Memorandum

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Place : Sacramento

From : Department of Food and Agriculture Chris Collison, Assoc. Env. Research Scientist
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Subject: **LITERATURE REVIEW OF THE ENVIRONMENTAL FATE OF METAM-SODIUM (VAPAM®)**

This review was based on data from the CDFA pesticide registration packages cited as Stauffer Chemical Company and ICI Americas, Inc., and from open literature articles.

Metam-sodium (sodium methyldithiocarbamate) is the active ingredient in Vapam®, a broad-spectrum soil fumigant produced by Stauffer Chemical Company. It is commonly applied as a preplant fumigant incorporated into the irrigation system.

Conversion In Soil

Metam-sodium degrades rapidly to methyl isothiocyanate (MITC) when in contact with moist soil. Smelt and Leistra (1974) found that the conversion of metam-sodium to MITC (>90%) took only a few hours. In experiments using spiked moist soil in glass septum flasks incubated at 12°C, conversion was complete in 3 hours in loamy soils and in 6 hours in a humic sandy soil. At 21°C in the sandy soil, a period of 3-4 hours was sufficient for conversion to MITC.

The decomposition rate of MITC in moist soil was also investigated (Smelt and Leistra, 1974). Depending on the soil type, half-lives for MITC were in the range of 8-14 days. The most rapid decomposition occurred in heavy, loamy soils at higher temperatures. Smelt et al. (1989) also investigated decomposition rates of MITC in "problem" soils (those demonstrating inadequate pest control by fumigation with metam-sodium). MITC in amounts ranging from 1.5 to 2.0 mg (equivalent to 150 kg/ha) was added to glass flasks partially filled with moist soil and incubated in the dark at 15°C. A comparison of the decomposition patterns of MITC in previously treated and untreated soils showed that, in general, MITC degraded much faster in the previously treated soils. This suggested that repeated applications of metam-sodium induced microbial adaptation resulting in enhanced biotransformation of MITC. In this study, MITC half-lives ranged from 0.5 to 50 days. The study results also indicated that the decomposition rate of MITC greatly depends on the initial content of the fumigant.

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Soil Mobility

In two field studies conducted "under normal agricultural conditions" in Mississippi and California by ICI Americas, Inc. (1989), MITC was found no deeper than 9 inches in soil and undetected at any depth 13 days after application. Vapam was applied to bare fallow soil at a rate of 100 gallons of formulated material (32.7% AI) per acre by chemigation with an overhead sprinkler. The respective zero-time MITC residues were 18 and 42 ppm in the upper 6 inches of soil in Mississippi and California. Half-lives were 13 and 26 hours in loam soil near Visalia, California and loam/silt-loam soil near Leland, Mississippi respectively. Four days post application, maximum residues of the degradation product 1,3-dimethylurea were from 0.13 to 0.51 ppm.

Leaching experiments were performed by Stauffer Chemical Company (1985a) using 32-37 cm long glass and steel columns hand packed with soil. A radiolabeled ^{14}C metam-sodium solution was used to spike the columns at concentrations equivalent to 1 quart/100 sq ft and, at the highest application rate recommended, 2 quarts/100 sq ft. Four soil types ranging from sand to loamy sand to sandy clay were tested. In each case, about 60% of the applied ^{14}C leached from the columns after 48 mL of water were poured on the soil (equivalent to 20 inches X the cross sectional area of the columns). About 90% of the leached ^{14}C was identified as MITC. Results indicated that the bulk of the soluble ^{14}C leached out of the soil soon after the volume of water necessary for soil saturation was added. Between 11 and 14% of the applied ^{14}C remained bound to the soil and 23 to 30% was assumed to have been lost as volatile degradation products, mainly MITC.

Volatile Emissions

Emissions of MITC from greenhouse soil were studied by Leistra and Crum, (1990). Concentrations of MITC in treated soil were measured and the data was used in a computer model to simulate emissions from the soil. The experimental fumigation was conducted in a greenhouse with wetted, sandy soil cultivated to a depth of 0.25 m. Two hundred and forty liters of the trade product (510 g metam-sodium per liter), which corresponds to 1950 L/ha of the trade product, was applied with a small self-propelled shank injector to a depth of 0.05-0.10 m. A 30 µm thick low density polyethene film was used to completely cover the soil after application and was left on the soil surface for 7 days. Before removal of the cover, the cumulative emission of MITC from the greenhouse soil was computed to be about 45% of the applied dosage. At day 14, seven days after removal of the cover, the total cumulative emission was 50% of the applied dosage.

The highest rate of emission from the film-covered soil ocurred on the first day after application. Concentrations in greenhouse air were computed to be around 50 mg/m on the first day and exceeded 10 mg/m during the first 4 days after injection. When the model was modified to exclude the factor of a film cover, the computed MITC emission rate one day after application was 2.5 times greater than the rate with a film cover. The cumulative emission after 14 days without a film cover was computed to be 64% of the applied dosage. The vapor pressure of MITC is 2.7 kPa at 20°C (Hartly and Kidd, 1983).

The emission model was further modified to simulate the homogeneous incorporation of metam-sodium into the soil to a depth of 0.24 m after a surface application. The results indicated a somewhat lower emission rate in the first 3-4 days. After about 4 days, the emission rate was similar to that for injection. At the end of the 14 day period, the computed cumulative emission corresponded to 38% of the applied dosage. Without a film cover, the emission was 49% of the equivalent dosage.

Hydrolysis

Half-lives for metam-sodium at 20°C in dilute solutions at pH 5, 7, and 9 were 23, 180, and 46 hours respectively. The major products of hydrolytic degradation at pH 5 were methylamine, MITC, and carbon disulfide. Minor hydrolytic degradation products included elemental sulfur and 1,3-dimethylthiourea (Stauffer Chemical Company, 1985b).

Photolysis

The major products arising from photolysis of metam-sodium in aqueous solution (120 ppm) at 25°C and pH 7 were MITC, N-methylthioformamide, methylamine, and elemental sulfur. Minor photolytic degradation products included N-methylformamide, carbon disulfide, carbon oxide sulfide, and hydrogen sulfide. Under these conditions, the half-life for metam-sodium was 1.6 hours (Stauffer Chemical Company, 1985b)

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