LEACHING OF METHOMYL FROM SOME AUSTRALIAN TOBACCO SOILS

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Leaching of methomyl from undisturbed cores of two Australian soils was investigated. With the volume of water and the rate of leaching used, only a small percentage (<10%) of methomyl applied was leached. More than half of the methomyl (50 to 58%) was retained in the cores after 3 weeks. This portion of methomyl would be available for root uptake by tobacco plants, since adsorption of methomyl onto soil colloids occurs to a small extent only. About 34 to 43% of methomyl applied was lost in 3 weeks, probably by transformation and volatilization. However, fast root uptake of methomyl by tobacco plants (within one day after application) reported previously would ensure sufficient systemic level of methomyl for the control of Tobacco Yellow Dwarf.

INTRODUCTION

Yellow dwarf disease is known to occur in tobacco plants in Australia resulting in serious decreases in yield. Methomyl, S-methyl-N-{(methylcarbamoyl)oxy}thioacetimidate, was used originally as a nematocide in tobacco-growing in Australia, but now it is used as a general insecticide and particularly to control Tobacco Yellow Dwarf (TYD). While in commercial practice both root application during transplanting of plants and subsequent foliar application of methomyl are used, Fung (1) showed that root application resulted in a higher systemic level of methomyl for the control of TYD. The purpose of this study was to investigate the movement of methomyl in soil which may affect the availability of methomyl for the root uptake by tobacco plants. Leaching of methomyl was studied using undisturbed cores of two Australian soils. Other behavior of methomyl such as decomposition as reported by Harvey and Pease (2) and microbila transformation in soil as reported by Fung and Uren (3) have been investigated.

MATERIALS AND METHODS

Soil: The soils used in the leaching study were Myrtleford fine sandy loam (soil I) of the Alluvial soil group and Ovens fine sandy loam (soil II) of the Grey-brown Podzolic soil group. The soils were selected from areas representative of soils on which tobacco is grown, and samples were taken from the Ovens Valley in the north-east of Victoria where no methomyl had been applied. Some physical and chemical characteristics of these soils are listed in **Table 1.** Most methods of chemical and physical analyses used were the standard methods described by Newell (4). In the method of analysis for clay minerals, the organic matter of soils was removed using sodium hypochlorite. The composition of clay minerals in the clay-sized fraction, which was oriented on ceramic tiles, was determined using a Philips PW 1050 diffractometer as described by Briner and Jackson (5). The composition is given as a fraction of the crystalline clay minerals and allophane (if any), and secondary minerals have been omitted.

Leaching Experiment: During a growing season (1975-6), undisturbed soil cores (8.5 cm diameter) were taken to a depth of 10 cm one hour prior to transplanting of tobacco plants. The cores were taken from soils which had been disked and contained 18% moisture which was 2% below normal field capacity at that time of the year. The manual equipment for collecting such cores and the coating of these cores with microcyrstalline wax have been described by Peverill and Douglas (6). A wax coated core of each soil was placed on a filter paper in a Buchner funnel. A second filter paper was placed on the core to allow equal distribution of solution when applied to the soil. A 500 ppm aqueous solution methomyl (250 ml), equivalent to the concentration and volume of solution normally applied to a tobacco plant during root application, was slowly poured into the core. The leachate was collected and the core was allowed to drip dry. Sodium azide (10^{-3}M) was added to the leachate to prevent microbial transformation of methomyl, and the leachate was analysed for methomyl by gas chromatography as described by Fung (7).

Distilled water (573 ml) was then allowed to percolate through the soil at a constant rate of 10 ml per minute without developing a measurable head of water on top of the soil. This was equivalent to the average district rainfall in a tobacco-growing season. The leachate was collected in 30 ml fractions using an automatic fraction collector. Sodium azide (10^{-3}M) was added to each fraction which was then analysed for methomyl as described above. The experiment was repeated with a second core of each soil.

Each core was allowed to air-dry for 3 weeks and then divided into 4 equal segments. A subsample (50 g) was taken from each segment and analysed for methomyl by gas chromatography as described by Fung (7).

Another core of each soil was similarly percolated with distilled water and then divided into 4 segments; the leachates collected and the subsamples of the segments of soil were analysed and used as controls.

Table 1. Some physical and chemical characteristics of two soils (0-10 cm).

Characteristic	Soil I	Soil II
Field texture	Fine sandy loam	Fine sandy loam
Colour	Greyish brown	Grey yellow brown
Munsell notations (dry)	10 YR 5/3	7.5 YR 5/6
pH (1:5 H_2O)	6.1	5.8
Organic matter (%)	2.1	2.3
Exchangeable cations (me/100 g soil)		
Ca^{++}	1.2	0.9
Mg^{++}	0.3	0.3
K^+	0.7	0.7
Na^+	<0.1	<0.1
H^+	8.0	10.2
C.E.C. (me/100 g soil)	10.2	12.1
Clay (%)	10.1	19.3
Quartz	present	present
Composition of clay (%)		
Kaolinite	35	20
Chlorite	10	5
Mica	40	50
Vermiculite	15	25

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Table 2. Amount of methomyl leached from the soil cores during 1 hour.

Leachate (30 ml) No.	Methomyl leached (mg)[a] Soil I	Soil II
1	0.46	0.50
2	0.46	0.44
3	0.38	0.41
4	0.29	0.40
5	0.27	0.38
6	0.22	0.31
7	0.19	0.25
8	0.18	0.18
9	0.18	0.17
10	0.17	0.16
11	0.16	0.14
12	0.15	0.15
13	0.14	0.13
14	0.13	0.14
15	0.13	0.12
16	0.13	0.12
17	0.13	0.12
Total amount leached	3.77	4.12

[a]Mean of figures obtained following analysis of duplicate samples of leachates.

RESULTS AND DISCUSSION

The amount of methomyl originally applied onto a soil core was 125 mg. Some of this methomyl in the original solution percolated through the core while the rest remained in the core. After addition of water, the amount of methomyl which remained in the core was leached, retained or lost presumably by volatilisation and transformation.

Analysis showed that the amount of methomyl percolated through soil I before leaching was 77.5 mg while that for soil II was 67.6 mg. Hence the amounts of methomyl remained in soils I and II before leaching were calculated as 47.5 mg and 57.4 mg, respectively.

The amount of methomyl in each of the 30 ml leachates and the total amount of methomyl leached from soils I and II are shown in **Table 2.** The amount of methomyl leached from both soils per unit of leachate decreased as the volume of leachate collected increased. However, the amount of methomyl leached remained constant towards the end of the leaching experiment. In other words, with the volume of leachate and the rate of leaching used, methomyl was constantly leached out of the soils.

The amounts of methomyl determined in the equal segments of soils I and II after leaching appear to have no relationship with those found in the leachates. The total amounts of methomyl found in the segments of soils I and II were 27.6 mg and 28.6 mg, respectively. The amounts of methomyl lost (transformed and volatilised) from soils I and II were calculated as 16.0 mg and 24.6 mg, respectively.

The fate of methomyl initially retained in the core can be expressed as percentage leached by water, percentage retained by the soil after leaching and percentage lost (transformed and volatilised). These percentages for both soils were similar; percentages of methomyl leached from soils I and II were 8% and 7%, respectively; percentages retained in soils I and II for 3 weeks were 58% and 50%, respectively; and percentages lost during the 3 weeks were 34% and 43%, respectively. The amount of methomyl leached was less than 10%. More than half of the methomyl in the cores was retained. The methomyl retained probably would only be slightly adsorbed onto the soil colloids because of the low organic matter in the soils (**Table 1**) and the neutral property of the pesticide. The percentage transformed and volatilised (34 to 43%) probably represents mainly the percentage of methomyl transformed by soil microorganisms. Chemical transformation and volatilisation of methomyl should have been small because the pesticide is stable and is not particularly volatile. This percentage of methomyl transformed and volatilised was about 3 to 4 times larger than the percentage of microbial transformation of methomyl found in a perfusion study by Fung and Uren (3), where columns of packed air-dried soils were used.

Since small adsorption of methomyl in the soils was predicted, most of the methomyl applied would be available for uptake and transformation. Even though 34 to 43% of methomyl was lost through transformation and volatilisation in 3 weeks, fast root uptake of methomyl by tobacco plants (within one day after application), as reported by Fung (1), would ensure an abundance of methomyl in the plants for the control of TYD.

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