Parathion Recovery from Soils After a Short Contact Period

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The fixation of pesticides in soils and the difficulties in their recovery are generally underlined in the residues chemistry literature (Chiba, 1969). Consequently, in a persistence experiment it is important to observe whether fixation of pesticide in soil occurs within a short period of time after application, and if it is a function of the soil properties alone is it also affected by other environmental conditions.

MATERIALS AND METHODS

Soil In the experiment the upper layers of 14 soils were used with different mineralogical composition and organic matter content. The properties of the soils are presented in Table 1. Sterile soils were obtained by irradiating subsequent samples of the initial soil in a JS-6000 irradiation chamber provided with a ^{60}CO radiation source. The radiation dose was 3 Mrad.

Chemicals High grade parathion (0.0-diethyl 0-p-nitrophenyl phosphorotioate) produced by Analabs Inc. and ^{14}C labeled in the alkyl chain produced by Amersham Radiochemical Centre were used in the experiment.

Extraction from soil Parathion and its degradation products were extracted from the soil by a procedure based on the fact that in a water-hexane system the partition of parathion is practically 100% in the organic phase while the decomposition products p-nitrophenol and diethyl phosphoric acid are concentrated in the aqueous phase only. The extraction was accomplished by shaking the soil with a 5:2 water:hexane mixture for 15' at room temperature. The soil was separated from the solvents by centrifugation (4000 rpm) and the aqueous phase was separated from the organic solvent in a separatory funnel.

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Table 1: Characteristics of soils used in the experiment

No.	Soil type	Predominant clay	Clay %	Organic matter
1	Sandy regosol	Montmorillonite	2.9	0.45
2	Loessial light brown clay loam	Kaol. / Mont.	16.9	0.66
3	Grumusolic brown silty clay loam	Montmorillonite	40.0	0.08
4	Red terra rossa clay	Kaolinite	75.5	1.07
5	Reddish brown grumusol	Montmorillonite	57.6	1.56
6	Red terra rossa clay	Kaolinite	76.6	1.89
7	Basaltic brown Mediterranean clay	Kaolinite	22.4	2.47
8	Clay loam hamra	Kaolinite	9.7	2.75
9	Basaltic brown Mediterranean clay	Kaolinite	32.0	3.61
10	Calcareous brown Mediterranean clay	Montmorillonite	42.9	3.94
11	Reddish brown terra rossa clay	Montmorillonite	65.3	4.18
12	Reddish brown terra rossa	Montmorillonite	71.1	4.94
13	Red terra rossa clay	Kaolinite	68.5	4.98
14	Brown rednzina	Montmorillonite	46.5	11.89

Analytical methods Radio-activity was counted with a Packard 3003 Tri-carb liquid scintillation spectrometer. The scintillation liquid contained 60 g naphtalene, 7 g PPO (2.5 - diphenyloxozole), 0.2 g POPOP [2.2 - p - phenylenebis - (5 - phenyloxazole), 100 cc methanol and 20 cc ethylene glycol in 1 liter dioxane. Both parathion in hexane and diethylthiophosphoric acid in aqueous solutions were determined in this way.

Procedure One gram of soil - air-dried and passed through a 60 mesh sieve - was shaken with 2 cc of 10 ppm ^{14}C-parathion solution in hexane for 30 min at 22°C. The solvent was then evaporated. In order to obtain "wet conditions" distilled water w:w was added to part of the

Table 2: Relative recovery of parathion in different soils as affected by environmental conditions after one day of application

Soil No.	Treatments		
	dry - sterile	wet - sterile	wet - natural
1	79	84	85
2	85	91	92
3	84	92	87
4	86	85	84
5	86	83	92
6	90	92	96
7	75	74	77
8	73	69	70
9	81	75	71
10	72	75	75
11	74	75	74
12	63	73	63
13	85	81	87
14	51	60	56

dry parathion heated soils. This procedure was applied to both sterile and non-sterile soils. The samples, in brown containers (to avoid photo-decomposition) and covered with paraffin film, were incubated at 22°C (room temperature) for a period of 24 hours. The samples were extracted as described and both the aqueous and the organic phase were tested for residue determinations. The entire experiment was conducted in duplicate.

RESULTS AND DISCUSSION

After 24 hours of soil-parathion incubation at room temperature no degradation of the pesticide occurred. In the aqueous phase of the water-hexane extract, diethyl thiophosphoric acid was not found for the majority of the soils studied, and only in certain soils did the water soluble degradation compounds appear in trace amounts. Consequently, it was presumed that the parathion recovery was complete. However, Table 2 shows that the recovery of the parathion in the hexane phase of the extract ranged between 90% and 50% for the 14 soils studied. The recovery depended

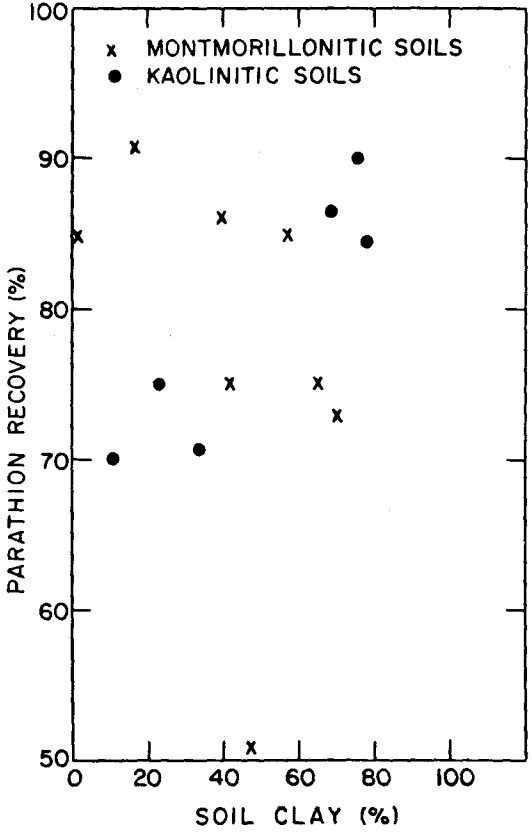

Fig. 1: Parathion recovery as a function of the soil mechanical composition.

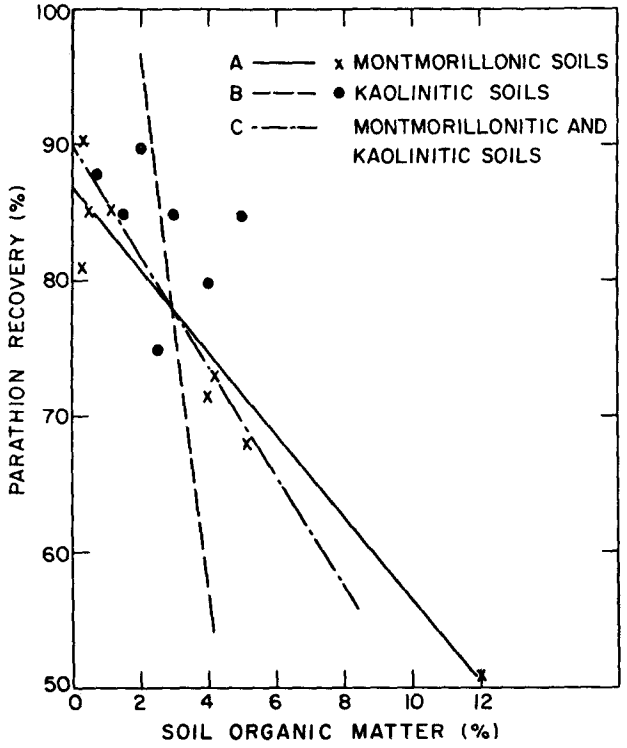

Fig. 2: Parathion recovery as a function of soil organic matter.

Table 3: Correlation values (r) between parathion recovered from the experimental soils and the soil composition

Soil	Organic matter %	Clay %
With montmorillonitic predominancy	- 0.96	- 0.24
With kaolinitic predominancy	- 0.36	+ 0.58
Total experimental soils	- 0.78	- 0.16

on the type of soil only, and was not affected by the soil treatment. The differences between the amount of parathion recovered from sterile dry soils, sterile wet soils and natural wet soils are in the range of analytical errors and it is evident that insecticide recovery was not affected by the environmental conditions, such as the presence of microorganism or soil moisture, but only by the soil properties.

Among the soil properties which may affect the insecticide recovery are the clay content, the type of clay and the organic matter content (Chiba, 1969). Correlations between these properties and the percentage of parathion recovered were calculated and the results are presented in Table 3.

It may be observed that the parathion recovery is not strongly dependent of the soil mechanical composition, but is affected by the type of clay and soil organic matter. Fig. 1 shows the parathion recovery as a function of the soil mechanical composition. As a general feature no appreciable inter-dependence between the amount of clay in the soil and the pesticide fixation occurs. However, it may be observed that the release of parathion is greater in the kaolinitic soils than in the montmorillonitic soils. This fact may be explained by the nature of adsorption in the 1:1 and 1:2 type of clays (Saltzman et al., 1974; Yaron, 1974; Saltzman and Yariv, 1974). A strong correlation is observed between the amount of organic matter in the soils and the parathion fixation (Fig. 2). This finding is in agreement with previous research (Saltzman et al., 1972), where it was observed that the parathion adsorption by

soils is dependent on the type of association between the organic and mineral colloids and that the parathion has a greater affinity to organic rather than to mineral adsorptive surfaces. However, the type of clay increases the fixation of parathion in the soils and it can be shown that for the soils with montmorillonitic predominancy, the fixation is much stronger than on kaolinitic soils.

The present observations indicate that parathion fixation is a function of soil organic matter and of the type of clay. Consequently, a single common extraction procedure may not be used for soils with different compositions. The environmental conditions did not affect the parathion recovery after a short period of incubation.

Literature

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