impermeable film.

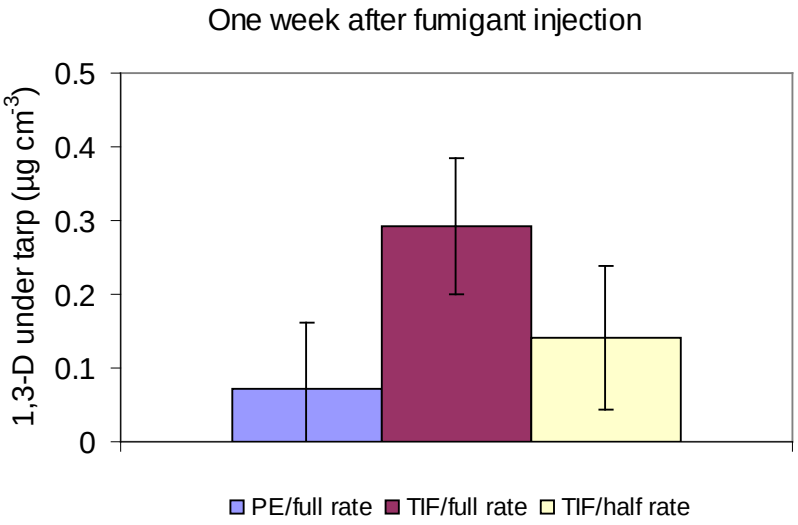

Figure 2. 1,3-Dichloropropene concentrations in air under tarp one week after fumigant application in summer 2010 field trial. Error bars are standard deviation of the mean (n=12).