The Uptake of Two Organophosphorus Insecticides by Slugs

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Few chemicals kill slugs in their natural habitat, probably because of their protective mucus coat, and an efficient molluscicide is badly needed. There have been reports of insecticides such as aldrin (STEPHENSON 1959) and D.D.T. (DINDAL 1971) being directly toxic to slugs, and others such as 'Isolan', BHC, parathion and chlorthion being toxic to snails when incorporated in bran baits (PAPPAS and CARMAN 1955).

Although slugs appear to be relatively immune to insecticides, they have the capacity to concentrate organochlorine insecticides into their body tissues to a considerable extent and instances of up to 100 times as much of these chamicals in slug tissues, than in the soil in which they live are known (CRAMP and CONDER 1965; EDWARDS 1973; EDWARDS and THOMPSON 1973; DAVIS 1968; DAVIS and FRENCH 1969; EISH 1970; STRINGER and PICKARD 1965; CRAMP and OLNEY 1967). There seems to be a linear relationship between the amounts of insecticide residues in soil and those in slugs living therein (PAPPAS and CARMAN 1955). However, there have been no reports of organophosphorus insecticides being concentrated into the tissues of slugs.

We studied the uptake of organophosphorus insecticides by slugs and their toxicity to these animals in two field experiments in successive years. Plots 10 m square were planted with spring wheat, and treated with insecticides when the plants were about 100 mm high. Polythene barriers round the plots were buried 150 mm deep and projected 300 mm above the soil. There were four replicates of each treatment and four untreated control plots. The insecticides were applied at a rate of 8 kg/ha either as a spray to the soil between the rows (diazinon), or as granules sprinkled on to the surface (phorate). Slugs were trapped in pitfall traps (8 per plot) that were examined daily, and after counting them the live ones were returned to the plot on which they had been caught. Periodically, live slugs were taken for residue analysis. Nearly all the slugs captured were <u>Agriolimax reticulatus</u>.

For analysis of residues, slugs were deep frozen and ground up with four times their weight of anhydrous sodium sulphate; the residues being extracted from the resulting slurry by tumbling in an acetone/hexane mixture. The solid matter was filtered off with glass wool and the aceton removed with water in a separating funnel. The residues were run off in the hexane, and sodium sulphate added. Small aliquots were analysed by gas-liquid chromatography using nitrogen carrier gas and a flame photometer detector. Column temperatures were 170^o for phorate and 130^o for diazinon. The analysis of soil residues

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were done in a similar way, using a large number of small soil cores and sub-sampling from these.

Discussion

Some of the data collected are summarised in Figs. 1-3. The phorate treatment proved to be so toxic to slugs (approximately 90% mortality) (Fig. 1)

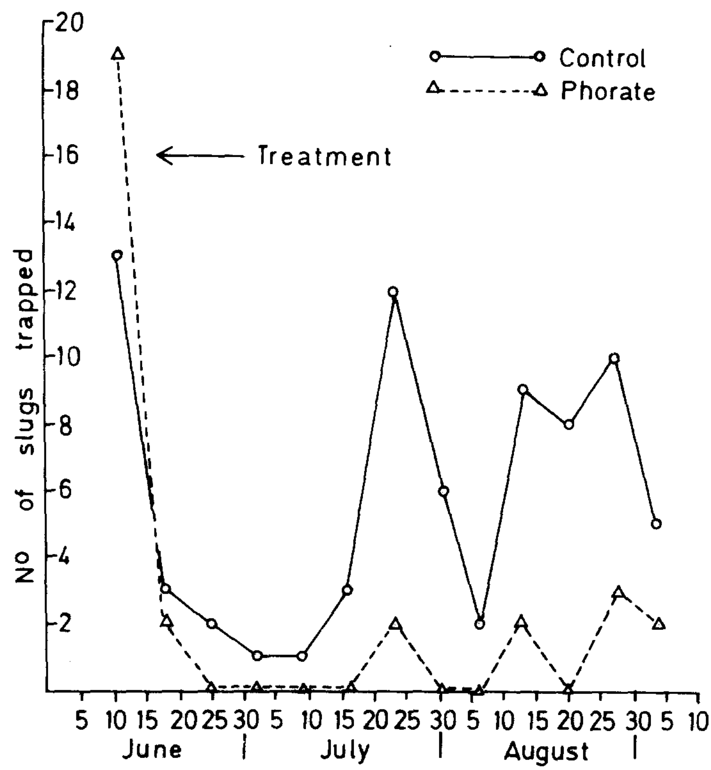

Figure 1. Effect of phorate (8kg/ha) on numbers of slugs.

that it was difficult to collect enough for residue analyses. The toxicity of phorate to slugs was confirmed when the numbers of dead slugs collected from phorate-treated plots (39) were compared with those from the control plots (9). No dead slugs were collected later than three weeks after treatment and because all the phorate residues had disappeared from soil within eight weeks, the differences in numbers recorded three months after treatment must have been residual effects. Clearly, phorate is very toxic to slugs when applied in this way. It seems probable that the phorate, a systemic insecticide, was taken from the soil into the cereal plants and acted as a stomach poison. By contrast, diazinon, a non-systemic insecticide, had no direct effect on slugs, and the numbers trapped in the diazinon-treated plots did not differ significantly from those caught in control plots. Clearly, phorate may have potential as a molluscicide. The dose used in our experiments was larger than that generally recommended, but smaller doses may also be effective and other methods of application may improve its efficiency. Moreover, because slugs commonly attack valuable horticultural crops, an efficient but relatively expensive treatment may nevertheless be acceptable.

The amounts of the two insecticides taken up by the slugs differed greatly. Although phorate residues in the slugs exceeded those in the surrounding soil (Fig. 2)

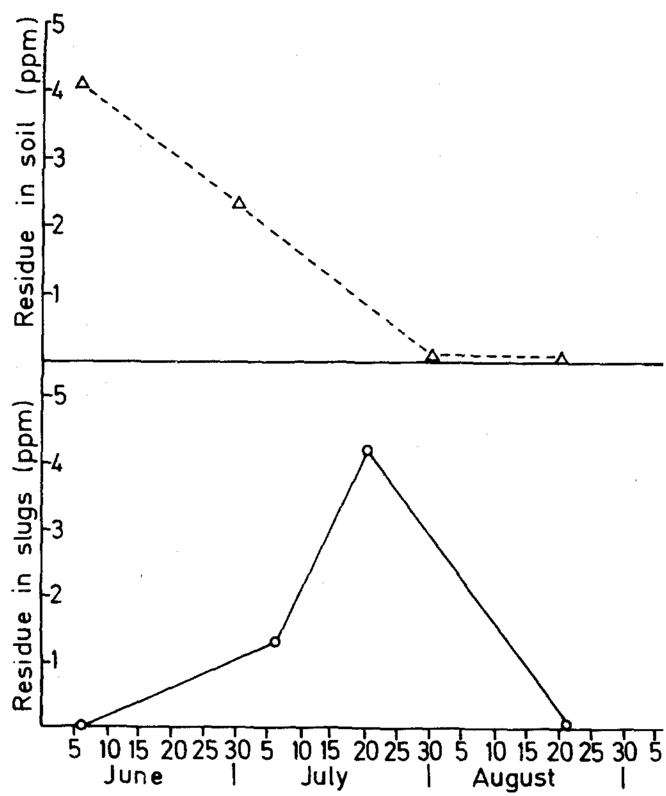

Figure 2. Uptake of phorate from soil by slugs.

they reached a maximum of little more than 4 ppm. By contrast, the maximum level of diazinon residues in the slugs was nearly 200 ppm.

This is surprising because the diazinon did not persist in the soil as long as the phorate and, when peak residues occurred in the slugs only traces were found in the soil. We still do not know whether the slugs took up the insecticide residues from the soil or with their food, but it seems unlikely that such large amounts of diazinon, a non-systemic insecticide, could enter the slugs with plant material, unless very large quantities of food were eaten, and it is very difficult to understand why maximum quantities were found in the slugs so long after those in the soil. Such large amounts of organophosphorus insecticides in slugs, may constitute a serious danger to birds and mammals which feed on them, even if the slugs are unaffected, because these insecticides are very toxic to vertebrates.

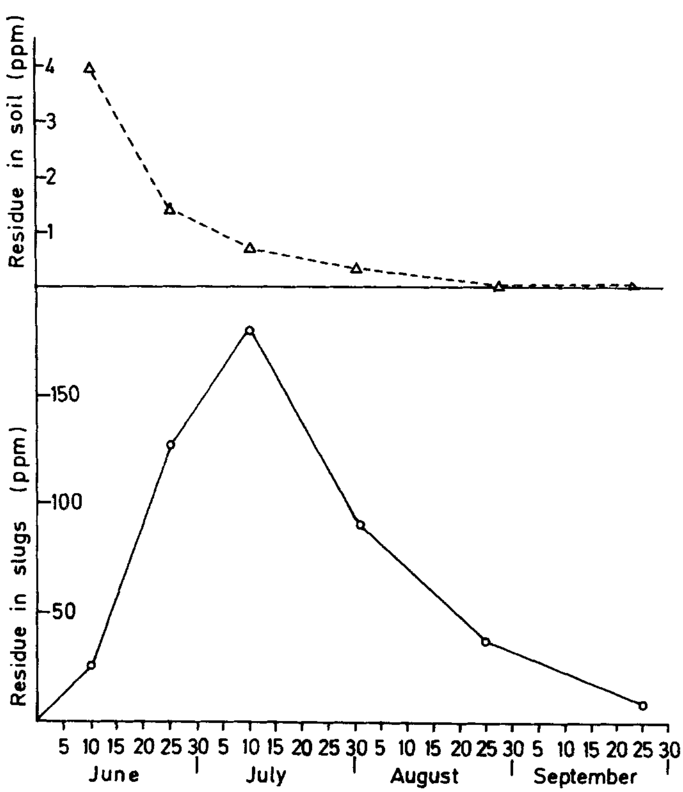

Figure 3. Uptake of diazinon (8 kg/ha) from soil by slugs.

References

STEPHENSON, J.W. Plant Path. 8 (2), 53, (1959).

DINDAL, D.L. Bull. Env. Contam. Toxicol. 6 (4), 362 (1971).

PAPPAS, J.L. and CARMAN, G.E. J. econ. Entomol. 48 (6), 696 (1955).

CRAMP, S. and CONDER, P. 5th Rept. Brit. Trust and Ornithol. Roy. Soc. Prot. Birds on Toxic Chemicals. 20 (1965).

EDWARDS, C.A. Persistent Pesticides in the Environment. C.R.C. Press, Cleveland, Ohio, 2nd Ed. 1973.

EDWARDS, C.A. and THOMPSON, A.R. Residue Rev. 45, 1 (1973).

DAVIS, B.N.K. Ann. appl. Biol. 61, 29 (1968).

DAVIS, B.N.K. and FRENCH, M.E. Soil Biol. Biochem. 1, 45 (1969).

GISH, C.D. Pest. Mon. J. 3, 241 (1970).

STRINGER, A. and PICKARD, J.A. Rept. Agr. Hort. Res. Sta. Univ. Bristol 172 (1965).

CRAMP, S., and OLNEY, P.J.S. 6th Rept. Brit. Trust Ornithol and Roy. Soc. Prot. Birds on Toxic Chemicals. 16 (1967).