THE DEPOSITION AND METABOLISM OF METHYL [125]IODIDE BY CROPS

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ABSTRACT

Several studies have identified an organic fraction of radioactive iodine releases following nuclear accidents, as well as releases arising from reprocessing activities. Methyl iodide has been identified as this primary component of this fraction.

The following paper describes a system for exposing crop plants with methyl iodide, using ^{125}I as an analogue for ^{131}I and ^{129}I. From these experiments deposition velocities to a leafy green vegetable were calculated at several points within the growth cycle. The subsequent fate of the ^{125}I was monitored until the crops were harvested at maturity.

INTRODUCTION

Radioisotopes of iodine are important radiologically, because of their ability to accumulate in the thyroid gland and their rapid transfer through the foodchain. Emission of radioiodines from nuclear facilities can occur in both routine operation and accident scenarios. Studies of the speciation of radioiodine have reported that a significant fraction is in an organic form (1,2), this is believed to methyl iodide (3). To date there is some work reporting deposition velocities for CH_3I (4,5), but little on its subsequent fate in the crop. The work outlined below was undertaken to rectify this situation by measuring the movement of activity between exposure and final harvest.

MATERIALS AND METHODS

The methyl [125]iodide was prepared by the reaction of potassium iodide and dimethyl sulphate. The resulting $CH_3{}^{125}I$ was transferred in a stream of helium passing through the reaction vessel and cryotrapped in the exposure vessel which was submerged in liquid nitrogen. Following preparation c.350kBq of $CH_3{}^{125}I$ was retained in the exposure vessel. To reduce confounding effects from dissociation of the methyl iodide, sources were prepared on the day of use and stored in the dark until required.

Cabbage (cv. Greyhound) seeds were sown in 3 l pots in John Innes no.2 compost on 5/4/95 and thinned to one plant per pot two weeks after germination. Plants were kept in an outdoor enclosure and irrigated automatically, a multipurpose feed (Phostrogen; Phostrogen, UK) was applied fortnightly.

At three occasions during the season, 76, 128, 159 days from sowing (DFS), plants were exposed to the prepared $CH_3{}^{125}I$. Twenty four hours before exposure twelve plants were transferred to a perspex chamber (0.7m x 0.7m x 0.8m, w x d x h) within a plant growth cabinet. The perspex chamber was part of a recirculating system of pipework that allowed the atmosphere of $CH_3{}^{125}I$ to be passed over the plants for one hour. The pump of the recirculating system was started after plants were placed in the chamber this allowed the conditioned air of the growth cabinet, 20°C and 50% RH, to enter the exposure system. On the day of fumigation the front of the perspex chamber was sealed and the activity immediately dispensed into the incoming air stream of the chamber. The activity was injected into the chamber by displacing the gas from the exposure vessel with water. The activity circulated within the system for the exposure period of one hour. The air concentration of the ^{125}I in the chamber was derived from a suck sample of 400 cm^3 min^{-1} passed through TEDA impregnated charcoal throughout the exposure period.

At the end of the exposure four plants were randomly selected and dissected into leaves, stems and roots. The remaining plants were returned to the enclosure for three later harvests; two days following exposure, a middle harvest and final harvest at maturity. The plant material was then oven dried and direct counted on a gamma counter (Compugamma, Wallac). From these counts deposition velocities and the loss of activity from the crop calculated.

RESULTS AND DISCUSSION

The mass normalised deposition velocity (Vd) did not vary significantly between harvests (Table 1.) This suggests that the uptake of $CH_3{}^{125}I$ is directly related to the live weight of the crop. This finding indicates that as the crop grows throughout the season the total deposition of activity per unit area will increase. The rates reported here agree well with those of Voillque and Keller (4), but are an order of magnitude lower than those of Atkins *et al.* (5).

Exposure	Mass normalised deposition velocity (x 10^{-3})(+\- s.e.) (cm3 g-1 s-1)	Crop
76 DFS	1.51 +\- 0.376	Cabbage
128 DFS	1.38 +\- 0.306	Cabbage
159 DFS	1.27 +\- 0.589	Cabbage
	3.0	Grass (3)
	50	Grass (4)

Table 1. Deposition velocities of crops exposed to $CH_3{}^{125}I$.

The activity directly after exposure was concentrated in the aerial parts at all exposure dates (Figs 1.,2.,3.). As the season progressed activity was lost from all plant components, this loss was more rapid from leaves compared with roots. In fact there appeared to be an indication of transport from the leaves to the roots between 0 and 2 days after exposure. This later finding may be of importance when considering root crops. There may also be the possibility of transfer from the soil to the roots following uptake by the soil during the exposure period, a transfer factor of 9 was reported for the movement of iodine to rice roots (6). The apparent increase in the total activity between 0 and 2 days following exposure at 76 DFS was a result of larger plants at the 2 day harvest (mean weight 0 days from fumigation 18.0 g, mean weight 2 days from fumigation 42.8 g).

The loss of activity from the cabbage plants was greater than that expected from radioactive decay following exposure at 128 and 159 DFS (Fig. 4), Unfortunately the data from the 79 DFS exposure were confounded by the high values recorded 2 days after exposure as discussed previously. There are two possible pathways for this loss of activity, shedding of old leaves containing activity or gaseous re-emission of activity from the plant tissue. Loss of radioiodine in a gaseous form following absorption has been observed (6,7).

In future modelling of the uptake by vegetation of radioiodine as methyl iodide, it should be noted that a significant deposition is observed and that the biological half-life is shorter than that attributable to radioactive decay. The fate of the losses from the system needs further investigation, as these will be of importance for movement of the long lived ^{129}I isotope within an ecosystem.

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Figure 1. Fraction of initial activity in plant components following exposure to $CH_3{}^{125}I$ 76 days after sowing

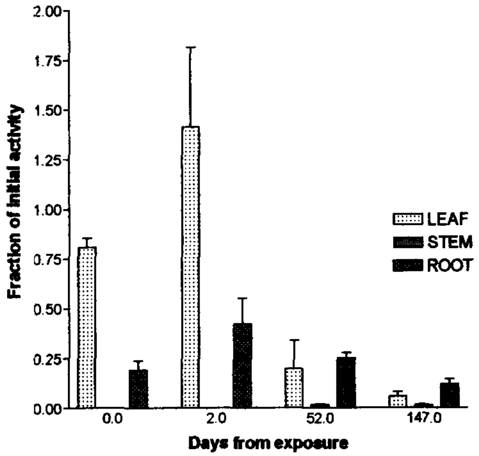

Figure 2. Fraction of initial activity in plant components following exposure to $CH_3{}^{125}I$ 128 days after sowing

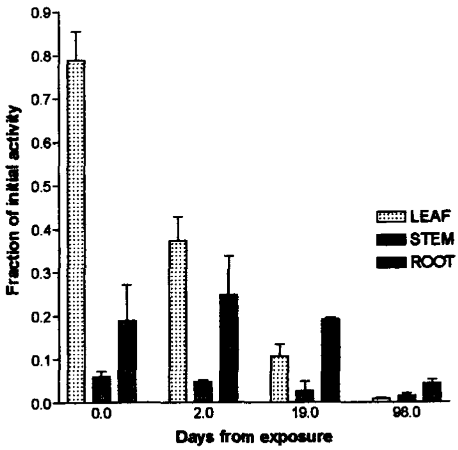

Figure 3. Fraction of initial activity in plant components following exposure to $CH_3{}^{125}I$ 159 days after sowing

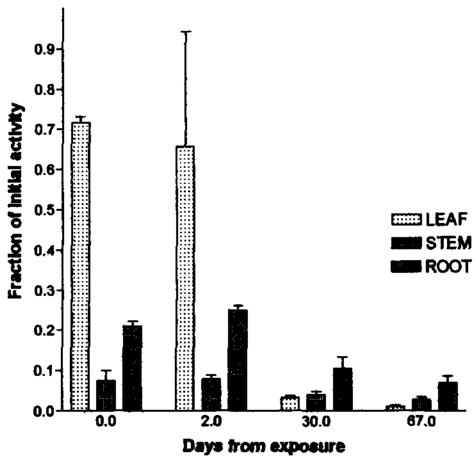

Figure 4. Loss of activity from cabbage folowing exposure at three separate times in the season