# EMISSION AND SOIL DISTRIBUTION OF FUMIGANTS IN FOREST TREE NURSERIES

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Production of tree seedlings in the majority of forest nurseries in the USA has relied on soil fumigation with methyl bromide (MeBr) to control soil-borne plant pathogens, weeds, parasitic nematodes and insects. Since the announcement of the scheduled MeBr phase-out, a number of nurseries throughout the United States have participated in research programs on MeBr alternatives including methyl isothiocyanate (MITC) and chloropicrin (CP). However, a majority of the research on alternatives to MeBr in forest tree nurseries has focused on pest control efficacy. There is rarely any information in the literature on the environmental fate, emission, and soil distribution patterns of these potential alternative fumigants when applied in forest tree nurseries.

**Experiments and Measurements:** Field experiments were conducted at forest nurseries in northern Wisconsin (near Hayward, WI) and southern Georgia (near Byromville, GA) to measure emission and soil distribution of MITC and CP following the application of soil fumigants. Four treatments were tested as combinations of two fumigants (dazomet – a granular MITC precursor or co-application of CP and metam sodium – a liquid MITC precursor) and two surface cover methods (tarp or water seal). The experimental design was a randomized block with four replications repeated for each surface cover treatment (in separate areas to accommodate for the water seal treatment). The dimension of each plot was 2.4 m wide by 9.1 m long separated by a 9.1 m buffer space between plots. A total of 16 plots were used at each experimental site.

For emission measurements, passive flux chambers were used because they could be placed on the small plots only during measurements and would not interfere with the water seal (irrigation) treatment. Emission samples were collected every 3 h during the first 3 days of each experiment. Incrementally longer sampling intervals were used at later times, and the emission sampling was continued for at least 17 days during each experiment.

To facilitate measurement of MITC and CP concentrations in the soil, multi-port soil air sampling probes were built before the experiments. One probe was installed at the center of every fumigation plot, and driven into the soil 60 cm from the surface with a post driver. To adequately document fumigant dispersion over time, 12 sampling events were made during the course of the Wisconsin experiment and 9 events for the Georgia experiment at various elapsed times from

0.14 to 19.83 days after fumigant application. A total of over 5000 soil air samples were obtained from the two field studies.

**Results and Discussion:** Among all treatments, a very small percentage (< 5%) of the equivalent MITC was lost through atmospheric emission (Table 1). Less MITC emission was found from the water seal than from the tarp plots. Final cumulative emission accounted for about 10 to 22% of the applied CP. Because of higher air and soil temperatures, cumulative MITC or CP emissions from the Georgia tarp plots were about twice that of the respective values from the Wisconsin experiment. Regardless of surface cover methods, > 70% of total cumulative emission of either MITC or CP occurred within one week after fumigation. These results indicate that MITC and CP emissions were within the same order of magnitude with surface covers of a water seal or tarp following fumigation with dazomet, metam sodium and CP in forest tree nurseries.

Significantly higher MITC and CP concentrations were typically observed in soil under the tarp than the water seal covers (Figure 1). MITC and CP were concentrated in the upper 30-cm soil profile under tarp and the effect lasted for about three days. MITC concentrations in soil air were similar in dazomet or metam sodium applications under tarp. The much lower fumigant concentrations in the water sealed plots, especially near the soil surface, may explain why adequate control of certain pests is sometimes not achieved when using this practice.

## Literature Cited

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Wang, D., S.W. Fraedrich, J. Juzwik, K. Spokas, Y. Zhang, and W.C. Koskinen. 2005b. Fumigant concentration distribution in forest nursery soils under water seal and plastic film after application of dazomet, metam sodium, and chloropicrin. *Pest Manage. Sci. ( in press).*

Table 1. Final cumulative emission loss of soil fumigants (Wang et al. 2005a).

| Chemical | Location | Final cumulative loss † | | | |
|---|---|---|---|---|---|
| | | Tarp | Water seal | Tarp | Water seal |
| | | (g/m²) | | (% of applied)‡ | |
| Dazomet | Hayward, WI - Spade | 0.373±0.081 aA | 0.048±0.015 bA | 2.1 | 0.3 |
| | Hayward, WI - Tiller | NE | 0.008±0.002 B | NE | 0.1 |
| | Byromville, GA | 1.062±0.196 aB | 0.727±0.184 aC | 4.7 | 3.2 |
| Metam sodium | Hayward, WI | 0.442±0.094 aA | 0.318±0.094 aA | 2.5 | 1.8 |
| | Byromville, GA | 0.922±0.305 aB | 0.203±0.046 bA | 5.2 | 1.1 |
| Chloropicrin | Hayward, WI | 1.600±0.219 aA | 3.718±0.551 bA | 9.5 | 22.1 |
| | Byromville, GA | 3.024±0.587 aB | 2.381±1.195 aA | 18.0 | 14.2 |

† Cumulative loss of methyl isothiocyanate (MITC) was measured for dazomet and metam sodium. Means ± standard errors are presented for four replications. Means with different letters within each chemical group are significantly different ($P \leq 0.05$) between the tarp and water seal treatments for the same location (lowercase letters) or between experiment locations for the same cover treatment (uppercase letters). NE = not evaluated.

‡ Assumed on a molar basis 100% conversion from dazomet to metam sodium, and 90% conversion from metam sodium to MITC.

Figure 1. Average concentrations of methyl isothiocyanate (MITC) and chloropicrin in soil air within 0.14 to 0.30 days (d) after application of fumigants (Wang et al. 2005b).