Effect of the canal irrigation system used in the UAR on the persistence of soil insecticide

By Ahmed Abdel-Wahab Abdel-Gawaad,* Mohamed Atia Hamad† and Farouk Helmy El-Gayar‡

THE EFFECT of the special canal irrigation system which exists in parts of Egypt, on the persistence of soil insecticides has been studied. Four soil insecticides PP 211, Dyfonate, endrin and Kepone (chlordecone), which have also been tested at seven different experimental stations for their effect in controlling the cotton leaf worm, were leached from different soil types. The quantities of insecticides leached were affected by soil type and type of insecticide. Insecticides or their breakdown products were leached more readily from light soils (i.e. sandy loam and calcareous sandy loam) than from heavier soils (i.e. clay loam and clay).

The chlorinated hydrocarbons and their breakdown products were leached more readily than organophosphorous insecticides. Lake and river water can undoubtedly be contaminated through run-off water from adjacent treated agricultural fields. In this case soil particles to which insecticidal residues are adsorbed are being washed off the soil. Also, water in deeper soil strata may be contaminated by insecticidal residues depending on the type of the soil and on the type of insecticides.

Review of literature

Menn *et al* (1960) reported that soil moisture has little effect on the degradation of trithion in soil.

Zaki and Reynolds (1961) studied the rate of leaching of three systemic insecticides. The rate of leaching was directly proportional to the water solubility of chemicals involved. Tested insecticides also move more rapidly in sandy soil than in muck soil.

Grim (1962) commented on the cation-exchange in the soil. He reported that in the case of highly polar organic molecules, layers more than 1 molecule thick can be adsorbed on the basal planes of some clay minerals, i.e. montmorillonite.

Harris (1964) showed that in moist soils inactivation of the insecticides was proportional to the organic matter content of the soil.

Burt *et al* (1965) suggested that volatile insecticides (phorate and disulfon) can move through dry soil to the roots of plants. The more soluble and less volatile insecticides (dimethoate and menazon) can move to the roots through water.

Whiteney (1967) reported that dursban was a greater deal more effective in moistened soil than in dry soil; it was highly effective when soil moisture was well below field capacity.

Harris (1967) showed that the influence of soil moisture on insecticide bioactivity was dependent on soil type. Soil moisture enhanced the bioactivity of tested insecticides more readily in sandy loam soil than in clay soil, and in clay soil than in muck soil.

Burkhardt and Fairchild (1967) reported that horizontal and vertical movement of insecticides varied with the soil type and moisture. Organophosphorous insecticides exhibited less movement than aldrin and heptachlor.

Lichtenstein *et al* (1967) commented on the effect of percolating water and of detergents on the persistence of aldrin and parathion in the soil. Amounts of aldrin (0·1 to 0·2 p.p.b.) and of parathion (0·2 to 0·8 p.p.b.) found in percolating water were far below the water solubility of these insecticides. The presence of salts prevented the appearance of aldrin residues in the percolated water and reduced the amount of parathion residues.

Gawaad *et al* (1968) reported that soil type affects leaching of soil insecticides. Lindane was found to be leached more readily from sandy soil than from loam or sandy clay loam soils. Also, different soil insecticides differed in their ability to withstand leaching. Thimet and Temik leached more readily than organochlorine insecticides.

Harris (1969) reported that there is little probability that certain organophosphorous compounds as well as diazinon, disulfoton or phorate will be moved below the plough layer of soils by percolating water. Thianozin on the other hand may move considerably in some soils as a result of percolating water, since it moved in the soil columns similarly to monuron, which has moved below the plough layer under some conditions.

* Plant protection dept., High Institute of Cotton Affairs, Alexandria.
† Soil salinity laboratory, Ministry of Agriculture, Alexandria.
‡ Plant protection dept., Faculty of Agriculture, University of Alexandria, U.A.R.

TABLE 1

Analysis of seven types of soil from various experiment stations

	High Institute of Cotton	Faculty of Agriculture	Elnahda Farm (3)	El-Mansoura	Sakha	Etay El-Baroud	El-Nahda Farm (2)
Mechanical Analysis							
Clay %	15.0	34.8	35.9	39.7	38.4	60.5	42.4
Silt %	10.0	12.5	9.8	24.7	19.8	21.7	10.5
Sand %	75.0	52.7	54.3	35.6	41.8	17.8	47.1
Texture	sandy loam	sandy clay loam	calcareous sandy loam	clay loam	sandy clay loam	clay	calcareous clay
Chemical Analysis							
pH	7.4	7.8	7.2	7.5	7.8	7.7	7.4
Organic matter	1.544	1.906	0.884	0.281	1.792	1.879	1.464
Electric conductivity (m.mols/cm.)	3.0	5.9	7.4	3.8	6.1	9.9	5.3
Soluble cations							
Na + Meq./L.	11.5	37.7	33.0	21.0	25.2	47.5	18.2
K + Meq./L.	1.0	0.8	1.8	1.6	0.5	1.2	0.6
Ca ++ Meq./L.	9.9	10.2	23.4	28.1	6.9	27.2	21.3
Mg ++ Meq./L.	13.1	7.7	17.1	23.4	7.0	19.0	22.8
Soluble anions							
Cl — Meq./L.	15.5	32.8	17.7	23.8	18.0	16.8	69.9
HCO — Meq./L.	4.8	7.1	3.0	3.0	4.2	5.6	4.2
Physical Properties							
Field Capacity	28.7	55.0	42.4	35.0	51.6	59.1	59.5
Microbial Analysis							
Fungi	39,336	31,210	48,594	51,156	18,861	176,144	22,204
Bacteria	2,146,000	1,560,537	694,200	1,704,852	1,508,514	2,796,244	1,905,153
Actinomycetes	4,112,809	2,768,447	423,462	2,574,604	2,091,957	3,005,822	2,394,300

TABLE 2

Insecticide (weight in g.*) in drainage water and percentage of insecticide leached from seven different soils

	PP 211	Dyfonate	Endrin	Kepone
Weight of insecticide	0.5153	0.4620	0.4620	0.4620
High Institute of Cotton	0.04565 (8.8%)	0.04094 (8.9%)	0.26482 (57.3%)	0.13066 (28.1%)
Faculty of Agriculture	0.03402 (6.6%)	0.03769 (8.2%)	0.07871 (17.0%)	0.08069 (17.4%)
Nahda (3)	0.04156 (8.7%)	0.05122 (11.9%)	0.08456 (18.3%)	—
El-Mansoura	0.02084 (4.1%)	0.02660 (5.7%)	0.06989 (15.1%)	0.00475 (1.2%)
Sacka	0.03805 (7.3%)	0.03608 (7.8%)	0.12839 (27.7%)	0.17045 (36.8%)
Nahda (2)	0.02945 (5.8%)	—	0.11601 (25.1%)	—
Etay-el-Baroud	0.01308 (2.5%)	0.01869 (4.0%)	0.12366 (26.7%)	0.07949 (17.2%)

* total figures given here are based on 5 replications

Materials and methods

1. Soil Analysis.

Soil samples from the experimental research stations at Alexandria's Faculty of Agriculture, Alexandria's High Institute of Cotton Affairs, El-Nahda Farm No.3, El-Mansoura's High Institute of Agriculture, Sakha, Etay El-Baroud and El-Nahda Farm No.2, were analysed mechanically, physically, chemically and microbiologically, at the Soil Salinity Laboratory, Alexandria.

2. Insecticides

The insecticides tested were:

Kepone (chlordecone) 50% wp. (Allied Chemical Int., USA).

Endrin 50% wp. (Velsicol Chemical Corp. USA).

Dyfonate (O-ethyl-S-phenyl-ethylphosphorodithioate), 5% gr. (Stauffer Chemical Corp., Switzerland).

PP 211 (organophosphorous insecticide) 38% wp. (I.C.I. Ltd., London).

3. Leaching Test

The effect of leaching was estimated by a simple percolation method. Metal cylinders 32 cm. in diameter, 80 cm. in depth and terminating in a hole 2 cm. in diameter (Fig. 1), were provided with glass wool and coarse sand at their bottoms. A quantity (70 lb.) of each soil type was placed in each cylinder, which were irrigated with water. Excess water was left to drain through the hole in the bottom. Soil contained in each cylinder was treated with the test insecticides 15 days after irrigation. The quantity of each insecticide used was mixed with ½ kg. of fine soil and placed on the surface of the irrigated soil contained in each cylinder. Each treatment was replicated twice.

Six cotton plants were cultivated in each cylinder. Every 15 days each cylinder was provided with 8·04 l. of water which equals 420 m^3/feddan. Cylinders were irrigated 5 times.

The water draining from each cylinder within 24 hrs. after each irrigation was collected to estimate its volume and to assess the insecticide residue contained in it.

Daphnia magna Straus, reared and handled according to the methods described by Frear and Boyd (1967) were used for bio-assay determination of insecticide residues in the drainage water.

Dosage-mortality standard curves for each of the tested insecticides were calculated. A minimum of four repeated tests were used for standard curve determinations.

One ml. of tested drainage water was pipetted in 250 ml. water containing 10 daphnids. Mortalities were scored after 24 hrs. All tests were replicated at least four times. The corrected motralities obtained were applied to the related standard curve to calculate the insecticide residues present in the samples of drainage water.

Results and discussion

Soil analysis data are tabulated in Table 1. Table 2 shows that tested insecticides were leached more readily from light soils than from heavier soils. Kepone and endrin were more leached readily than the organophosphorus insecticides PP 211 and Dyfonate, regardless of the soil type.

Soil type was reported to affect the persistence of soil insecticides in the soil by Zaki and Reynolds (1961), Grim (1962), Harris (1964), (1967), (1969), Burkhardt and Fairchild (1967) and Gawaad *et al* 1968.

Soil minerals differ in their properties in adsorbing certain anions, cations and organic molecules. Soil consists of different groups of soil minerals such as kaolinite, montmorillonite, pyrophyllite, halloysite, illite, mica, etc. The percentage of every mineral in the soil differs from one soil to another. Moreover, soil types differ in their colloidal content, organic matter, soluble anions, soluble cations, surface area, pH, cation exchange capacity and content of micro-organisms. Therefore, soil insecticides may be expected to differ in leaching characteristics from one soil type to another. Results showing the insecticides tested were leached more readily from light soils than from heavy soils, may

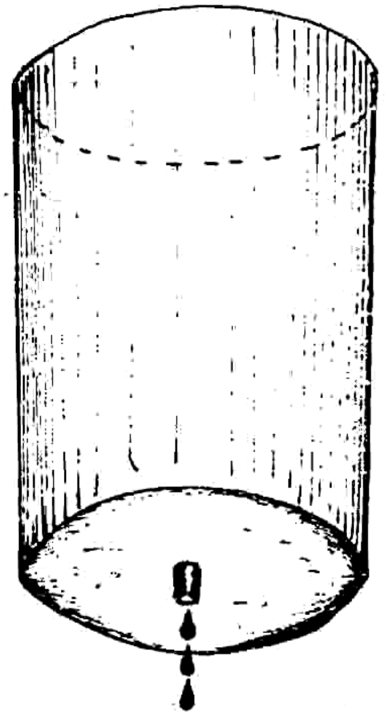

Fig. 1. Metal cylinders 32 cm. in diameter, 80 cm. in depth and terminating in a hole 2 cm. diamater.

be attributed to the high adsorption capacity of heavy soils due to their larger surface area.

Organophosphorus insecticides residues in leached water were always less than the residues of chlorinated hydrocarbon insecticides. This may be attributed to the shorter persistence of organophosphorus insecticides in the soil and to their degradation by the action of soil micro-organisms.

REFERENCES

Burkhardt, C. C. and M. L. Fairchild. 1967: Bioassay of field treated soil to determine bioactivity and movement of insecticides. *J. Econ. Ent.* **60** (6): 1602-1610.

Burt, P. E., R. Bardner and P. Etheridge, 1965: The influence of volatility and water solubility of systemic insecticides on their movement through soil and absorption by plant roots. *Ann. Appl. Biol.* **56**, 411-418.

Frear, D. E. H. and Boyd, J. F. 1967: Use of *Daphnia magna* for the micro-bioassay of pesticides: 1. Development of standardised techniques for rearing *Daphnia* and preparation of dosage-mortality curves of pesticides. *J. Econ Ent.* **60** (5): 1228-1236.

Gawaad, A. A. A., El-Sayed, N. M. Ali, and Ahmed Y. Shazli. 1968: Factors affecting persistence of soil insecticides: I- Leaching of some soil insecticides in three Egyptian soils (to be published).

Grim, Ralph E. 1962. Applied clay mineralogy. McGraw Hill book Company.

Harris, C. R. 1964. Influence of soil type and soil moisture on the toxicity of insecticides in soils to insects. Nature 202 (4933): 724.

Harris, C. R. 1967. Further studies on the influence of soil moisture on the toxicity of insecticides in soil. *J. Econ. Ent.* **60** (1) 41-44.

Harris, C. I. 1969: Movement of pesticides in soil. *J. Agri. Food. Chem.* **17** (1) 80-82.

Lichtenstein, E. P., T. W. Fwhremann, K. R. Schulz, and R. F. Skrentny. 1967. Effect of detergents and inorganic salts in water on the persistence and movement of insecticides in soils. *J. Econ. Ent.* **60** (6) 1714-1717.

Menn, J. J., G. G. Patchett and G. H. Batchelder. 1960. The persistence of trithion and organophosphorous insecticides in soil. *J. Econ. Ent.* **53** (6): 1080-1082.

Whiteney, W. Keith. 1967. Laboratory tests with Dursban and other insecticides in soil. *J. Econ. Ent.* **60** (1): 68-94.

Zaki, M. and R. T. Reynolds. 1961. Effects of various soil type and methods on application uptake of three systemic insecticides by cotton plants in green house. *J. Econ. Ent.* **54**: 568-572.

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