APPLICATION OF AMMONIUM THIOSULFATE TO REDUCE TELONE II EMISSIONS FROM SOIL

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The anticipated phase-out of methyl bromide (MeBr) has stimulated an intensive search for effective alternatives. 1,3-Dichloropropene (Telone II, or 1,3-D), used alone or in combination with chloropicrin, is considered as one of the most promising MeBr replacements. However, both isomers of 1,3-D are highly volatile. A number of studies have shown that 11-90% of applied 1,3-D can escape into the air after soil fumigation. Because 1,3-D is acutely toxic and potentially carcinogenic, excessive emissions of its vapor into the atmosphere may contribute to air pollution and cause detrimental effects to human health and the environment. Thus, in order to continue Telone fumigation in an environment-compatible manner, it is important to develop mitigation practices to reduce its emissions while sustaining its effectiveness for pest control.

Atmospheric emissions of a fumigant can be reduced if the fumigant's volatility is eliminated because of degradation or transformation of the parent compound. In our recent work we have identified thiosulfate products as highly efficient reactants for MeBr, 1,3-D, chloropicrin, methyl iodide, and propargyl bromide. Thus, thiosulfate products may be used as surface reactants to suppress emissions of these fumigants. As ammonium and potassium thiosulfates are commercial fertilizers, this mitigation approach is cost-effective and simple to implement. Here we report transformation of 1,3-D by ammonium thiosulfate (ATS) in soil under different conditions, and experiments demonstrating reduction in Telone II emissions after surface amendment of ATS.

Transformation of 1,3-D in ATS-amended soil was proportional to the relative ratio of ATS to 1,3-D. As shown in Table 1, the half-life of *cis*-1,3-D in soil was reduced from 256 h (~10 d) in the non-amended soil to 18 h when the ratio was 2:1, and further to only 4 h when the ratio was 4:1. Similar relationships between ATS amendment levels and 1,3-D transformation were observed for both Arlington and Carsitas soils, indicating that ATS-induced 1,3-D transformation was independent of soil type (Table 1). Overall, as the ratio of ATS to 1,3-D was doubled, the half-life of 1,3-D was halved.

We subsequently conducted column experiments to evaluate the reduction of 1,3-D emissions by surface amendment of ATS. In large columns packed with Arlington sandy loam, 1,3-D emission rate (% of applied dosage) decreased rapidly with increasing ATS application rate (Figure 1). When ATS was applied in 9 mm water at 64 g m^{-2}, total 1,3-D emission was reduced by 61%. The reduction increased further to 89% when ATS was applied at 193 g m^{-2}. Bioassays showed that ATS application did not affect 1,3-D's effectiveness for controlling citrus nematodes that were inoculated at different depths along the column.

Surface amendment of ATS was further tested using field plots in which Telone EC (an emulsified formulation) was applied via subsurface drip irrigation in Coachella Valley, CA. ATS application reduced overall 1,3-D emissions by 50% when soil surface was not tarped, and by 71% when the soil surface was tarped with polyethylene sheets (Figure 2). Analysis of nematode population throughout the season and yields of two cultivars of tomato showed that ATS application did not affect the effectiveness of Telone fumigation for nematode control or crop growth.

Application of ATS to suppress 1,3-D emissions was also tested recently during shank-fumigation of Telone II in a carrot field in Bakersfield, CA. Telone II was shank injected at 18 inches deep and at 12 gal per acre, and Thio-Sul (ATS formulation) was applied after fumigation at 60 gal per acre. Nematode population was determined before and after fumigation treatment. Volatilization of 1,3-D was measured for 7 days. Results from this study will be available at the meeting time.

Data so far convincingly show that ATS application during Telone fumigation effectively reduces 1,3-D emissions, but will have little or no effect on the efficacy of pest control. The magnitude of emissions reduction will likely depend on the application rate of ATS, the amount of water used to deliver ATS, and the timing of ATS application with respect to Telone treatment. This risk-mitigation measure should be further tested and developed under other conditions and on a larger scale.

TABLE 1 Half-life (in hours) of 1,3-D isomers in soils amended with ammonium thiosulfate (ATS) at different molar ratios relative to the fumigant

Soil type	ATS:1,3-D ratio			
	0:1	1:1	2:1	4:1
Arlington sandy loam:				
cis-1,3-D	256	50	18	4
Trans-1,3-D	224	96	50	18
Carsitas loamy sand:				
cis-1,3-D	385	58	24	13
Trans-1,3-D	365	117	55	25

Figure 1. Decreases in 1,3-D Emissions with ATS Application (Column)

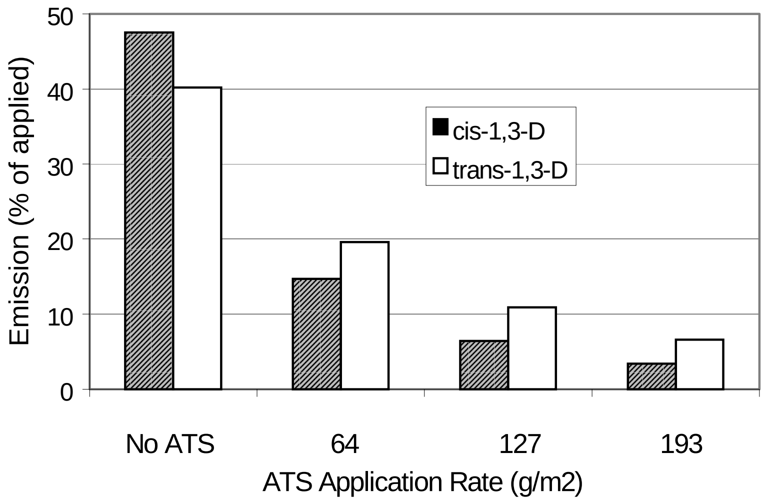

Figure 2. Decreases in 1,3-D Emissions after ATS Application (Field Plot Experiment)