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The influence of commodity, packing material and the properties of the fumigation chamber on the concentration of methyl bromide (MeBr) in the gas phase[1]

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Summary

In the fumigation of plants and other commodities, the concentration of the fumigant in the free space of the chamber, is greatly dependent on the nature of the product being fumigated, the packing material used and on the properties of the fumigation chamber itself. It is proposed that in expressing dosages for specific treatments, a characteristic that takes these influences into account, should always be used. It is insufficient merely to specify certain initial doses.
Experiments to determine the effects of these factors on fumigation with methyl bromide are described.

1. Introduction

VAN DE POL and RAUWS (1957) studied the influence of commodity, packing material and the properties of the fumigation chamber on the behaviour of hydrocyanic acid gas. The present experiments with methyl bromide were done because of the considerable difference in the behaviour of these two chemicals when used as fumigants. Because it is only the fumigant in the free space that has an effect on insects and mites we have investigated the extent to which the concentration of 'free' methyl bromide is influenced by sorption on the commodity, the packing material and the surfaces of the chamber. We have limited our study to the range of concentrations determined on the one hand by the dose required to kill the pest and on the other, by the dose causing phytotoxic reactions. This range is usually small and therefore, the employment of the correct dose is of great importance. The experiments were made in 1960.

1 This article is a continuation of an article issued in *Neth. J. agric. Sci. 5* (1957) 2 : 115—126.

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2. Methods

The work was done in an experimental fumigation chamber made of iron, with grey oil painted walls, of three cubic metres capacity and a gas circulation system giving a charge of 120 cubic metres per hour. The chamber was equipped with a heating unit which was used to precondition the chamber and its contents to the temperature required by the experiments, namely 21° C. Liquid methyl bromide stored under pressure in a cylinder was led into a glass measure whence by opening a tap it passed through a volatilizer and into the fumigation chamber. Throughout all fumigations the fan in the circulation system was operated in order to maintain a homogenous gas/air mixture.
All experiments were done in duplicate at atmospheric pressure and the concentration of methyl bromide was measured every 10 minutes by means of a thermal conductivity meter (PHILLIPS and BULGER, 1953).
Generally there was a considerable interval between experiments, but the chamber was always ventilated for at least fifteen minutes after use. Previous experiments had shown that this interval was adequate to prevent any residual effect such as sorption on the chamber itself, from affecting a succeeding treatment.
The relative humidity was determined during each experiment but has not been taken into account, because in other experiments at constant temperature it was found that over a range of 37—100 per cent this factor had no influence on the concentration of 'free' methyl bromide in the chamber. This was in accordance with the findings of CHISHOLM and KOBLITSKY (1943).
Gas concentration was determined in the empty chamber and in the chamber packed with different plant products and packing material. In all cases equal amounts by weight of material were used, namely 80 kg narcissus bulbs, woody plants, dry sand, flower pots, soil, sphagnum, peat dust, crates and straw.
All the experiments were done according to the recommendation of LATTA, RICHARDSON and BULGER (1950) for the treatment of non-foliated plants, namely 48 g methyl bromide per cubic metre (equivalent to 3 lb per 1000 cubic feet) for two hours at a temperature of 21° C.

3. Results

Time and concentration curves recorded for a number of materials are shown in the FIGURE, and the results including a comparison with those obtained for hydrocyanic acid are given in the TABLE. The relative humidity in these experiments varied from 55—98 per cent.
The results show that the concentration of 'free' gas is strongly influenced by the sorption of different materials. This influence is however, considerably smaller with methyl bromide than with hydrocyanic acid. Even with methyl bromide, the loss can amount to 18 per cent (straw) over a period of 120 minutes. In the empty chamber the loss amounted to 4 and 29 per cent respectively for methyl bromide and hydrocyanic acid. When loaded with equal weights of concrete blocks the difference was smaller, namely 16 and 27 per cent.

4. Conclusion

It is clear from these data that sorption must be taken into account when calculating the dosage for fumigation treatment. It is proposed therefore, that in prescribing treat-

FIGURE. The concentration of the 'free' gas during a fumigation with 48 g MeBr per m^3 in an empty cell and in the same cell with woody plants, crates and peat dust

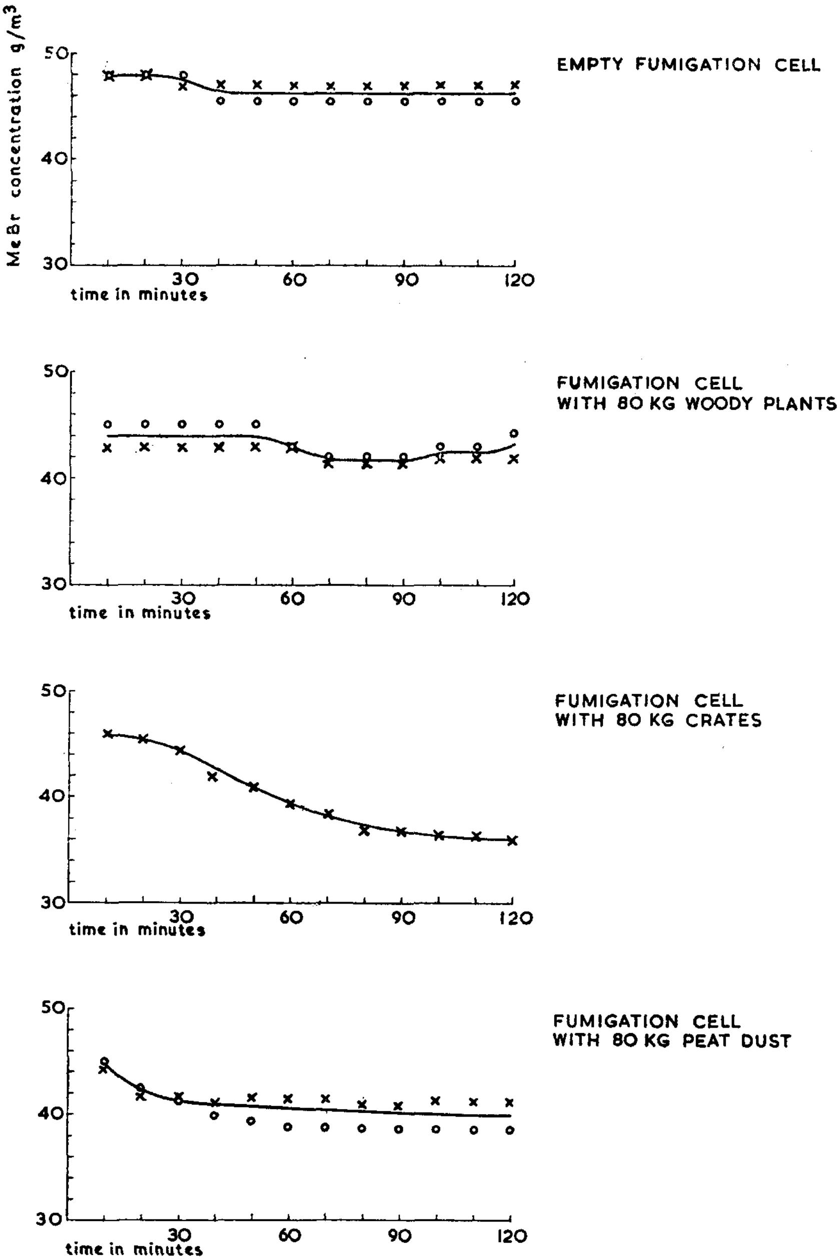

TABLE. Sorption of methyl bromide by different materials in comparison with hydrocyanic acid (Initial dose 48 grams of MeBr and 6 grams of HCN per cubic metre resp.)

Commodity	Total loss in 120 minutes in percentages of the initial dose	
	MeBr	HCN
Empty cell	4	29
80 kg dry narcissus bulbs	4	—
80 kg woody plants	10	46
80 kg dry sand	6	29
80 kg flower pots	8	—
80 kg soil [1]	10	54
80 kg sphagnum [2]	14	—
80 kg peat dust [3]	16	76
80 kg crates	17	71
80 kg straw	18	87

1 Moisture content soil 10,2 and 9,3 % (MeBr fumigations); 9,1 and 7,4 % (HCN fumigations) resp.
2 Moisture content sphagnum 77,7 and 79,0 % resp.
3 Moisture content peat dust 88,0 and 87,1 % (MeBr fumigations); 77,8 % (HCN fumigations) resp.

ment with methyl bromide and hydrocyanic acid, a dosage characteristic should be used that takes into account the loss of gas concentration resulting from the sorptive properties of the chamber and its contents, and possibly leakage or other factors. A suitable characteristic is the concentration time product (CTP) which is a measure of the area under the observed time and concentration curve expressed in appropriate units: usually grams per cubic metre or ounces per 1000 cubic feet multiplied by time in hours.

In practice constants should be calculated for chambers and for different materials in order that the initial dosage necessary for any given CTP can be estimated.

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