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Lower toxicity impact of common insecticides used for more than three decades as exemplified by the relative susceptibility of adults of *Diaphorina citri* Kuw. (Homoptera : Psyllidae)

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ABSTRACT : Relative toxicity of fifteen insecticides to citrus psylla, *Diphorina citri* Kuw., adults was determined in the laboratory. Carbaryl, phosphamidon, phosvel, formothion, phenthoate, fenitrothion, fenthion, morphothion and tetrachlorovinphos were found to be 406.4, 84.9, 36.5, 8.5, 8.2, 8.0, 5.0, 4.4 and 4.1 times, respectively more toxic than endosulfan. On the other hand, five of them, *viz.*, malathion, diazinon, pyrethrin, lindane and nicotine sulphate proved to be 0.7, 0.6, 0.5, 0.2 and 0.05 times less toxic, respectively. Although there was an increase in the LC_{50} values of nicotine sulphate, endosulfan and lindane since 1959, the actual median lethal concentrations being 0.4083, 0.01914 and 0.1182 per cent, respectively during 1992; the shift in the level of susceptibility of *D. citri* to these insecticides was not pronounced. This is exemplified by low relative susceptibility values, i.e., 3.59, 2.40 and 1.97, respectively. The toxicity of malathion was more or less the same even after a lapse of nearly 33 years. This suggests that those commonly used insecticides did not cause appreciable resistance in *D. citri* after such a long gap.

Adults and nymphs of citrus psylla, *Diaphorina citri* Kuw. suck the sap from the tender leaves and shoots and ultimately result in dry up of the branches of various cultivated varieties of citrus in India. Besides white fly, the citrus psylla too has now assumed the status of a major pest and is a cause of concern for citrus growers. This necessitated to evaluate the toxicity of a wide spectrum of insecticides for their proper selection as also to detect shift in the level of susceptibility of *D. citri* to commonly used insecticides after more than three decades.

MATERIALS AND METHODS

This pest was found breeding in large numbers on citrus plants during March-April, 1992 in the orchards of Indian Agricultural Research Institute, New Delhi, and its severe infestation provided a regular source of supply of the test insect.

The insecticides were formulated in the laboratory from their technical grades. However, in the case of pyrethrin and nicotine sulphate, the material used were commercial 2% and 40% emulsion concentrates, respectively. Insecticidal emulsions were pre-

pared by using benzene as solvent and triton x-100 as emulsifier, being maintained at 5.0 and 0.625 per cent levels, respectively.

The insecticidal films were obtained by spraying the top as well as the bottom of a pair of petridish (9 cm diameter) with one ml of each of the different concentrations of various insecticides under Potter's tower at 24 cm mercury pressure. The sprayed petridishes were allowed to dry under an electric fan for about thirty minutes. Thereafter, the adults of *D. citri* were released on dry films. After one hour, the treated insects from each petridish were transferred to separate glass rearing jars containing tender citrus leaves as food. The jars were covered with muslin and kept at 27 ± 1°C. Each treatment was replicated thrice with at least twenty-five adults per replication. Mortality counts were taken 24 h after treatment. The control mortality was corrected by the formula given by Abbott (1925). Five to seven concentrations of each insecticide were tested to obtain the concentration—probit mortality curve. The data were subjected to probit analysis (Finney, 1971). The values of relative toxicity of different insecticides were calculated by taking LC_{50} value of endosulfan as unity.

RESULTS AND DISCUSSION

It is evident from Table 1 that the different insecticides in the descending order of toxicity to the adults of *D. citri* are carbaryl, phosphamidon, phosvel, formothion, phenthoate, fenitrothion, fenthion, morphothion, tetrachlorovinphos, endosulfan, malathion, diazinon, pyrethrin, lindane and nicotine sulphate. Out of fifteen insecticides the first nine were about 406.4, 84.6, 36.5, 8.5, 8.2, 8.0, 5.0, 4.4 and 4.1 times respectively more toxic than endosulfan. Malathion, diazinon, pyrethrin, lindane and nicotine sulphate were about 0.7, 0.6, 0.5, 0.2 and 0.05 times as toxic as endosulfan.

The Directorate of Plant Protection, Quarantine and Storage, Ministry of Agriculture, New Delhi (Anonymous, 1992) in a recent publication entitled, "Major uses of pesticides" recommended carbaryl and endosulfan for its control. Though carbaryl is still very effective, yet a good number of other highly toxic insecticides to the pest can be chosen amongst those tested in the present investigation (Table 1). This has increased the range from which one can select one or more insecticides for use as and when the pest causes serious infestation. However, this will depend on their availability in the market, prevailing price, residues and safety to human beings.

As early as 1959, Pradhan and co-workers determined the LC_{50} values of different pesticides against *Diaphorina citri*. Again, during 1992, the toxicity of fifteen commonly used insecticides was evaluated to ascertain the trends of its susceptibility to these insecticides and to provide alternative insecticides for its control. After more than three decades, there has been only 3.6, 2.4 and 2.0 times change in the susceptibility level in respect of nicotine sulphate, endosulfan and lindane when the LC_{50} values were compared with those determined in 1959 (Table 2). On the other hand, toxicity of malathion to *D. citri* remained more or less the same, the LC_{50} values being 0.03 in 1992 and 0.04 per cent during 1959. Obviously, the response of *D. citri* to malathion did not change significantly.

Table 1. Relative toxicity of different insecticidies to the adults of *Diaphorina citri* Kuw.

Insecticide	Heterogeneity χ^2 =	Regression equation Y =	LC_{50}	Fiducial limits	Relative toxicity
Carbaryl	3 = 6.161	2.268x + 1.205	0.00004710	0.00005599 0.00003961	406.37
Phosphamidon	4 = 5.213	1.780x + 0.812	0.0002254	0.0002712 0.0001875	84.91
Phosvel	3 = 5.732	2.367x – 1.435	0.0005236	0.0005995 0.0004572	36.55
Formothion	3 = 0.129	3.096x – 5.373	0.002239	0.002599 0.001925	8.55
Phenthoate	3 = 4.676	3.970x – 8.364	0.002323	0.002705 0.001995	8.24
Fenitrothion	3 = 0.026	2.326x – 2.850	0.0002371	0.003035 0.001852	8.01
Fenthion	3 = 0.571	2.676x - 4.589	0.003823	0.004409 0.003329	5.01
Morphothion	3 = 2.233	4.835x – 12.570	0.004305	0.004775 0.003882	4.44
Tetrachlorovinphos	4 = 6.017	1.010x + 1.298	0.004624	0.006730 0.003177	4.14
Endosulfan	4 = 2.073	1.870x – 3.009	0.01914	0.024390 0.015030	1.00
Malathion	4 = 8.282	1.385x-1.130	0.02667	0.033570 0.021170	0.72
Diazinon	4 = 5.315	1.197x – 0.419	0.03365	0.047420 0.023890	0.57
*Pyrethrin	4 = 14.566	2.142x – 4.748	0.03554	0.04162 0.03035	0.54
Lindane	4 = 1.896	0.956x + 0.152	0.1182	0.20180 0.08569	0.16
*Nicotine sulphate	3 = 10.190	2.203x – 7.360	0.4083	0.4871 0.3423	0.05

*In these cases only, the data were found to be significantly heterogeneous at P = 0.05; Y = Probt kill; x = log (concentration × 10^7); LC_{50} = concentration calculated to give 50% mortality.

Table 2. Relative susceptibility of some insecticides *to Diaphorina citri*

Insecticide	LC_{50} (1992)	LC^*_{50} (1959)	Relative susceptibility
Endosulfan	0.01914	0.007982	2.40
Lindane	0.1182	0.06001	1.97
Nicotine sulphate	0.4083	0.11370	3.59
Malathion	0.02667	0.04010	0.55

*Pradhan *et al.* (1959)

$$\text{Relative susceptibility} = \frac{LC_{50} \text{ worked out in the present investigation (1992)}}{LC_{50} \text{ worked out during 1959}}$$

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