REDUCING FIELD-SCALE EMISSIONS OF 1,3-D WITH SEQUENTIAL SURFACE IRRIGATIONS

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Summary. A field experiment was conducted to measure subsurface movement and volatilization of the 1,3-dichloropropene (1,3-D) after shank injection to an agricultural soil. Aerodynamic, integrated horizontal flux and theoretical profile shape methods were used to obtain fumigant flux density and cumulative emission values. The volatilization rate was measured continuously for 16 days and the range in the daily peak volatilization rates for the three methods ranged from 18 to 60 μg m^{-2} s^{-1}. The total 1,3-D mass that volatilized to the atmosphere was approximately 44-68 kg ha^{-1}, or 10-15% of the applied active ingredient. This represents approximately 30-50% of the total emissions observed in recent field and field-plot studies. Significant reductions in volatilization of 1,3-D are possible when repeated surface irrigations are applied to a field shortly after fumigation and continuing for several days.

Introduction. The State regulatory agencies' current VOC inventories are based on assuming that 100% of the VOC portion of an applied pesticide is lost to the atmosphere. This tends to overestimate the VOC loading since pesticides are affected to some degree by irreversible sorption, and abiotic and biotic degradation that tends to reduce emissions. While assuming 100% emission may be convenient, this approach is not a suitable substitute for actual emission measurements under field-relevant conditions.

As new stricter rules governing ambient ozone levels are implemented, regulations will be placed on activities that produce ozone. In regions with significant agricultural production, VOC emissions from soil fumigation will likely be considered. Therefore, research is needed to accurately determine the true level of VOC emissions from soil fumigation and to develop methods to reduce emissions to low levels. Failure to do so may cause agricultural producers to face potentially restrictive control strategies, which may cause a reduction in profit or force growers to cease food production.

A field experiment was conducted to measure the volatilization rate of 1,3-dichloropropene (1,3-D) after shank injection. 1,3-D has relatively high volatility and water solubility and relatively short field half-life. After fumigation, residual 1,3-D may be detectable in soil for several weeks. There have been few published field experiments describing efforts to measure field-scale emissions of 1,3-D after shank injection or for situations where irrigation water is applied shortly after application. The experimental data reported from this study provides state regulators and the scientific community with important information on emissions from soils.

Location. The field site was located in near Buttonwillow, CA. The soil type was a Milham sandy loam (fine-loamy, mixed, thermic Typic Haplargids). The field experiment began on August 31, 2005 and ended September 16, 2005. Two weeks prior to the start of the field experiment, the soil was plowed and disked to break up large soil aggregates. Then, the field was sprinkler-irrigated and allowed to drain so that the initial soil water content was approximately 0.2 (cm^3 cm^{-3}). The 1,3-D was applied by a commercial applicator using a rig containing 9 shanks on a 4.5 m tool bar (50 cm spacing). Telone II ® was applied to 8.4 acres (178 m x 188 m) at a depth of 46 cm (i.e., 18 inches) and application rate of 12 gal/ac. The total applied mass was 447 kg.

Results. Figure 1 shows a time series of the volatilization rate during the experiment. Three methods were used to calculate the volatilization rate including the aerodynamic, integrated horizontal flux and the theoretical profile shape methods. The three methods demonstrate a similar temporal pattern throughout the experiment. The maximum daily volatilization rate for each method occurred on the 3rd day (t = 3.54 d) and ranged from approximately 18 to 60 $\mu g\ m^{-2}\ s^{-1}$. From Figure 1 it is clear that for several measurement periods the ADM method produces much higher volatilization rates compared to the IHF and TPS methods and that the IHF and TPS methods agreed more closely throughout the experiment.

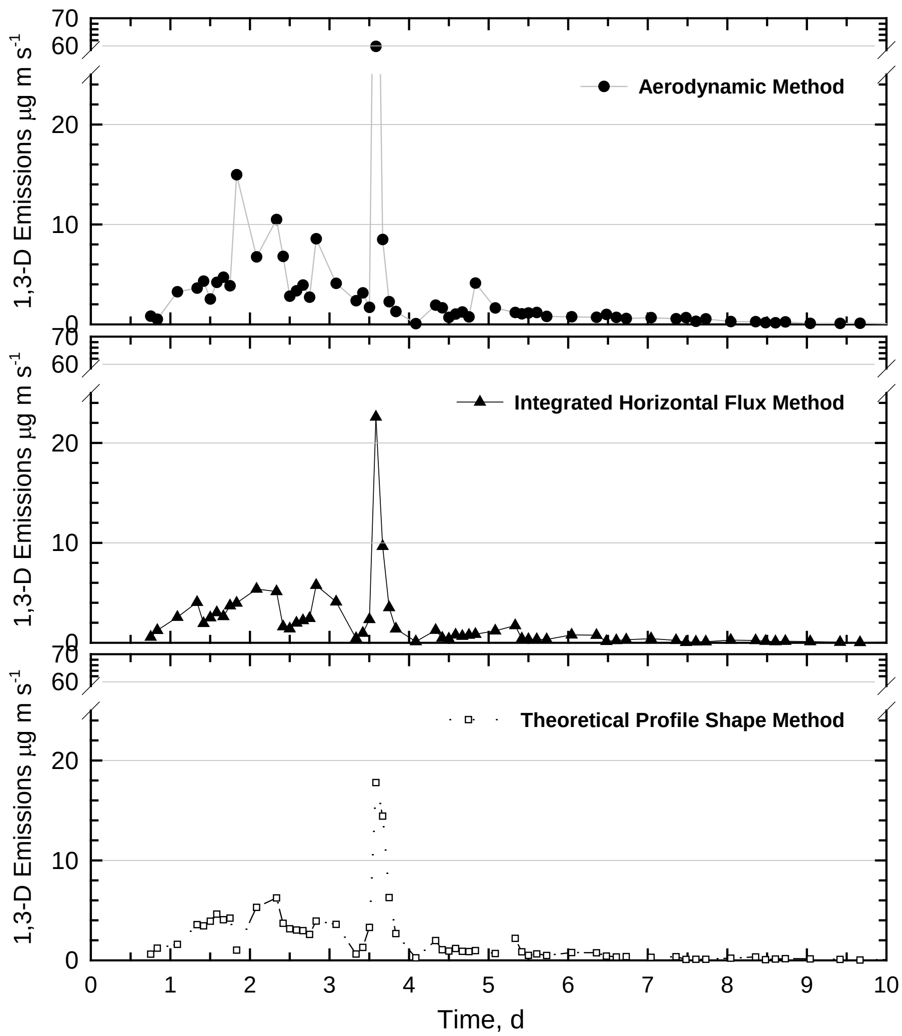

Figure 1. Emissions of 1,3-D as a function of time (day) after application

Table 1 provides shows the total 1,3-D mass (kg) lost to the atmosphere and the percent of applied Telone (parentheses). This information was obtained by integrating the volatilization rate over time and multiplying by the total field area. It is clear that the IHF and TPS methods provide estimated volatilization rates that are very similar. The total emission estimates from the IHF and TPS methods were found to be 10% of the applied material, while the cumulative emission estimate from the ADM method was 15%.

Table 1. Total 1,3-D emissions in (kg) and percent of applied (in parentheses).

	***Cis*–1,3-D**	***trans*–1,3-D**	**1,3-D**
Aerodynamic Method	39 (17%)	29 (13%)	68 (15%)
Integrated Horizontal Flux Method	26 (11%)	18 (8%)	44 (10%)
Theoretical Profile Shape Method	27 (12%)	19 (9%)	46 (10%)

Laboratory Study. For comparative purposes, a laboratory study (1) was conducted using soil collected from the field site, and that simulated the observed experimental temperature conditions during the experiment. This study reported that the total emissions of *cis*-1,3-D after 14 days were 33.1% for a non-irrigated treatment and 17.1% for an irrigation treatment that duplicated the amounts and timing of water applied to the field. This compares very well with the estimated total *cis*-1,3-D emission (Table 1) using the aerodynamic method (i.e., 17%; cis-1,3-D) but is larger than the total *cis*-1,3-D emissions estimates from the TPS and IHF methods (i.e., 11-12%).

References

Ashworth, D.J., and Yates, S.R., Surface irrigation reduces the emission of volatile 1,3-D from agricultural soils, *Environmental Science and Technology*. 41:2231-2236. 2007.