A SOIL BACTERIUM WHICH GROWS ON METHYL BROMIDE AND ITS APPLICATION TO THE DISSIPATION OF METHYL BROMIDE DURING SOIL FUMIGATION.

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Bacterial oxidation of methyl bromide (MeBr) during field fumigation operations was reported by Miller et al. (1997). In laboratory incubations, repeated additions of MeBr to these live soils resulted in faster rates of MeBr consumption relative to killed controls (Fig 1). This suggested that bacteria present in the soils were using MeBr as a substrate for growth. A pure culture of a grain negative, motile rod-shaped bacterium capable of growth upon MeBr was isolated from dim sods (fig. 2). The isolate, designated strain IMB-1, was closely related to the nitrogen-fixing genus *Rhizobium* and specifically to the N-methyl carbamate-degrading strain ER2 (Topp et al., 1993). Strain IBM-1 was found to be a facultative methylotroph, which in addition to its ability to grow on MeBr, was also able to achieve growth by oxidation of methyl iodide (MeI), methyl chloride, methylated amines, formate, methanol, acetate, and glucose. No growth was achieved with methane or methyl fluoride. Strain IBM-1 retained its ability to oxidize MeBr even after being carried through two consecutive transfers on any of the above growth substrates. However, a 20 % enhancement of MeBr oxidation was noted in cells which were grown on glucose while being exposed to traces of MeI, as opposed to those just grown on glucose.

The above results with sawn IMB-1 suggested the possibility that this microorganism could be employed as a means to dissipate MeBr during field fumigations. Addition of either MeBr-grown or glucose-grown cells to soils dramatically enhanced the rate of MeBr oxidation. For example, fumigation-levels of MeBr were completely consumed within I day after addition of MeBr-grown cells, and within 2 days for glucose-grown cells. In contrast, unamended live sods required 7 days incubation before MeBr was completely oxidized (Fig 3). In another experiment, pre-incubation of soils with low levels of Mel resulted -4 oxidation of MeI, and subsequently these sods had greatly enhanced rates of MeBr oxidation (Fig. 4). Inclusion of trimethylamine slightly enhanced this activity. Pre-incubated soils competely oxidized MeBr within 34 days, while untreated soils required 8 days. Presumably, pre-treatment of sods with Mel enhanced the population of bacteria like IMB1, thereby accelerating the rate of MeBr oxidation.

The above remits indicate that a technique may be devised whereby biological treatment of soils prior to their fumigation results in the destruction of MeBr while it is held within the soil matrix, thereby preventing its efflux to the atmosphere. This can be achieved by either pre-applying to the soils low levels of Mel, or by adding live cells of mass-cultured strain IMB-1 to the soils. These approaches must be tempered by the fact that chloropicrin inhibits bacterial oxidation of MeBr in soils (Miller et al., 1997), and future work will investigate whether or not currently applied dosages of chloropicrin are compatible with our proposed dissipation techniques. Furthermore, field tests are planned to determine if the dissipation techniques will achieve the dual goals of eliminating efflux of MeBr to the atmosphere while retaining the efficacy of MeBr as an agricultural fumigant

1. Topp, E., R.S. Hanson, D.B. Ringelberg, D.C. White, and R. Wheatcroft. 1993. Isolation and characterization of an N-methylcarbamate insecticide-degrading methylotrophic bacterium. Appl. Environ. Microbiol. 59: 3339 - 3349.
2. Miller, L.G. T.L. Connell, J.R. Guidetti, and KS. Oremland. 1997. Bacterial oxidation of methyl bromide in fumigated agricultural soils. Appl. Environ. Microbiol. (in press).

Figure 1

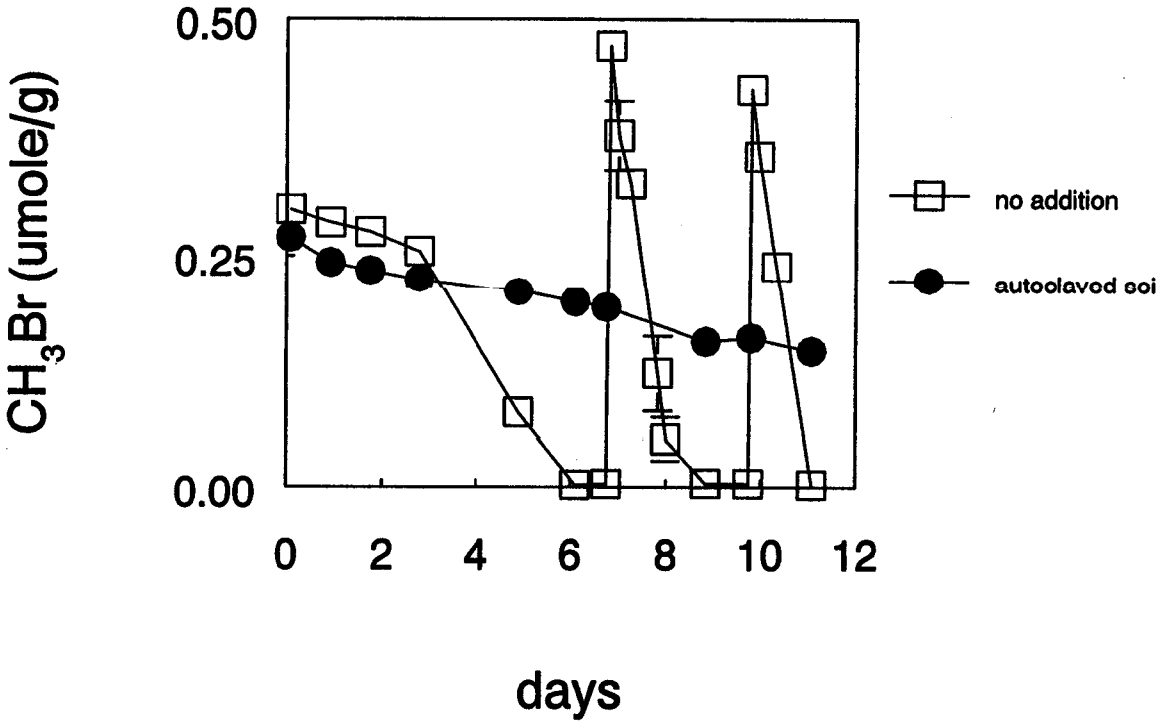

Figure 1. Consumption of MeBr by live and autoclaved Irvine soils. Live soils received additional MeBr injections when all the gas was consumed (Miller et al., 1997).

Figure 2

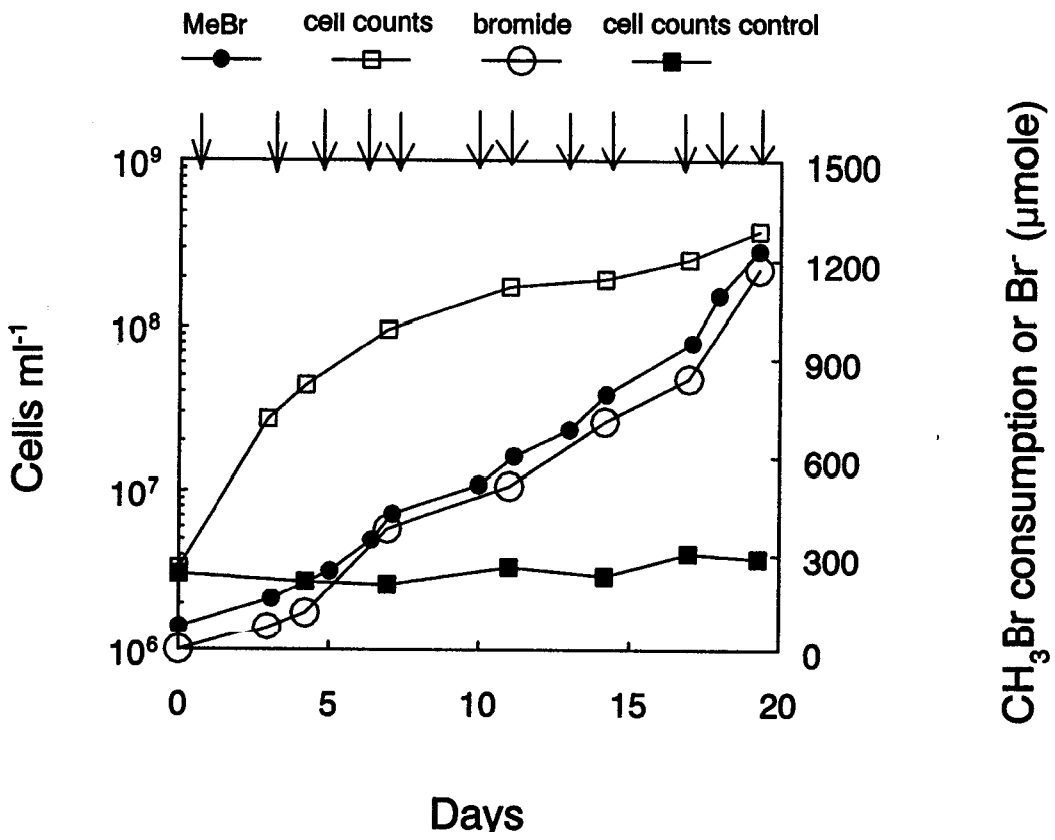

Figure 2. Growth of a pure culture upon MeBr. MeBr consumption is the cumulative quantit of 12 discrete additions made over the course of the incubation after it was determined before each addition that MeBr was absent from the gas phase (Miller et al., 1997).

Figure 3

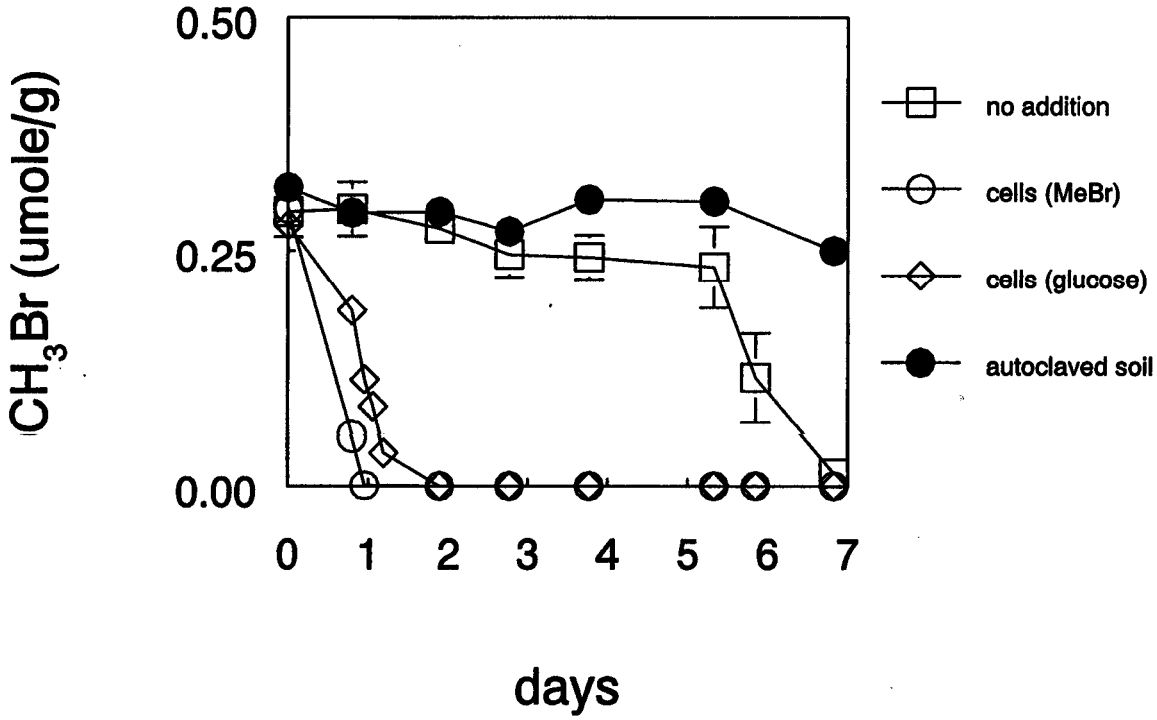

Figure 3. Consumption of MeBr by Irvine soils, including soils amended with live cells of strain IMB-1 grown on either MeBr or glucose.

Figure 4

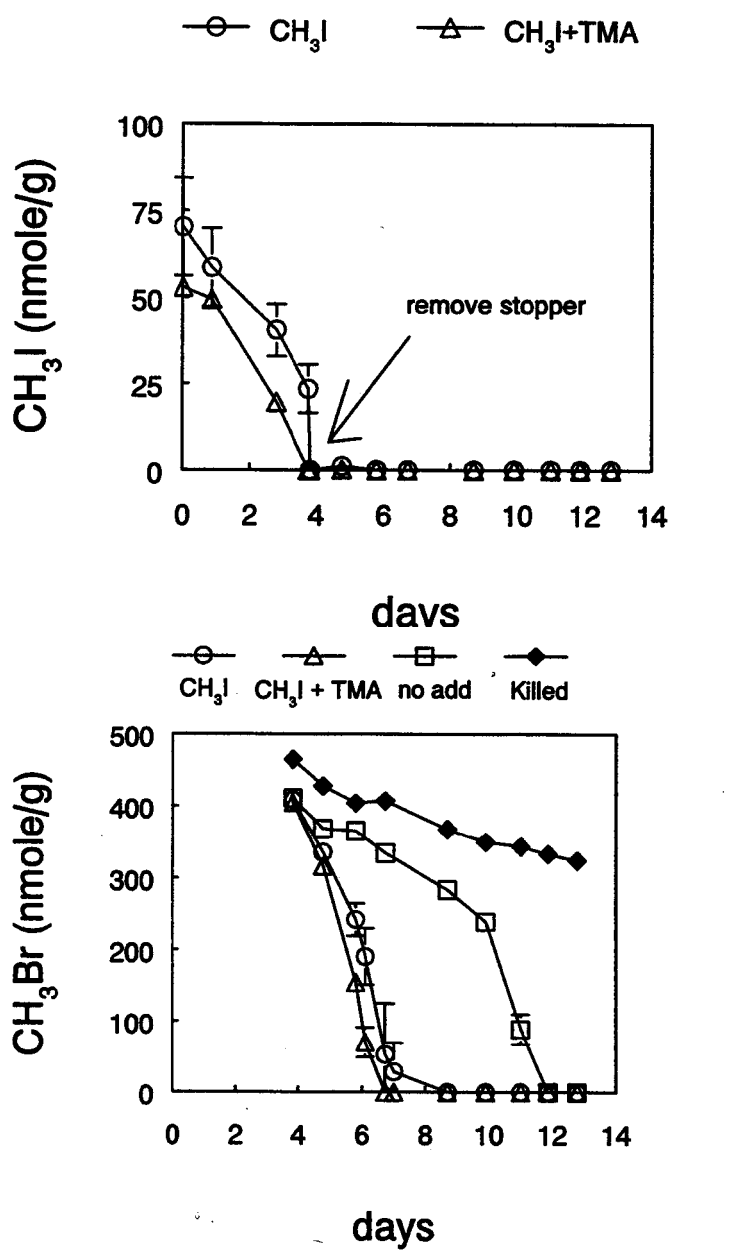

Figure 4. Pretreatment of soils with MeI which enhanced bacterial MeBr degradation.