Toxicity of Insecticides to the Aphid Predator *Coccinella novemnotata*[1,2]

J. W. TRAVIS, L. A. HULL, AND J. D. MILLER[3]

Pennsylvania State University, Fruit Research Laboratory, Biglerville 17307

ABSTRACT

Environ. Entomol 7: 785–786 (1978)

A laboratory bioassay study of 9 insecticides, phosalone, phosmet, carbaryl, Penncap M, dimethoate, azinphosmethyl, demeton, phosphamidon and endosulfan was conducted on adult *Coccinella novemnotata* (Herbst) to compare their contact toxicities. The study was conducted to determine if *C. novemnotata* can tolerate materials commonly used in the integrated pest management program on apple in Pennsylvania. Phosphamidon was the most toxic of the compounds tested. Endosulfan caused no mortality at any of the dosages tested. The other insecticides caused 70% mortality or less of adult *C. novemnotata*.

The ladybird beetle, *Coccinella novemnotata* (Herbst), is a natural predator of the apple aphid, *Aphis pomi* DeGeer, in southcentral Pennsylvania (Travis, unpublished data). During the 1977 growing season this beetle reached high population levels which aided significantly in reducing aphid infestations. To aid in development of future programs of integrated pest management, the need exists to determine the toxicity of various pesticides used for the control of the apple aphid to adult *C. novemnotata*.

Research dealing with the effect of various pesticides on coccinellid aphid predators has previously been summarized (Ripper 1956, Hodek 1966, and Croft and Brown 1975). The present study was conducted to determine the ability of adult *C. novemnotata* collected from an Adams Co., Pa., apple orchard for several commonly used insecticides.

Materials and Methods

Adult *C. novemnotata* were collected from an apple orchard at the Pennsylvania State University, Fruit Research Laboratory, Biglerville. The beetles were collected from the tress by brushing them from the leaf with a camel's hair brush into a cardboard container. Leaves infested with aphids were put into the containers and the beetles were taken to the laboratory.

Due to the limited number of *C. novemnotata* available for testing, the 1st group collected was sprayed with the insecticides phosphamidon 8EC, Penncap 2FM® (encapsulated methyl parathion), carbaryl 50W, dimethoate 25W, and phosalone 25W. The 2nd group collected was sprayed with the insecticides endosulfan 50W, demeton 6EC, azinphosmethyl 50W, and phosmet 50W. Each insecticide was tested at 4 dosage levels with each level replicated twice containing 12 beetles/replication. A control group treated with distilled water was included with each replication and group. Fresh mixtures of insecticide and distilled water (pH 5.7) were made within 3 h of application.

A laboratory sprayer which is a modification of the Schein inoculator (Schein 1964) was used to treat the *C. novemnotata* with the insecticides. To test the reproducibility of the laboratory sprayer, 4 replicates of 30 spray applications each, using distilled water, were performed on different days. The spray deposit weights were analyzed statistically by an F test and were found not to be significantly different at the 5% level. The laboratory sprayer applications also were analyzed with respect to the sequence of application within each replicate. From this analysis, no dependence on time was found. The estimate of the avg spray deposit weight is 25.5 mg/cm^2. The 95% confidence interval for the spray deposit weight is 25.3 to 25.7 mg/cm^2. The coefficient of variation for the present test of sprayer reliability is 5%, which is considered acceptable (Busvine 1971).

The beetles were taken from the capture cups and placed in groups of 12 in 9-cm petri dishes lined with filter paper. The petri dishes were placed in the laboratory sprayer and the treatments applied.

After treatment the beetles were removed to screened cages which contained apple leaves infested with green aphids. The caged beetles were placed in a greenhouse where they remained for the duration of the experiment. Temperatures averaged 29°±4° and 29°±2° during the day and 23°±3° and 23°±3°C during the night for the 1st and 2nd groups, respectively. Relative humidity ranged from 70–80% during the day and from 85–90% during the night for both groups. Mortality data were taken at 24 and 48 h after treatment.

Dose-mortality data at 48 h were statistically analyzed by using a computer program for probit analysis (Barr et al. 1977).

[1] Coleoptera: Coccinellidae.

[2] Authorized for publication on Dec. 9, 1977 as Journal Series Paper no. 5422 of the Pa. Agric. Exp. Stn. This publication was supported in part by the National Science Foundation and the Environmental Protection Agency, through a grant (NSF BMS 75-04233) to the Univ. of Calif. The findings, opinions and recommendations expressed herein are those of the authors and not necessarily those of the Univ. of Calif., the NSF or the EPA. Received for publication Dec. 16, 1977.

[3] Grad. Asst., Asst. Professor and under grad. student, respectively, Dept. of Entomology.

0046-0225/78/0607-8502$00.75/0

Results

The toxicity relationships of the insecticides are presented in Fig. 1. Phosphamidon was the most toxic of the insecticides tested. Several of the compounds, azinphosmethyl, Penncap M, dimethoate, demeton and carbaryl are similarly toxic to *C. novemnotata* in the dosage range evaluated. However, because of a greater slope of regression line, demeton is more toxic than the other insecticides of this group at higher dosages. Phosmet and phosalone were much less toxic to the beetles than the other insecticides. Endosulfan caused no mortality at any of the dosages tested.

The LC_{50} comparison (Table 1) indicates similar relationships in toxicity. Azinphosmethyl was chosen as the standard insecticide since it is currently the most commonly used insecticide in Pennsylvania apple orchards (Anon. 1978). The last column of Table 1 gives the toxicity ratio of the insecticides as amounts of AI of material required to result in 50% mortality as compared to azinphosmethyl. For example, phosalone required 50 times more AI of material to result in 50% mortality of adult *C. novemnotata* than did azinphosmethyl. Endosulfan caused no mortality.

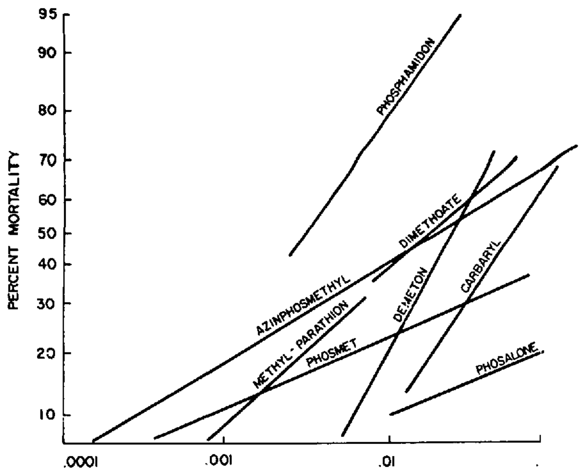

FIG. 1.—Log dosage-probit-mortality curves of several insecticides to adult *C. novemnotata*.

Discussion

The beetles were subjected to direct contact toxicity of the insecticides. Ingestion and fumigation of the beetles by the insecticides were avoided. Since the later 2 modes of action of the insecticides were eliminated from the experiment, the beetle population reacted to the insecticides over a larger dosage range than would normally be expected. This is related in the low slope values obtained and correspondingly in the wide fiducial ranges. If the fiducial limits were above 1% AI, they were considered too large to be realistic, based on amounts of AI of the insecticides recommended for field application. The R^2 values (Table 1) indicate that there was a strong linear relationship between probit mortality and log of dosage for all the insecticides tested.

In summary, the results presented here show that *C. novemnotata* can survive applications of some of the commonly used insecticides in Pennsylvania and may play a more important role as a predator of the apple aphid in Pennsylvania's integrated pest management program.

REFERENCES CITED

Anonymous. 1978. 1978 Pennsylvania Tree Fruit Production Guide. The Pennsylvania State University, University Park, PA.

Barr, A. J., J. H. Goodnight, J. P. Sall, and J. T. Helwig. 1977. A User's Guide to SAS, 1977. SAS Institute, Inc., Raleigh, NC. p. 329.

Busvine, J. R. 1971. A critical review of the techniques for testing insecticides. Eastern Press Limited, London, England.

Croft, B. A., and A. W. A. Brown. 1975. Responses of arthropod natural enemies to insecticides. Annu. Rev. Entomol. 20: 285–335.

Hodek, I. 1966. Ecology of Aphidophagous Insects. Academia, Prague.

Ripper, W. E. 1956. Fffect of pesticides on balance of arthropod populations. Annu. Rev. Entomol. 1: 403–38.

Schein, R. D. 1964. Design, performance, and use of a quantitative inoculator. Phytopathology. 54: 509–12.

Table 1.—Contact toxicity of 8 insecticides to *C. novemnotata*.

Chemical and formulation	Slope±SE	R^2 value	LC_{50}[b]	95% fiducial limits[b]	Toxicity ratio at LC_{50}[c]
Phosalone 25W (OP)	0.68±0.78	70.2%	1.52	←—→[d]	50.0
Phosmet 50W (OP)	0.43±0.17	87.5%	0.35	0.008—→[d]	14.0
Carbaryl 50W (C)	1.62±0.43	93.4%	0.07	0.114—→[d]	2.7
Penncap M 2EC (OP)	1.02±0.77	83.2%	0.026	0.003—→[d]	1.0
Dimethoate 25W (OP)	1.01±0.39	88.5%	0.026	←—→[d]	1.0
Azinphosmethyl 50W (OP) (standard)	0.69±0.15	86.0%	0.026	0.003—→[d]	1.0
Demeton 6EC (OP)	2.45±0.40	87.0%	0.024	0.345–0.012	0.9
Phosphamidon 8EC (OP)	1.70±0.46	96.7%	0.004	[d]←—0.009	0.2

[a] OP = organophosphate, C = carbamate.
[b] Percent concentration of active ingredient.
[c] Toxicity ratio at LC_{50} relative to azinphosmethyl = $1/(LC_{50}$ azinphosmethyl/LC_{50} candidate).
[d] Not a realistic value.