SURFACE APPLICATION OF FERTILIZER AMMONIUM THIOSULFATE TO REDUCE METHYL BROMIDE EMISSION FROM SOIL

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Polyethylene plastics are known to be very permeable to MeBr, and high MeBr emissions occur from polyethylene film tarped fields. MeBr emission can be reduced if a highbarrier plastic is used in place of the polyethylene film. Another fundamentally different, but potentially effective approach to minimize MeBr emission, is to apply a fast MeBr-degrading material at the soil surface, so that MeBr is detoxified before it escapes into the air. To be acceptable in production agriculture, however, such a material must not only be effective for degrading MeBr, but also be inexpensive and environmentally benign.

In our recent research, we identified ammonium thiosulfate (ATS), a sulfur and nitrogen fertilizer, as an effective, safe and inexpensive MeBr degrader that may have the potential to be used on the production scale. ATS is a commercial fertilizer that is available at a very low cost. For instance, Thio-Sol (Texas Sulfur Co.), a liquid containing 60% ATS, is sold at only $1.5 a gallon. In this presentation, we report characteristics of ATS-enhanced MeBr degradation and drastically reduced MeBr emissions from ATS treated soil columns.

1. Rapid MeBr Degradation in ATS-treated Soil

First, we conducted three degradation experiments, in which degradation of MeBr in ATS-treated soil was studied as a function of ATS application rate, soil type and soil temperature. In the first experiment, the ratio of ATS-to-MeBr in an Arlington sandy loam (Riverside, CA) was varied from 0: 1 to 4: 1. In the second experiment, three soil types (all from CA) were tested. In the third experiment, degradation at 4 different soil temperatures was measured. Half-life values of MeBr degradation under these conditions are summarized in Tables I and 2. We observed:

i). MeBr degradation accelerated with the increasing rate of ATS application. In the unamended soil, the half-life for MeBr was 133 h (or about 5 d), which was reduced to only less than 5 h when 4 parts of ATS was added into the soil that was treated with I part of MeBr.

ii). Degradation of MeBr in ATS amended soil quantitatively produced bromide ion - a nonvolatile, water soluble and relatively innocuous product.

iii). ATS was equally effective for different soil types.

iv). MeBr degradation in ATS treated soil accelerated with increasing temperature. This implies that very rapid degradation can occur in warm, tarped soil.

2. Reduced MeBr Emissions from ATS-treated Soft Columns

To tentatively assess the effectiveness of surface ATS application for reducing MeBr emission, volatilization of MeBr was measured from soil columns that received different ATS amendments. The column system was made of a 60 cm (long) x 12.5 cm. (i.d.) glass column packed with soil and a 5 cm (long) x 12.5 cm (i.d.) sampling chamber that was mounted on the top of the soil column. Volatilization of MeBr from the soil surface was continuously measured till emission ceased. The soil used was Arlington sandy loam, and the soil bulk density was 1.55 g/cm^3 and water content 19%. MeBr was injected 30 cm at 125 lb per acre. Four different ATS amendments were included:

A. Tarped column, and no ATS addition - Control;
B. Tarped column; Thio-Sol in water was applied at 85 gallons per acre at the soil surface 24 h before MeBr injection - Pre-ATS Amendment:,
C. Tarped column; Thio-Sol in water was applied at 85 gallons per acre immediately after MeBr injection - Parallel *ATS Amendment;*
D. Bare column; Thio-Sol in water was applied at 85 gallons per acre immediately after MeBr injection - *Bare ATS Amendment.*

The measured cumulative volatilization losses, in % of applied MeBr, are shown in Figure 1, and the measured bromide concentrations in the soil at the end of the experiment are shown in Figure 2. We observed:

i). Under polyethylene plastic tarped condition, surface application of ATS, either before or immediately after MeBr injection, reduced MeBr emission from 61% to less than 10%.
ii). In the untarped column, the reduction was less, but was still substantial compared to the tarped control.
iii). Analysis of bromide in soil indicates that MeBr was extensively degraded to bromide ion near the soil surface.

Using an existing fertilizer to minimize MeBr emission represents a novel mitigation approach. The potential of using ATS to reduce MeBr emission is of particular significance not only because that there is a lack of effective alternatives to MeBr, but also because that the global use of MeBr as a soil fumigant will likely continue for many years to come. The effect of ATS amendment on the efficacy of MeBr for parasitic nematodes and other pests, however, is yet to be evaluated. The significant reduction in MeBr emission caused by ATS application, as seen in our column study, nevertheless justifies that additional effort should be invested to further explore this approach.

Table 1. Measured first-order MeBr degradation half-life in ammonium thiosulfate amended soils (20°C)

Soil	ATS-to-MeBr molar ratio	Half-life(in h)
Arlington sandy loam:	0: 1 (control)	133
	1:1	58
	2:1	21
	4:1	4.7
Linne clay loam:	0: 1 (control)	152
	2:1	16
Carsitas loamy sand:	0: 1 (control)	116
	2:1	15

Table 2. Measured first-order MeBr degradation half-life in ammonium thiosulfate amended Arlington sandy loam (2:1 ATS-to-MeBr ratio) at different temperatures

Temperature (0 C)	Half-life (h)
10	36
20	21
30	10
40	4.5

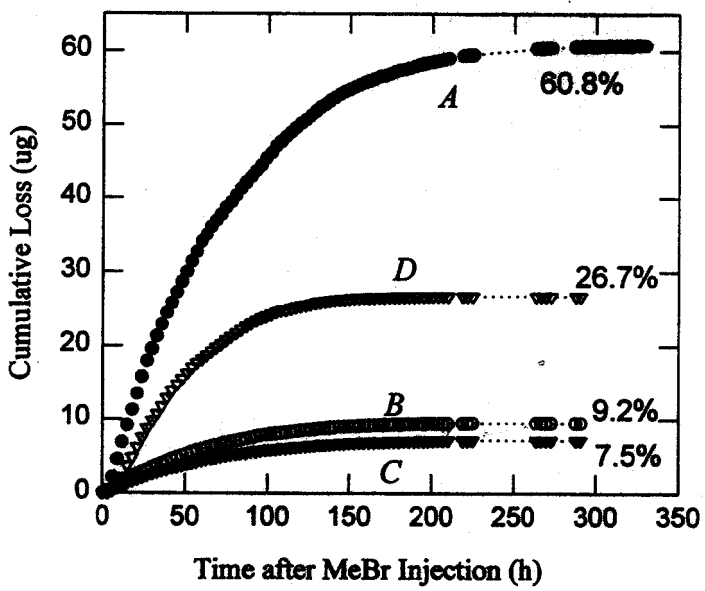

Figure 1. Emission loss of MeBr (0/o of applied) from Control (A), Pre-ATS Amendment *(B),* Parallel ATS Amendment (C), and Bare ATS Amendment (D)

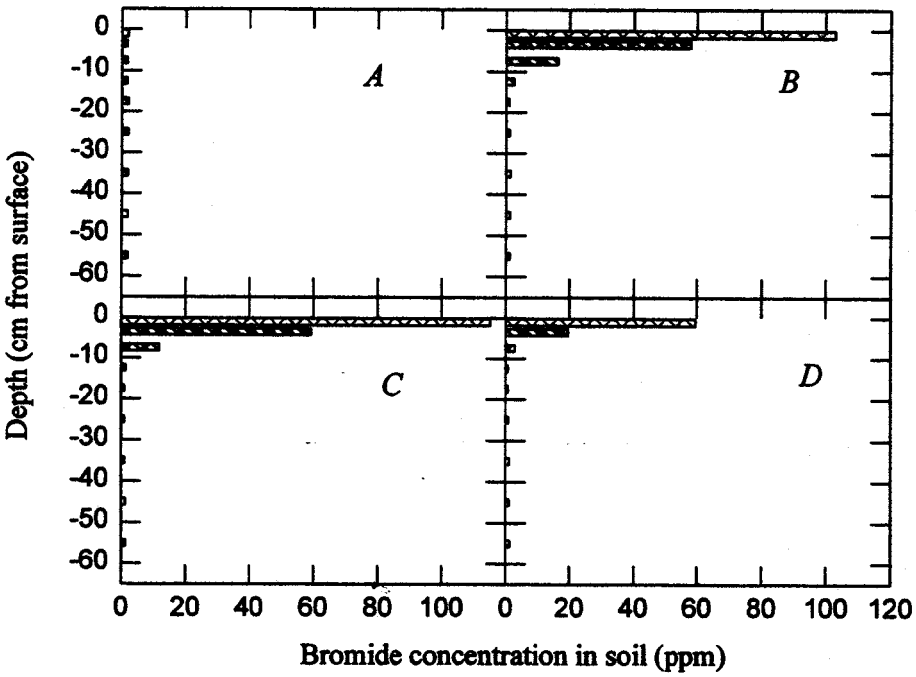

Figure 2. Soil bromide distribution (in mg/kg) at end of study in Control (A), Pre-ATS Amendment *(B),* Parallel ATS Amendment (C), and Bare ATS Amendment (D)