Using Irrigation and Organic Amendment to Reduce Fumigant Emissions

Project No.: **09-AIR5-Gao**

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Objectives:

The goal of this project is to develop effective, economical and environmentally sound methods to minimize fumigation emissions for Prunus and other perennial crop production systems that require pre-plant soil fumigation. The specific objective is to determine the effectiveness of irrigation and composted dairy manure incorporation into surface soil as well as other effective treatments on emission reductions in field operations.

Interpretive Summary:

Achieving low emissions will increase the probability of continued use of soil fumigants by minimizing environmental impact and meeting air quality standards. Methods that are effective, economically feasible, and environmentally sound are the most desirable. To determine the effectiveness of several surface sealing and tarping treatments on emission reductions from soil fumigation, a field trial was conducted in a sandy loam soil in the San Joaquin Valley Agricultural Sciences Center (SJVASC), California in fall 2008. Emissions of 1,3-dichloropropene (1,3-D) were measured from various treatments over shank injection of Telone® II. Surface treatments included a bare-soil control, a high application rate of composted dairy manure, post-fumigation intermittent water seals, and tarping with standard polyethylene (PE) film tarp and a low permeable film as VIF (virtually impermeable film). The manure application did not reduce fumigant emissions. The water seals and standard PE tarp reduced emissions about 20% and 50%, respectively. The VIF demonstrated the most emission reduction (>95%) and glue joints did not present problems in the field in reducing the tarp effect. The VIF also showed the potential to improve uniform distribution of gaseous fumigants in the soil profile, in addition to the potential of retaining higher concentration under the tarp than other surface treatments, which can lead to improved efficacy and/or potential use of lower rates than currently used. The information should be useful for considerations by

various commodities and regulatory agencies in identifying effective practices to minimize emissions from soil fumigation.

Field trial and measurement:

A field trial was conducted from September 24 through October 8, 2008 at the USDA-ARS SJVASC in Parlier, California. Telone® II (containing 97.5% 1,3-D) was shank applied to 45 cm depth at a target rate of 380 kg ha^{-1} (33.7 gallons per acre). The soil was Hanford sandy loam. The following treatments were applied and tested in three replicates:

1. Control
2. Manure incorporation into surface soils at 49.4 Mg ha^{-1} (~20 ton/ac)
3. Water seals (25 mm water sprinkler applied immediately after fumigant injection followed by 4 mm water at 24 and 48 h, respectively)
4. HDPE tarp
5. VIF tarp

Emissions and fumigant concentration in soil-gas phase were monitored for about two weeks. Emissions of tarp treatments were measured from both continuous sheet and glue joints. Some other variables were also measured (detailed in the annual report).

Results and Discussions:

Emission flux and cumulative emission loss are shown in **Figure 1** and **Table 1**, respectively. The results show that the highest emission losses were from the control and the manure treatment, followed by water seals and HDPE tarp. The lowest emission loss was from the VIF tarp. Statistical analysis indicates that only the differences in the cumulative emission loss between the VIF tarp and all other treatments are significant (α=0.05), as well as that between the HDPE tarps and the manure treatment. Similar to the HDPE tarp treatments, there were no differences in emission losses between continuous sheet and glue joint of VIF tarp indicating that the VIF gluing technique worked successfully.

Figure 2 shows fumigant concentrations in soil-gas phase for the control, water seals, HDPE tarp and VIF tarp treatments at selected sampling times. The VIF tarp retained the highest concentration under the tarp most times and a more uniform distribution is apparent compared to all other treatments, although the absolute concentration under the VIF tarp appeared lower than other treatments. This is because the VIF treated plot happened to receive only 60% of the target application rate (**Figure 2**). A similar target rate (achieved at 92%) tested in a previous year's trial under VIF showed similar distribution pattern, but with much higher concentrations throughout the soil profile up to 60 cm depth (unpublished data). The improvement in fumigant distribution by the VIF can be significant because it can lead to improved efficacy throughout the soil profile rather than providing most control near the application depth and poorer control at the soil surface or at lower depths, as is the case for the control or water seal treatments.

This research shows that emission reduction by standard PE tarp, post-fumigation water treatments, and organic amendment are limited and can be affected by specific soil and environmental conditions as well as how the treatments are applied. The most promising and dependable emission reduction technique is the use of a low permeable film VIF, which not only significantly reduces emissions but has the potential to improve uniform distribution and retain high fumigant concentration in soils. This may further lead to lower application rates than are currently being used and still result in satisfactory pest control. Detailed investigations are needed in this regard. The tarp material, however, may be costly, which may not be feasible for some growers.

For details of this research, please refer to the *completed report 2008 – 2009 Final Reports.*

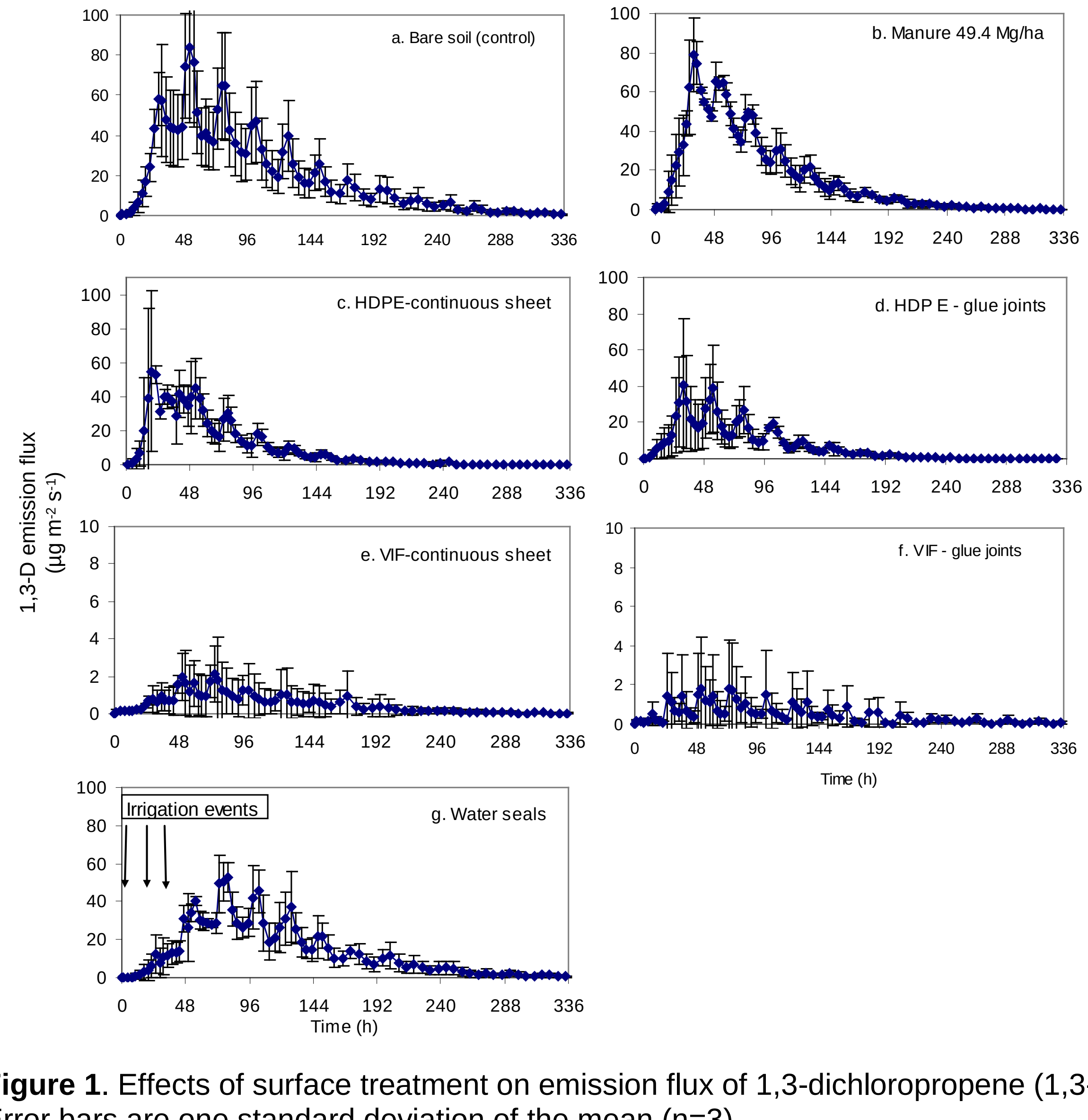

Figure 1. Effects of surface treatment on emission flux of 1,3-dichloropropene (1,3-D). Error bars are one standard deviation of the mean (n=3).

Table 1. Cumulative emission loss of 1,3-dichloropropene from 2008 field trial

Treatment	Emission loss (% of applied)
Control	42.4 (±17.0)
Manure at 49.4 Mg ha^{-1}	50.5 (±10.0)
Water seals	33.6 (±6.8)
HDPE (continuous sheet)	21.6 (±6.5)
HDPE (glue joints)	23.9 (±15.1)
VIF (continuous sheet)	1.4 (±1.0)
VIF (glue joint)	1.9 (±2.4)

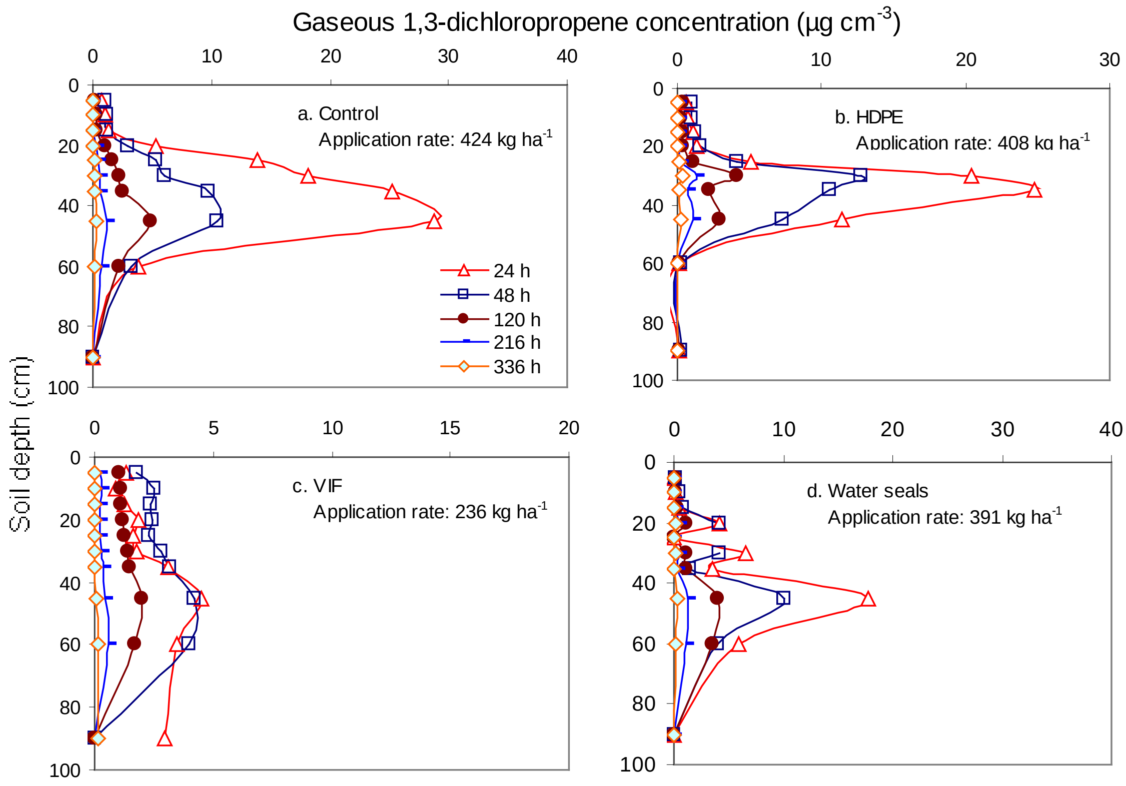

Figure 2. Distribution of gaseous1,3-dichloropropnene in soil profile after shank injection of Telone® II at 45 cm depth in 2008 field trial. Note the VIF tarped plot had much lower application rate than others resulted in generally lower concentrations in the profile; but a more uniform distribution pattern is apparent.