

SUSCEPTIBILITY OF BED BUGS TO INSECTICIDES

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The susceptibility of a normal laboratory strain of the bed bug, *Cimex hemipterus* Fabricius to certain synthetic contact insecticides, viz. dieldrin, diazinon and malathion was investigated in relation to DDT and lindane. The data were subjected to probit analysis. It was found that diazinon was the most effective insecticide, as residual films on filter papers, and was followed by malathion, lindane and DDT/dieldrin. It was also found that *C. hemipterus* was fairly susceptible to all the insecticides investigated.

Resistance of bed bugs to insecticides, particularly to DDT and BHC, in different parts of the world has been reported by several workers (Rao and Halgeri,¹ Busvine,² Cwilich *et al.*,³ Brown^{4, 5}, Menon *et al.*,⁶ Gratz,⁷ Micks,⁸ and Perti and Ranganathan⁹). The susceptibility of resistant strains of bed bugs to several synthetic contact insecticides has been studied by Busvine,¹⁰ Burden,¹¹ Loggren *et al.*,¹² and Krishnamurthy and Kalra¹³. It is, however, observed that the susceptibilities are not strictly comparable since different techniques of assessment have been used by different workers. It appeared of interest, therefore, to study the relative susceptibility to certain synthetic contact insecticides of the species of the bed bug, *Cimex hemipterus* Fabricius, endemic in Kanpur. This paper presents results on the susceptibility of a normal laboratory strain to dry residues and oil films of the insecticides.

MATERIALS AND METHODS

Insecticides—The insecticides used in these investigations were: DDT (tech), Lindane (99 % r—BHC), Dieldrin (tech), Diazinon (tech) and Malathion (tech; low odour) obtained from the trade in India.

Test insects—Susceptible strain of *C. hemipterus* drawn from laboratory cultures was used. The insects were reared by the method described by Damodar *et al.*¹⁴. Adult bed bugs, two to three weeks old, fed on rabbit blood, three to four hours prior to the exposure of the insects to the insecticides, were used in the tests.

EXPERIMENTAL PROCEDURE

The susceptibility of *C. hemipterus* to the various insecticides was investigated on two types of residual films on filter papers.

Dry residual films—Requisite concentrations of the insecticides were prepared in acetone. 'Whatman' filter papers (No. 1, 11 cm) were laid flat on pin points and one millilitre of the insecticidal solution was delivered on each filter paper with a hypodermic syringe. The filter papers were then allowed to dry for three hours before exposure of the insects.

Oil residual films—'Whatman' filter papers (No. 1, 11 cm) were impregnated with the solutions of the insecticides in BOC white Oil (specific gravity, 0.826) in varying concentrations. The insecticides completely dissolved in the solvent used. A filter paper was immersed

in insecticidal solution for five minutes and the excess liquid dripped off by suspending the treated paper, for six minutes, by means of a clip. The treated paper, was subsequently kept for five minutes, between two double layers of untreated filter papers, under four pound (1.82 kg) weight and hung for three hours, at room temperature, before exposure of the insects.

The assessment was broadly based on World Health Organization¹⁵ method for determining the susceptibility/resistance of bed bugs to insecticides. Since the WHO Test Kit (1960) provides only papers treated with DDT and Dieldrin, residual films of the various insecticides investigated were prepared in this laboratory, by the methods described above. Ten adult bed bugs were taken in a clean round bottom glass tube (15 cm × 1.5 cm) kept vertically on a stand. A strip (5.0 cm × 2.5 cm) of the treated filter paper, folded longitudinally in the form of 'Z', was introduced into the tube which was then loosely plugged with cotton wool and kept in a dark place. At the end of twenty four hour exposure on the treated filter paper strip, the insects were transferred into a clean glass tube provided with a strip of untreated filter paper, folded in the form of 'Z' as before. Observations on the mortality were recorded twenty four hours thereafter. The 24 hour exposure period was used since there was no mortality of insects in the controls, both when the insects were exposed on untreated filter papers and those treated with the solvent alone. There were two replicates in each assay. The temperature and relative humidity during the experiments were 24.5—26.5°C and 75—80 per cent respectively.

RESULTS AND DISCUSSION

The results obtained in the various experiments were subjected to probit analysis Finney,¹⁶ and are summarized in Table I and graphically presented in figures 1 and 2. The relative susceptibility of *C. hemipterus* to the insecticides has been determined based on LC_{50} .

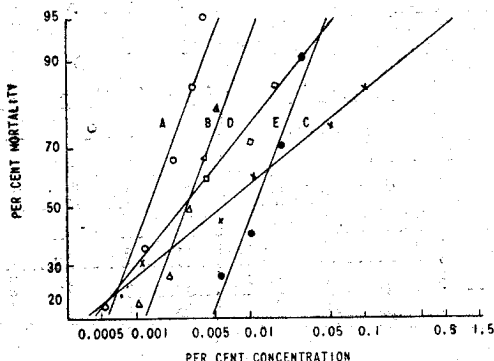


FIG. 1 — Susceptibility of *C. hemipterus* to dry residual films of insecticides.

A = Diazinon; B = Malathion; C = Dieldrin; D = Lindane; E = DDT.

The solvent used (Busvine¹⁷, Damodar¹⁸ et al) and the mode of application of an insecticide on insects (Negherbon¹⁹) markedly influence the toxicity of insecticides against different species of insects. It will be noted from the data in Table I and Figures 1 and 2 that the order of susceptibility of *C. hemipterus* to various insecticides varies with the type of residual film of the insecticide. When the insects were exposed on dry residual films they were most susceptible to Diazinon followed by Lindane, Malathion, Dieldrin and DDT. On the oil residual films, however, the insects were observed to be most susceptible to Malathion followed by Diazinon, Lindane, Dieldrin and DDT.

TABLE 1
SUSCEPTIBILITY OF *C. Hemipterus* TO RESIDUAL FILMS OF INSECTICIDES

Type of residual film	Insecticide	Heterogeneity	Regression equation	LC ₅₀		Fiducial limits		Relative susceptibility* compared to:	
				%	LC ₉₀	of LC ₅₀	of LC ₉₀		DDT
DRY RESIDUAL FILMS	Diazinon χ^2 (2)	=-0.0608	$Y = 2.6020x + 12.5625$	0.0012	0.0039	0.0009 0.0018	0.0022 0.0087	9.166	2.000
	Lindane χ^2 (2)	=-0.0145	$Y = 1.1965x + 8.1298$	0.0024	0.0235	0.0011 0.0052	0.0053 0.1547	4.583	1.000
	Malathion χ^2 (2)	=-0.1540	$Y = 2.6113x + 11.7010$	0.0027	0.0084	0.0020 0.0038	0.0039 0.0181	4.074	0.888
	Dieldrin χ^2 (3)	=-0.0126	$Y = 0.7667x + 6.7311$	0.0055	0.2593	0.0017 0.0184	0.0211 3.1614	2.000	0.436
	DDT χ^2 (2)	=-0.0421	$Y = 2.4047x + 9.7060$	0.0110	0.0377	0.0073 0.0168	0.0096 0.1485	1.000	0.218
OIL RESIDUAL FILMS	Malathion χ^2 (2)	=-0.0616	$Y = 2.1049x + 8.9256$	0.0136	0.0554	0.0089 0.0210	0.0243 0.1267	184.242	2.080
	Diazinon χ^2 (2)	=-0.0726	$Y = 2.7005x + 9.7581$	0.0173	0.0516	0.0171 0.0256	0.0245 0.1086	144.838	1.635
	Lindane χ^2 (2)	=-0.1126	$Y = 3.5724x + 10.5293$	0.0283	0.0647	0.0208 0.0386	0.0386 0.1086	88.530	1.000
	Dieldrin χ^2 (2)	=-0.0842	$Y = 1.6021x + 5.5033$	0.4852	3.0608	0.2790 0.8438	0.6439 14.5490	5.164	0.058
	DDT χ^2 (2)	=-0.0691	$Y = 7.1136x + 2.1822$	2.5057	3.7938	2.2065 2.8454	2.9866 4.8207	1.000	0.011

*Based on LC₅₀

Y = Probit kill;

x = Log concentration.

The grading of the susceptibility of *C. hemipterus* to the various insecticides when assessed by different techniques was carried out by the method described by Wal *et al*²⁰. The results on the grading are depicted in Table 2. It will be seen from this data that in the overall assessment, Diazinon was the most toxic to *C. hemipterus* followed by Malathion, Lindane and DDT/Dieldrin.

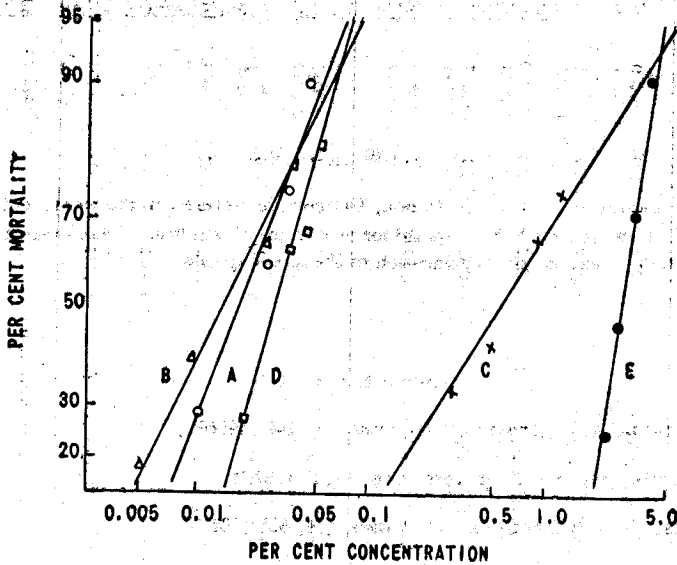


FIG. 2—Susceptibility of *C. hemipterus* to oil residual films of insecticides. A = Diazinon ; B = Malathion ; C = Dieldrin ; D = Lindane; E = DDT.

TABLE 2
GRADING OF THE SUSCEPTIBILITY OF *C. Hemipterus* TO INSECTICIDES

Insecticide	Dry residual film	Oil residual film	Total No. of Marks*	Average†
Diazinon	5	5	10	5.0
Malathion	4	4	8	4.0
Lindane	3	3	6	3.0
DDT	2	1	3	1.5
Dieldrin	1	2	3	1.5

*Marks obtained on the basis of LC₅₀ of insecticides.

†Total number of marks divided by the number of techniques employed.

It will, however, be observed from the above data that *C. hemipterus* is fairly susceptible to all the insecticides investigated. The results suggest that considering the toxic hazards (Hayes²¹), associated with the use of organophosphorus insecticides such as Diazinon and Malathion, dry residues of the chlorinated hydrocarbon insecticides, Lindane, Dieldrin or DDT may be advantageously used for the control of bed bugs where susceptible a rains of the insect are encountered. The World Health Organisation¹⁵ has also recommended that 'where resistance to DDT is not encountered, this is the insecticide of choice for the control of *Cimex* sp'.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. J. N. Nanda, Director, for interest in the work; to Dr. P. N. Agarwal for valuable suggestions and to Shri R. K. Tripathi for help in probit analysis. Thanks are also due to British Museum (Natural History), London, for identification of the insect species.

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