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Organochlorine residues in soil and plant.

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Aim

To determine the relationship between soil and plant Dieldrin contamination in vegetables.

Background

The O/C contamination of vegetables for either human or stock consumption is required to satisfy health and export regulations. Stock on horticultural enterprises can directly graze vegetable crops either by accident (poor fencing, etc.) or by design to remove postharvest or unsaleable crop residues. Volunteer vegetable crops and processing factory byproducts, eg. potato peelings, vegetable trimmings etc. can also be fed to stock.

The Dieldrin Maximum Residue Limit (M.R.L.) of vegetables for human consumption is 0.1 ppm expressed as a fresh (whole) weight basis, presumably because vegetables are often eaten raw. This standard contrasts with previously reported pasture, crop and soil O/C levels which have all been expressed on a dry weight basis.

The % dry matter in vegetables can range from 4% (lettuce) to 15% (beetroot), therefore the risk of obtaining a fresh weight violative level is lessended by a factor of 25 to 7 respectively, relative to a dry weight M.R.L.

Experimental Method

From previously tested areas within a farm paddock, a suitably high level of Dieldren contamination was located. An area approximately 4 m x 4 m was rotary hoed to a 10 cm depth and approximately 2.5 tonne of this mixed soil transported to an experimental site at the Bunbury Regional Office. This soil was mixed again as it was deposited inside a 2 m diameter x 0.5m high weldmesh container lined with perforated plastic sheeting. The soil in this 'pot' was now allowed to settle for three months.

This procedure was repeated on six farms covering a range of soil types.

In July 1989 all six pots were weeded and eight soil samples to 10 cm depth/plot were collected.

In mid August 1989 the pots were fertilized with 1000 kg/ha of potato E.

Seed of carrot, radish, dwarf bean and corn together with seedlings of beetroot, onion, lettuce, cabbage, silver beet, capsicum and tomato were planted. This range of vegetables covered the more popular root, leaf and fruit (seed) categories. Unfortunately there was insufficient area in the pots for potatoes, however, these were grown in 1990.

The vegetables were sprayed with insecticides (Ambush, Rogor), fungicides (Mancozeb) and herbicides (Fusilade) when required. All pots received 25 gm of urea and 25 gm potassium sulphate/week.

The vegetables were harvested when mature, washed free of visible soil, and 500 gm samples sent for O/C analysis. The root and fruit vegetables were subdivided into the human edible part, eg. radish root and the leafy

remainder, eg. radish leaf, both fractions which can be fed to stock. The cabbages and lettuces were also subdivided into the edible outermost and inner sections after discarding the most external leaves (which generally would not be eaten by humans).

One bulked soil sample/plot was collected at planting, midseason and during the harvesting period. These were analysed for O/C's in a batch.

Results and Discussion

Most vegetables grew satisfactorily to marketable quality with the exception of corn which pollinated poorly. This vegetable was not submitted for O/C analyses. On one of the loam soils beetroot, onions and capsicum failed to grow to harvestable size. Reasons for this are unclear but may be ralated to low pH and/or trace element imbalance. Other soil factors and pests may also be involved.

Dieldrin levels expressed on a dry weight basis, as relevant for stock consumption, are presented in Table 4.

The Dieldrin contamination of vegetables is dependent on soil factors (level of soil contamination, soil type and soil structure) and plant factors (vegetable species and plant part). The effect of the soil factors are quite similar to those reported for pasture and crop species, ie. at equivalent levels of soil Dieldrin, loam soils contaminate vegetables more than peat soils, and poorly structured loams will contaminate vegetables more than well structured loams.

Dieldrin contamination of vegetable species was essentially restricted to the root vegetables (beetroot, carrot and radish) and lettuce, although two cabbage and a capsicum leaf sample did just reach the animal M.R.L. of 0.05 ppm (dry weight) in two of the loams. The direct contact of Dieldrin contaminated soil with the roots of carrot, radish and beetroot during the entire growing period caused the high levels of Dieldrin recorded in these vegetables. The actual uptake mechanism was not specifically studied but appears to be by both adsorption and active absorption/translocation.

Of these root vegetables, carrots were the largest in mass and most contaminated relative to radish or beetroot. Leaf parts in carrots and radish, but not in beetroot also contained Dieldrin although two to ten times less than their respective root part.

The inner leaf samples of lettuce were less contaminated than the outer leaves, and again indicate an active uptake mechanism of root absorption/ translocation in addition to external adsorption.

The feeding of root and leaf parts of root vegetables and lettuce tops to animals must be considered a high risk for body fat contamination if these vegetables have been growing on soils contaminated with Dieldrin residues.

Only the carrot root samples grown in the poorly structured loam exceeded the 0.1 ppm fresh weight Dieldrin M.R.L. for human consumption. The 2.33 ppm dry weight levels equates to 0.28 ppm fresh weight. This is the most serious soil-plant contamination relationship observed in the research programme, ie. a large rooted vegetable growing in a soil which most readily contaminates plants and animals .

TABLE 4

DIELDRIN CONTAMINATION IN VEGETABLES (ppm dry weight basis)

Vegetable Species	Plant Part	Dry Weight	Peat	Sandy Peat	Loam*	Loam	Loam	Sandy Loam
Beetroot	Leaf	9.7	<0.01	<0.01	<0.01	N/S	0.02	0.01
	Root	14.8	0.01	0.02	0.19	N/S	0.12	0.04
Carrot	Leaf	10.8	0.05	0.02	0.26	0.13	0.02	0.06
	Root	10.6	0.15	0.11	2.33	0.74	0.30	0.58
Radish	Leaf	5.8	0.08	0.02	0.20	0.09	0.09	0.08
	Root	4.4	0.06	0.03	0.59	0.25	0.20	0.27
Onion	Leaf	8.3	0.01	<0.01	N/S	N/S	N/S	<0.01
	Bulb	11.8	<0.01	<0.01	0.03	N/S	0.03	0.02
Cabbage	Outer	9.7	0.02	0.02	0.06	<0.01	0.03	0.05
	Mid	8.4	0.02	0.02	0.03	0.02	0.02	0.06
	Inner	8.4	0.01	0.02	0.03	<0.01	0.01	0.05
Lettuce	Outer	3.0	0.44	0.64	0.25	0.27	0.07	0.37
	Inner	4.0	0.13	0.24	0.21	0.27	0.07	0.12
Silverbeet	Leaf	7.4	<0.01	0.01	0.01	0.03	<0.01	0.01
Beans	Fruit	11.0	<0.01	<0.01	0.01	0.01	<0.01	<0.01
Capsicum	Fruit	7.0	<0.01	<0.01	<0.01	0.01	N/S	<0.01
	Leaf	11.7	<0.01	<0.01	0.05	N/S	N/S	0.01
Tomato	Fruit	5.6	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Leaf	8.3	0.02	0.02	N/S	N/S	N/S	0.02
	Stalk	13.2	0.02	<0.01	0.21	0.07	0.03	0.03
Soil Dieldrin (ppm)			1.43	1.90	1.51	1.21	0.83	0.76

* Poor structured loam
N/S - Not sampled