Uptake and Metabolism of DDT and Lindane by the Earthworm, *Pheretima posthuma*

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Earthworms are known to accumulate DDT and its metabolites from the soil in varying degrees (EDWARDS and THOMPSON 1973). A recent survey in delhi (India) showed a concentration factor of about 172 for DDT by the earthworm, Pheretima posthuma (YADAV et al. 1975). However, the studies on the rate of uptake of this insecticide from the soil by the earthworm are greatly lacking (DAVIS 1971; EDWARDS and JEFFS 1974). No such work is known with lindane and the Indian earthworm, P. posthuma. YADAV et al., (1975) found traces of lindane in some samples of earthworms and soil. Thus laboratory experiments were designed to study the rate of uptake of DDT and lindane by the earthworms from the soil containing either DDT or lindane or both. The metabolism of DDT in earthworm was also studied under these conditions.

Materials and Methods

P. posthuma and soil collected from the Delhi University Campus were used for this study. Only healthy earthworms were used for the study and they were acclimatized to the laboratory conditions for one week. The soil was spread on a clean plastic sheet and sprayed with an acetone solution of DDT and lindane by an atomizer so as to give a concentration of 1 ppm. In experiments using both DDT and lindane, the concentration of each insecticide was 1 ppm. The soil was kept in boxes of 30 x 30 x 60 cm size and 60 earthworms were released in each box. Each experiment was replicated four times.

First set of four earthworms was removed from each treatment a after 24 hours. Subsequent samples were taken weekly for a period of 10 weeks. The worms were kept individually in petri dishes containing moist filter paper for 24 hours to remove the gut contents. The worms were then placed in polythene bags and frozen until used. The extraction, clean up and analyses by thin layer and gas chromotography, etc. of the insecticides were carried as described elsewhere (YADAV et al. 1975).

Results and Discussion

The rate of uptake of DDT by the earthworms is shown in fig.1. When only DDT was present in the soil, the uptake was 6.5 ppm at 24 hours and in one weeks time the earthworms accumulated 11.4 ppm of total DDT. During the entire course of treatment, the total DDT content in the earthworms showed three peaks at 1.5 and 9 weeks,

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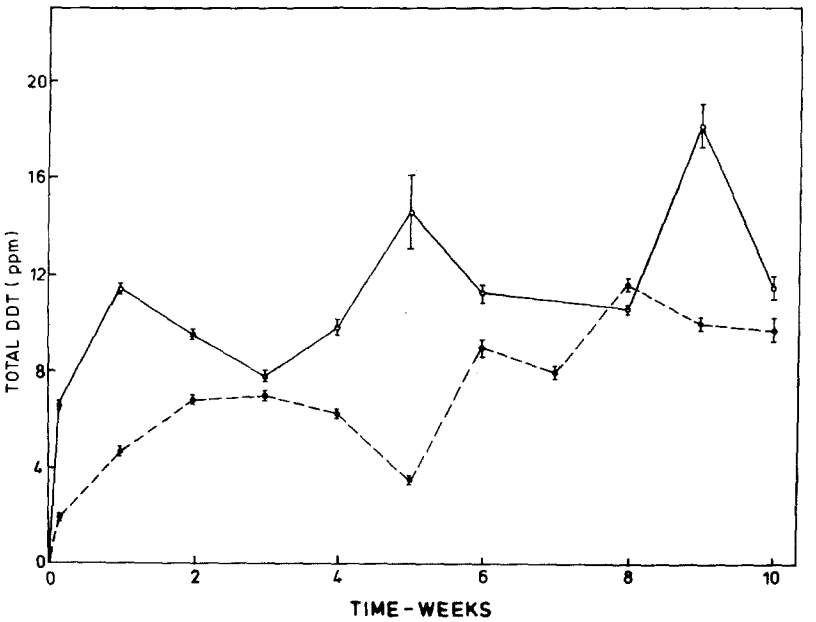

Fig. 1. Uptake of total DDT by P. posthuma from the soil treated with 1 ppm DDT alone (o——o) or with 1 ppm each of DDT and lindane (●- - -●).

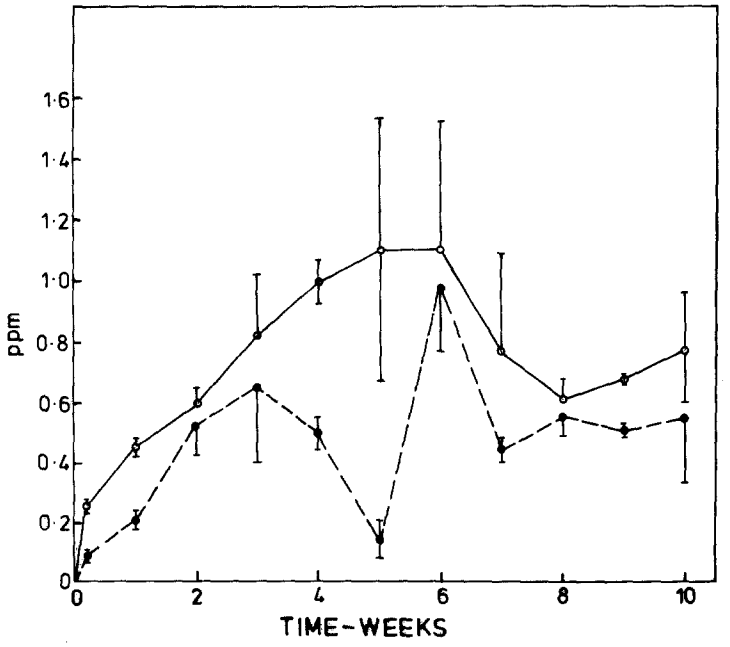

Fig. 2. Uptake of lindane by P. posthuma from the soil treated with 1 ppm lindane alone (o— o) or with 1 ppm each of DDT and lindane (●- -●),

respectively. The maximum total DDT content obtained was 18 ppm after 9 weeks. The rate of uptake and the highest concentration of DDT by Pheretima was much more than in case of Lumbricus in similar laboratory experiments. In a period of six months Lumbricus could accumulate only about 4.5 ppm DDT whereas Pheretima accumulated about 18 ppm in only ten weeks at the same concentration of DDT in soil (EDWARDS and JEFFS 1974). Such differences in the rate of pick up of organochlorine insecticides, DDT and dieldrin, by earthworms from soil have been reported by DAVIS (1971). The initial rapid absorption may be due to ingestion. The fluctuations in the DDT concentration may be due to redistribution and excretion (EDWARDS and JEFFS 1974). However, experimental evidence for the same is lacking.

In the presence of lindane, the rate of uptake of DDT was less compared to earthworms treated with DDT alone (Fig. 1). Total DDT in this experiment also showed three peaks at 3.6 and 8 weeks, with the maximum concentration being 11.6 ppm at 8 weeks. The initial uptake of DDT was not so rapid as in the case of DDT alone. This is apparently due to the presence of lindane which seems to inhibit the DDT uptake.

The rate of absorption of lindane in the absence or presence of DDT is shown in fig. 2. The amount of lindane picked up by the earthworms was much less compared to DDT. The maximum concentration observed was 1.1 ppm at 5 weeks. The uptake increased only gradually reaching a peak at 5 weeks which then declined subsequently. In the presence of DDT, the lindane uptake was slightly lower, the maximum concentration being 0.98 ppm at 6 weeks. It is evident from the present data that lindane is not being accumulated by the earthworms and the highest level achieved is almost equal to the concentration of lindane in the soil. There are no reports on the uptake and concentration of lindane by earthworms as yet. However, some cyclodiene insecticides are accumulated by earthworms to a much lesser extent than DDT (GISH 1970). The concentrations of the DDT metabolites present in the earthworms is given in fig. 3. Only two metabolites of DDT, namely p,p'-DDE and p,p'-DDD were detected. DDE was the major metabolite followed by DDD. The proportions of DDE:DDD:DDT at the end of 1, 5 and 9 weeks were 58:21:21, 38.8:34:27.2, and 24.4:21.7:53.9 respectively. The two metabolites together accounted for 79 and 73 percent of the total at 1 and 5 weeks respectively. The rate of metabolism was apparently low at 9 weeks, however, this was only one point on the graph. In the literature, only DDE has been reported as a metabolite of DDT in earthworms (EDWARDS and JEFFS 1974). YADAV et al. (1975) showed the presence of DDD in Pheretima in addition to DDE and various other DDT metabolites. Teh proportions of DDD and DDE were variable whereby one or the other was the predominant metabolite.

The metabolism of DDT in the presence of lindane is presented in fig. 4. The proportion of metabolites seem to be more than in the case of DDT treatment alone. The proportions of DDE, DDD and DDT at 3.6 and 8 weeks were 42.8:36.2:21, 50:32.2:17.8 and

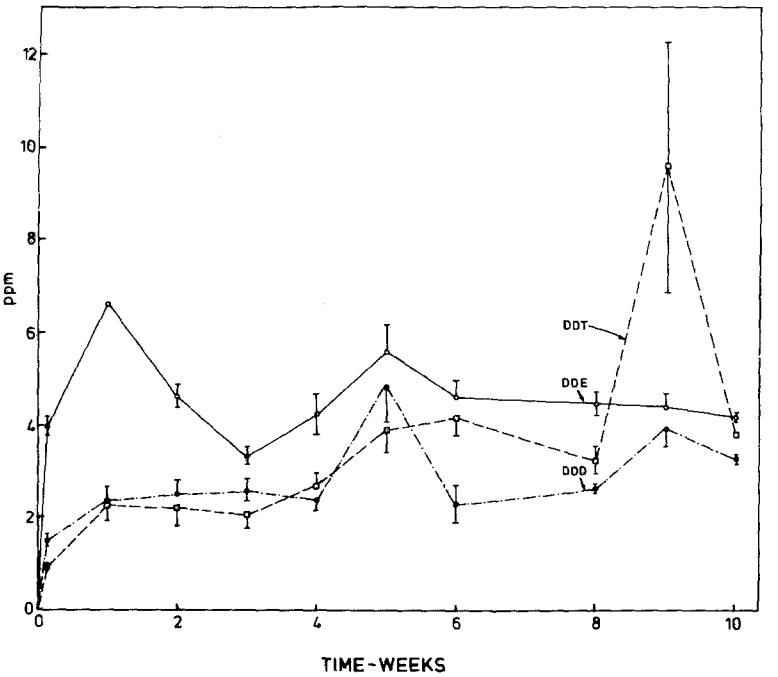

Fig. 3. DDT and its metabolites present in P. posthuma. living in soil treated with 1 ppm DDT.

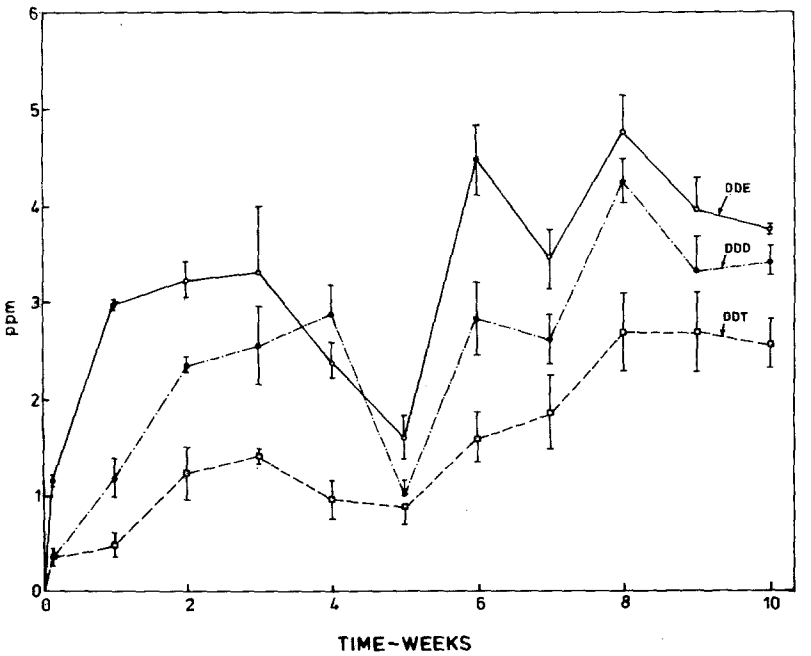

Fig. 4. DDT and its metabolites present in P. posthuma living in soil treated with 1 ppm each of DDT and lindane.

40.5:36.2:23.3 respectively. The combined metabolites accounted for 79, 82, and 76.7 per cent of the total DDT during the same period. It appears that the presence of lindane inhibits the uptake of DDT, but slightly accelerates the metabolism of DDT. An acceleration of lindane metabolism was observed in rats pretreated with DDT or lindane (CHADWICK and FREAL 1972).

The lindane did not seem to be metabolized much by the earthworm. A few small peaks were observed in the gas chromatograms which were not identified.

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