DEMONSTRATION OF LOW PERMEABILITY TARP TECHNOLOGY IN SOIL FUMIGATION FOR PERENNIALS

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Control of soil-borne pests and replanting diseases still relies on pre-plant soil fumigation for establishing healthy trees and grapevines in California. Open-field perennial tree and grapevine nursery growers depend largely on soil fumigation to meet the requirements of the CDFA's Nursery Stock Nematode Control Program, i.e., to deliver nematode-free crops. Since the phase-out of methyl bromide, alternatives such as 1,3-dichloropropene (1,3-D) and chloropicrin have been increasingly used in these sectors. With only a few registered, the alternatives are also highly regulated to minimize potential exposure risks and contribution of VOCs to the air through emissions. Management strategies that minimize emissions and improve pest control efficacy offer the best hope for maintaining the availability of fumigants to the commodities in the prospective short-term and intermediate future. Low permeability tarp technology (e.g., virtually impermeable film or VIF) has shown promise in meeting these requirements. However, the VIF tarp has also shown vulnerability to damage from tearing or stretching in field applications. A new film, the so-called totally impermeable film (TIF), claims to have lower permeability to fumigants and more advantages in preserving its integrity and is less prone to damage than VIF in field installations. This project was designed to evaluate the potential of TIF in reducing emissions, improving efficacy by retaining and enhancing fumigant distribution in soil profile, and reducing application rates in deep-rooted perennial soils.

Objectives: 1) Demonstrate the potential of TIF to reduce emissions and improve fumigant distribution in soil from broadcast application with alternative fumigants to MeBr; 2) Determine the potential of using reduced fumigant application rates in achieving good efficacy under the TIF tarp; 3) Determine fumigant persistence under the TIF tarp over time from different fumigant application rates and evaluate the effects on the waiting period between application and tarp-cutting for minimizing potential exposure risks to workers and by-standers.

Study Methods: A series of field tests have been conducted since October, 2009 in USDA-ARS, San Joaquin Valley Agricultural Science Center, 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 San Joaquin Valley. The first field trial was conducted Oct. 27−Nov. 9, 2009. Telone C35 was shank applied to an 18" depth at a 20" shank spacing using a conventional Telone rig. Three fumigation rates (full rate at 48 gallons or 540 lbs per acre, ¾ full rate, and ½ full rate) plus a non-fumigation control and two types of plastic tarps, standard polyethylene (PE) and TIF (VaporSafe^{TM}, 10.5-foot wide, 1-mil

thickness, clear, Raven Industries, Sioux Falls, SD, USA), were tested in 3 replicates (Figure 1). Two sheets of the TIF were applied with gluing and no problems were observed during the installation (Figure 2). Fumigant emissions, distribution and changes in the soil-gas phase, residual fumigants in soil at the end of the trial as well as selected efficacy investigations (nematodes and weeds) were carried out. In this trial, over-application of the ¾ full rate occurred, which resulted in little difference from the full rate. Also due to some problems associated with application, collection of soil-gas data was not successful. A second trial was established on June 9 through July 1, 2010 on the same soil and focused on monitoring fumigant distribution and changes in soil profile under the TIF tarp at the full and half rate compared to standard PE tarp at the full rate. A third trial is planned for September, 2010 to repeat the treatments as tested in the 2009 field trial. The aim is to closely monitor fumigant concentration time (CT) exposure indices and correlate them with efficacy data of nematodes, pathogens and weeds. For all the trials, air fumigant concentrations immediately under the tarps are monitored to evaluate the potential impact on the waiting period for using the TIF tarp.

Results and Conclusions: Emission measurement indicated that the TIF tarp resulted in >95% emission reductions in both emission flux and cumulative loss in comparison with standard PE tarp during the tarp-covering period of two weeks. 1,3-D concentrations under the TIF tarp were usually 3 times or higher than that under standard PE film at the full rate. 1,3-D concentrations under the TIF at the half rate were similar or higher than that under the PE film at the full rate. Prior to tarp-cutting, as high as 1 µg cm^{-3} was still observed under the TIF film as compared to 0.2 ug cm^{-3} under the PE film at the full rate. Emission monitoring showed a sudden increase of emission flux following tarp-cutting with much higher rates from the TIF plots than the PE plots. The concerns regarding surges of emissions upon tarp-cutting with TIF do exist even after 2 weeks of tarping. The TIF tarp retained higher fumigant concentrations and appeared to improve fumigant distribution in the soil profile as compared to the standard PE tarp. All data indicate the ability of TIF to retain fumigants under the tarp and the potential of using reduced rates for satisfactory pest control.

Two weeks after fumigation, all three application rates were found highly effective against citrus nematodes in bags installed at 0.5, 1, 2, and 3 ft soil depths under both TIF and PE. The efficacy of the half rate in both TIF and PE against resident pin nematodes was 98% in samples taken up to 5 ft and the full rate provided 100% control effectiveness at the same soil depth. Five months after fumigation, pin nematodes were only recovered from the untreated control treatment and none were detected at all rates of fumigated plots under either TIF or PE. Native weed recovery from each treated plot was counted for species and biomass up to 5 months after fumigation. The last count showed that the TIF-full rate yielded the lowest weed biomass, followed by TIF-half rate or PE-full rate, while the highest was from the non-fumigated control and PE-half rate.

The field data indicate that the low permeability tarp TIF can effectively control emissions, improve efficacy by effectively retaining fumigants and improve fumigant distribution in soil profile. There is a high potential for using reduced rates of Telone C35 with TIF for good pest control efficacy. However, issues to be addressed include how to avoid the surge of emissions upon tarp-cutting by determining a proper waiting time and how much rates can be reduced for satisfactory efficacy, which means 100% nematode control for open-field perennial nurseries.

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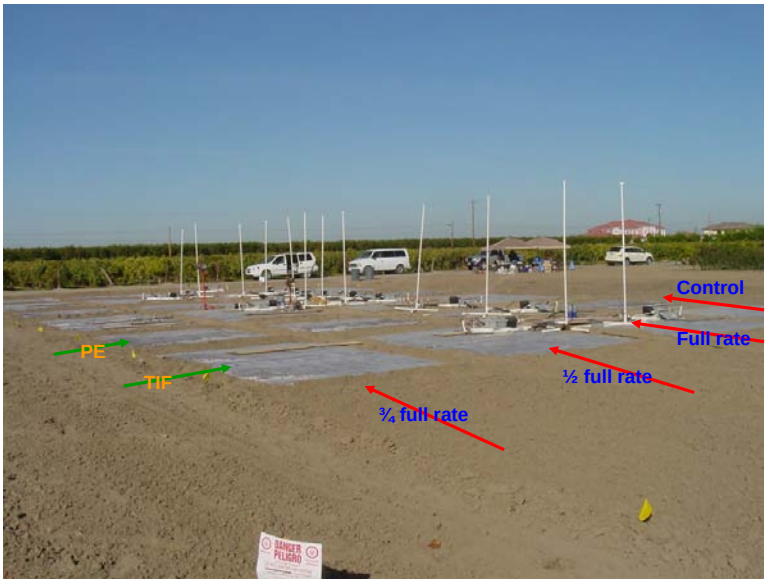

Figure 1. A field layout testing the effect of TIF tarp on emission reduction and efficacy from deep shank injection of Telone C35 in October, 2009 at Parlier, CA.

Figure 2. Installation and gluing sheets of totally impermeable film (TIF) in soil fumigation trial conducted in October, 2009 at Parlier, CA.