ENTOMOLOGY

Influence of Soil Type and Soil Moisture on the Toxicity of Insecticides in Soils to Insects

Insecticides are commonly used for control of soil insects, but little is known about the factors influencing insecticide activity in soil. In the few investigations reported, emphasis has been placed on insecticides in the chlorinated hydrocarbon group. It has been established that DDT, γ-BHC, and dieldrin are inactivated by dry clay soils[1-3], and that under conditions of high relative humidity reactivation occurs[3,4]. Barlow and Hadaway[3] have suggested that insecticide inactivation on dry mud surfaces results from the physical phenomenon of adsorption, and that reactivation under conditions of high relative humidity occurs because the insecticide particles are unable to compete with water for the adsorptive surfaces on the soil particles. Other investigators[5-7] have noted that insecticides are also inactivated in soils high in organic matter. The mechanism of inactivation by the organic fraction is not clear, but Roberts[7] recently concluded that dieldrin is adsorbed by the organic fraction of the soil. This communication summarizes preliminary results obtained in a comprehensive investigation, now in progress at this laboratory, to determine the influence of soil type and soil moisture on the activity of both chlorinated hydrocarbon and organophosphate insecticides applied to soil for insect control.

The test insects, 24–48-h-old first-instar nymphs of the common field cricket, *Gryllus pennsylvanicus* (Burmeister) (Orthoptera: Gryllidae), were reared according to a technique described elsewhere[8]. Insecticide solutions were made up in redistilled *n*-pentane and applied to the soil using a standard procedure[9]. Two soil types were used: a Plainfield sand and a muck, containing 0·52 and 64·60 per cent organic matter, respectively. Samples were prepared containing 0 per cent water (oven dry) and 5·5 and 162 per cent water for sand and muck, respectively (field moisture capacity). The test insects were placed on the treated soil 1 h after treatment and held under constant light at 80° ± 1° F and 65 ± 5 per cent relative humidity. Mortality counts were made after 18 h. Bioassays were conducted using 5–8 concentrations of insecticide, causing mortalities ranging from 15 to 90 per cent. Duplicate groups of ten insects were tested at each concentration. Assays were replicated twice. The log-probit data were analysed by computer. Tests were conducted with heptachlor, DDT, diazinon, *V–C* 13 and parathion, and the LD_{50} values were used as a basis for comparison.

Table 1. Influence of Soil Type and Soil Moisture on the Toxicity of Insecticides in Soils to First Instar Nymphs of the Common Field Cricket, *Gryllus pennsylvanicus* (Burmeister)

Insecticide	Soil type	LD_{50} (p.p.m.) Moist	Dry
Heptachlor	Plainfield sand	0·068	0·528
	Muck	4·192	5·392
DDT	Plainfield sand	1·745	17·323
	Muck	67·232	99·803
Diazinon	Plainfield sand	0·258	34·070
	Muck	16·947	11·521
V–C 13	Plainfield sand	3·803	717·313
	Muck	278·572	164·968
Parathion	Plainfield sand	0·246	6·001
	Muck	22·626	9·099

Results of the tests (Table 1) indicated that all of the insecticides were more active in moist sand than in dry sand. Heptachlor was 7·8, DDT 9·9, parathion 24·4, diazinon 132·1 and *V–C* 13 188·6 times more toxic in moist sand than in dry sand. Dry muck soil did not inactivate the insecticides to the extent that the mineral soil did. Although heptachlor and DDT were 1·3 and 1·5 times less toxic in dry muck as in moist muck, diazinon, *V–C* 13 and parathion were 1·5, 1·7 and 2·5 times more toxic. Thus, although it would appear that the insecticides were strongly adsorbed in a dry mineral soil, they did not appear to be strongly adsorbed by a dry muck. In moist mineral soil it would appear that the activity of the insecticides was dependent on their ability to compete with water for the adsorptive surfaces on the soil particles.

Comparison of insecticide toxicity between the two soil types yielded further striking results. At field moisture capacity DDT was 38·5, heptachlor 61·6, diazinon 65·7, *V–C* 13 73·3 and parathion 92·0 times less toxic in the muck as compared with the sand. In moist soil all the insecticides were strongly inactivated by the organic soil, with the extent of inactivation being dependent on the specific insecticide used. In dry soil there was no obvious correlation between organic content and toxicity: *V–C* 13 and diazinon were less toxic on dry sand than on dry muck, while parathion, DDT and heptachlor were 1·5, 5·8 and 10·2 times more toxic. These results indicate that in moist soils inactivation of the insecticide is proportional to the organic content of the soil, while in dry soils inactivation is related to the adsorptive capacity of the mineral fraction.

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[1] Hadaway, A. B., and Barlow, F., *Nature*, **167**, 854 (1951).
[2] Downs, W. C., Bordas, E., and Navarro, L., *Science*, **114**, 259 (1951).
[3] Barlow, F., and Hadaway, A. B., *Bull. Entomol. Res.*, **46**, 547 (1955).
[4] Gerolt, P., *Bull. World Health Org.*, **24**, 577 (1961).
[5] Edwards, C. A., Beck, S. D., and Lichtenstein, E. P., *J. Econ. Entomol.*, **50**, 622 (1957).
[6] Fleming, W. E., Parker, L. B., Maines, W. W., Plasket, E. L., and McCabe, P. J., *U.S. Dept. Agric. ARS Tec. Bull.*, 1266, 44 (1962).
[7] Roberts, R. J., *J. Econ. Entomol.*, **56**, 781 (1963).
[8] Harris, C. R., and Svec, H. J., *Bull. Entomol. Res.*, **54**, 805 (1963).
[9] Lichtenstein, E. P., and Schulz, K. R., *J. Econ. Entomol.*, **52**, 118 (1959).

Inhibition of Egg Maturation in a Pregnant Viviparous Cockroach

In 1955, Lüscher and Engelmann[1] described the sexual cycle in females of the viviparous cockroach, *Leucophaea maderae*. The essentials of the original findings in *Leucophaea*, that is, the periodic change of the corpus allatum activity paralleled by egg maturation, have since been confirmed[2-4]. The bulk of work that ensued concentrated on the elucidation of the control of the sexual cycle in *Leucophaea*[2,3,5] and related species of the following genera: *Byrsotria*, *Blaberus*, *Nauphoeta*, *Pycnoscelus*[6,7], and *Diploptera*[8,9]. In the regulation of this cycle a nervous and a humoral mechanism seemed to operate independently in *Leucophaea*[5], whereas in some other species investigated[6,7] a nervous pathway alone accounted for the control of the activity of the corpora allata. In all these cases the severance of the ventral nerve cord during pregnancy resulted in activation of the corpora allata followed by egg maturation; in *Leucophaea*, however, egg maturation was significantly delayed. In *Leucophaea* and the other species mentioned the nervous pathway was assumed to involve the activation of stretch receptors associated with the genital apparatus as the brood sac was filled. It was thought that this information was then transmitted via the ventral nerve cord to the brain; the brain in turn inhibited the corpora allata.

If this assumption is correct, the severance of the nerves originating from the genitalia should then result in an activation of the corpora allata even during pregnancy. In *Leucophaea* branches of the ventral nerves of segments 7–9 innervate the genitalia[10]: that is, nerve 7, the brood sac, parts of the bursa copulatrix, and vagina; nerve 8, the dorsal parts of the bursa and the ventral pair of gonapophyses; nerve 9, the accessory sex glands and the other 2 pairs of gonapophyses. No connexions between these ventral segmental nerves have been found. In 18 pregnant females 4–5 weeks after ovulation the ventral nerves 7, 8, or 9 were successfully severed bilaterally, either each pair alone or the 3 pairs together. In many cases the operation included the dorsal nerves 7, 8, or 9.