

# DISTRIBUTION AND LEACHING OF METHYL IODIDE IN SOIL FOLLOWING EMULATED SHANK AND DRIP APPLICATION

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## Abstract

The pest-control efficacy and groundwater contamination risks of methyl iodide (Mel) as a fumigant is highly related to its gas-phase distribution and leaching after soil application. Emulated shank injection and subsurface drip application of Mel into Arlington sandy loam columns at 20 cm depth showed that Mel diffused rapidly in soil, and reached 70 cm depth within 2 h. Relative to shank injection, drip application inhibited diffusion, resulting in significantly lower concentration profiles in the soil air. Leaching of Mel was significant from the soil columns even after 7-d containment plus 7-d aeration, with concentrations >10  $\mu\text{g L}^{-1}$  in the early leachate. Persistent residues of Mel remaining in soils after leaching were 50-240  $\text{ng kg}^{-1}$ . The results suggest that fumigation with Mel may pose a risk of groundwater contamination in vulnerable areas.



Fig. 1 Shank injection (left) and drip application of fumigants in the field

## Introduction

- Fumigation (Fig. 1) is a popular method to sterilize soil in high value crop production;
- Due to the high potential to deplete stratospheric ozone, the mostly common used fumigant methyl bromide is being phased out;
- Methyl iodide (Mel) shows equivalent or better pest-control effect and is a promising chemical alternative to methyl bromide;
- The environmental fate and transport of Mel after soil application are of great concern;
- Pest-control efficacy & groundwater contamination risks of Mel as a fumigant are dependent on its gas-phase distribution and leaching potential in treated soils, which are unknown.

## Objectives

To investigate 1) the gas-phase distribution, 2) leaching, and 3) persistent residue retention of Mel in soils following shank injection and subsurface drip application.

## Methods

- Four soil columns (12 x 70 cm, Fig. 2) were prepared by packing Arlington sandy loam (OC 0.92%, pH 7.2) into stainless steel cylinders to give a bulk density of  $1.61 \text{ g cm}^{-3}$ ;
- 750 g of 5 mM  $\text{CaCl}_2$  were added to each column for moisture adjustment. The columns were equilibrated for 60 d with top sealed;
- The top 20 cm soil in the columns was tilled to give a bulk density of  $1.29 \text{ g cm}^{-3}$ . This was to simulate the soil bedding operation in field practices;
- The columns were set in a fume hood at  $21^\circ\text{C}$ . With tops covered by impermeable films, each column was spiked with  $100 \mu\text{L}$  of Mel at 20 cm depth. The chemical was either directly injected to the column center with a syringe (*shank injection*) or drip-applied at  $2.0 \text{ ml min}^{-1}$  with 250 ml of  $\text{H}_2\text{O}$  using a peristaltic pump (*drip application*);
- At predetermined times, soil air samples were collected at different column depths and analyzed for Mel contents with gas chromatography techniques;
- The column top cover was removed 7 d after fumigant application, allowing another 7 d of aeration. The columns were then leached with 5 mM  $\text{CaCl}_2$  under 2 cm constant water head. Contents of Mel in the leachate were monitored.

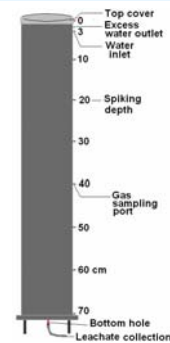


Fig. 2 Soil column

## Results

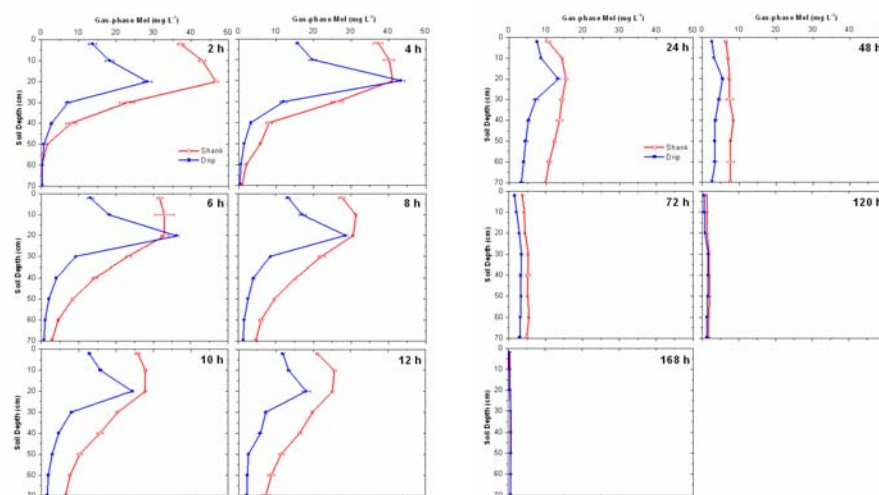


Fig. 3 Concentration profiles of gas-phase Mel in soil columns under shank injection and drip application in 168 hours after placement.

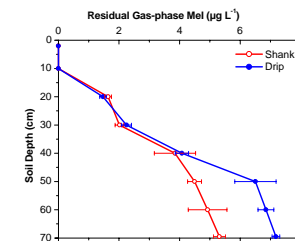


Fig. 4 Residual gas-phase Mel in the soil air after 7 days of volatilization in the open atmosphere.

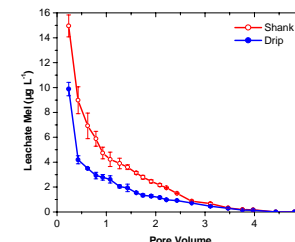


Fig. 5 Concentrations of Mel in leachates from soil columns.

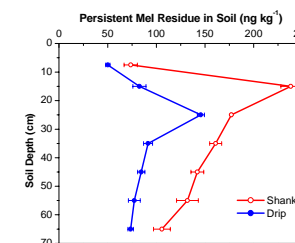


Fig. 6 Persistent residues of Mel remained in soils after water leaching.

## Conclusions

- Mel diffused rapidly in moist soils, and reached 70 cm depth within 2 h;
- The gaseous diffusion flux was controlled by soil bulk density and moisture content;
- Shank injection resulted in significantly higher gas-phase concentration profiles than drip application;
- Leaching of Mel was significant from treated soils, with concentrations >  $10 \mu\text{g L}^{-1}$  in early leachate;
- Soil fumigation with Mel may contaminate ground water in vulnerable areas.