Tolerance of the Stages of *Stethorus punctum* to
Selected Insecticides and Miticides

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ABSTRACT

The toxicity of 16 pesticides to all life stages of the predatory coccinellid *Stethorus punctum* (LeConte) resulted in a high number of survivors from all treatments except 0.50 lb active ingredient (AI) per 100 gallons of carbaryl WP 50%, and 0.1875 lb AI/100 gal carbofuran WP 75% when tested in an insectary. At the dosages tested, most other materials tested could be used in an integrated control program of apple pests with a high rate of survival of this predaceous arthropod.

The ladybird beetle, *Stethorus punctum* (LeConte), is one of the most important native predators of the European red mite, *Panonychus ulmi* (Koch), in south-central Pennsylvania. A need exists to establish the toxicity of various insecticides and miticides used for control of apple pests to all life stages of *S. punctum* to develop programs of integrated control.

There are only a few reports in the literature on the effectiveness of any specific dosages of insecticides or miticides on any life stage of *S. punctum*. There are still fewer reports of the effectiveness of any material commonly used in orchard spray programs today. A review of the literature pertaining to this subject has been published (Colburn and Asquith 1970). The present paper reports the insectary evaluation of the effect of 16 insecticides and miticides, at dosages used for apple pests, on the adults, eggs, larvae, and pupae of *S. punctum*. This information is essential in deciding if a material can be utilized in future integrated chemical and biological control programs.

We (Colburn and Asquith 1970) found that 0.50 lb AI/100 gal Galecron® (N′-(4-chloro-o-tolyl)-N,N′-dimethylformamidine) 4 ec/100 gal; 0.375 lb AI Gardner® (2-chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl phosphate) WP 75%; 0.375 lb AI Imidan® (O,O-dimethyl S-phthalimidomethyl phosphorodithioate) WP 50%; 0.125 lb AI azinphosmethyl WP 50%; and 0.200 lb AI Lovozal® (phenyl 5,6-dichloro-2-(trifluoromethyl)-1-benzenimidazolecarboxylate) WP 40%, when evaluated in the laboratory for toxicity to *S. punctum* adults all resulted in a high number of survivors for all treatments.

**Materials and Methods.**—The insecticides and acaricides tested, their formulations, active ingredients of proprietary compounds, and sources were:

**Chlorinated hydrocarbons:**
- Endosulfan WP 50%, Niagara Chemical Division, FMC Corp.
- Carbaryl WP 50%, Union Carbide Co.
- Carbophur WP 75%, Niagara Chemical Division, FMC Corp.

**Carbamates:**
- Formetanate SP 95%, Morton Chemical Co.
- Carbaryl WP 50%, Union Carbide Co.
- Carbophur WP 75%, Niagara Chemical Division, FMC Corp.

**Phosphorous compounds:**
- Azinphosmethyl WP 50%, Chemagro Corp.
- Demeton EC 6 lb/gal, Chemagro Corp.
- Dialilor EC 6 lb/gal, Hercules Inc.
- Dimethoate EC 2.67 lb/gal, American Cyanamid Co.
- Dimethoate WP 25%, American Cyanamid Co.
- Gardenia WP 75%, Shell Chemical Co.
- Imidan WP 50%, Stauffer Chemical Co.
- Phosalone WP 25%, Chipman Division, Rhodia, Inc.

**Miscellaneous compounds:**
- Final SP® 95% (N′-(4-chloro-o-tolyl)-N,N′-dimethylformamidine hydrochloride, Morton Chemical Co.
- Galecron EC 4 lb/gal, Giba Corp.
- Lovozal WP 40%, Fisons Corp.
- Pictran® WP 50% (tricyclohexylhydroxynitril) Dow Chemical Co.

The test materials were weighed and mixed in the appropriate amount of water. The tests on all stages of the beetle were conducted in an insectary.

**Evaluation of Tolerance of Adults.**—Adults of *S. punctum* were obtained from 3 apple orchards in south-central Pennsylvania on 5 different dates in 1970 from May 14 to Aug. 25. Adult beetles were collected from trees and tested by the methods described previously (Colburn and Asquith 1970). Each formulation was tested on 20 beetles with a check of 10 wetted (water) and 10 nonwetted beetles maintained on each test date.

Relative humidity ranged from 20 to 100% (mean 70%). Temperature ranged from 55 to 92°F (mean 73°F). Observations were made at 1, 2, 4, 8, 12, 24, and 48 h after treatment. An average percent survival was computed.

**Evaluation of Tolerance of Eggs.**—Eggs of *S. punctum* were collected on 8 different dates in 1970 from 2 Adams County apple orchards, one at Arendtsville and the other at Heacock's orchard near Biglerville. The eggs were collected from the trees first by selecting leaves with adult *S. punctum* present. These leaves were taken to the laboratory and the eggs were placed under a microscope, and each egg was circled in ink on the leaf and numbered.

When an egg (or eggs) was located on a leaf and the egg's location was marked, the leaf petiole was inserted in moistened (water) cotton and sealed with paraffin. The cotton was moistened each day for the duration of the test. A small amount of each test pesticide was placed in separate styrofoam cups and an entire leaf with the eggs was dipped in each separate solution. The leaves were then taped to a strip of wood in an upright position. Each pesticide was tested on 10 eggs of *S. punctum*. Five check eggs
were dipped in water and 5 were kept dry throughout each test period.

Relative humidity ranged from 16 to 100% (mean 65%). Temperatures ranged from 50 to 94°F (mean 71°F). Results were recorded each day for 7 days. An average daily percent emergence was computed.

Evaluation of Tolerance of Larvae.—Larvae of S. punctum were collected from Heacock's apple orchard on 6 different dates in 1970 and returned to the insectary for the test. Larvae were collected by removing leaves containing the larvae from the apple trees and placing them in plastic bags for transport back to the insectary.

A special cage to confine the larvae during the test was constructed from the following materials: 1 plastic box 2 × 2 × 1 1/2 in, white dacron-ninon screening. Acrylite* acyrlic plastic,* and Testor's plastic cement no. 3501.*

The cage was constructed by drilling 1-in. holes in both the front and back sides of the plastic box with a 1-in. hole saw. These holes were then covered with the screening which was glued in place. The box was glued to a 2 1/2 × 5 1/2 × 1/2-in. plastic strip leaving 3/4 in. overhang in the front to allow the front of the box to be opened. Two 3/2-in. holes were then drilled through the plastic and the base of the box leaving 1 1/6 in. between holes. These openings supported the stoppers which held the leaves in position. One-half-inch strips of plastic were glued along both outer edges of the base piece of plastic to hold the cage in position over a petri dish which was filled with water to keep the leaves healthy during the test. Two of these cages were placed side by side in both the front and back sides of the plastic box.

The front of the box was shut and the test was begun. Entire York Imperial apple leaves with pupae were immersed in each material and allowed to air dry. The petiole of the leaf was placed through the holes in the stoppers, allowing the leaves to obtain water from the petri dish. The leaves in the stoppers were placed in the test boxes, and European red mites were brushed onto the leaves as a food source for the S. punctum larvae.

A small amount of each pesticide was placed in separate styrofoam cups. The larvae were immersed in the material and placed on a small piece of filter paper in the center of the bottom of the test cage. The front of the box was shut and the test was begun.

Each formulation was tested on 20 S. punctum larvae. Ten check larvae were placed in the test boxes, and European red mites were brushed onto the leaves as a food source for the S. punctum larvae.

Relative humidity ranged from 20 to 100% (mean 66%). The temperature range was 55-92°F (mean 74°F). Results were recorded at 1, 2, 4, 8, 12, 24, and 48 h after treatment. An average percent survival was computed.

Evaluation of Tolerance of Pupae.—S. punctum pupae were collected from 2 apple orchards, Arendtsville and Biglerville, on 3 different dates in 1970 and returned to an insectary for the test period.

Entire 'York Imperial' apple leaves with pupae present were removed from the trees and placed in plastic bags and taken to the insectary; here the pupae were checked by use of a microscope to assure that they were alive. When pupae were located on a leaf the location was recorded, and the leaf was then selected for the pupal test.

A small amount of each pesticide was placed in separate styrofoam cups. With the pupae marked and numbered, an entire leaf with the pupae present was dipped into each material and allowed to air dry. The petiole of the leaf was placed through

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Table 1—Influence of various insecticides and miticides on all stages of S. punctum.

<table>
<thead>
<tr>
<th>Material</th>
<th>lb/gal</th>
<th>Adults% Eggs%</th>
<th>Larvae% Pupa%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endosulfan</td>
<td>0.500</td>
<td>45</td>
<td>100</td>
</tr>
<tr>
<td>Formetanate</td>
<td>0.750</td>
<td>85</td>
<td>35</td>
</tr>
<tr>
<td>Carbaryl</td>
<td>0.500</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Carbofuran</td>
<td>0.075</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Azinphosmethy</td>
<td>0.125</td>
<td>85</td>
<td>70</td>
</tr>
<tr>
<td>Demeton</td>
<td>0.1875</td>
<td>35</td>
<td>80</td>
</tr>
<tr>
<td>Diazinol</td>
<td>0.375</td>
<td>65</td>
<td>20</td>
</tr>
<tr>
<td>Dimethoate</td>
<td>0.250</td>
<td>55</td>
<td>80</td>
</tr>
<tr>
<td>Cardone</td>
<td>0.250</td>
<td>70</td>
<td>65</td>
</tr>
<tr>
<td>Imdian</td>
<td>0.250</td>
<td>95</td>
<td>70</td>
</tr>
<tr>
<td>Phosalone</td>
<td>0.375</td>
<td>90</td>
<td>70</td>
</tr>
<tr>
<td>Galenon</td>
<td>0.500</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Lovozal</td>
<td>0.200</td>
<td>55</td>
<td>30</td>
</tr>
<tr>
<td>Plictran</td>
<td>0.125</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>Check (water)</td>
<td>0.250</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Check (water)</td>
<td>0.250</td>
<td>50</td>
<td>40</td>
</tr>
</tbody>
</table>

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*After 48 hours continuous exposure.  
*After 7 days continuous exposure.

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Fig. 1.—Plastic box cage used to confine S. punctum larvae during insecticide and miticide evaluations. A, Plastic boxes; B, acrylite base; C, dacron-ninon screening; D, petri dish; E, stopper; F, filter paper.
Sterilization of the Beet Leafhopper*: Induction of Sterility and Evaluation of Biotic Effects with a Model Sterilant (OM-53139) and $^{60}$Co Irradiation$^{1,2}$

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ABSTRACT

Fourteen chemicals comprising alkylating agents, organophosphorus compounds, an antimetabolite (aminopterin), and an antibiotic (porfipromycin) were evaluated as chemosterilants of Circulifer tenellus (Baker). Topical application and contact exposure were found unsatisfactory, but oral administration in sucrose solution through paraharm membranes was satisfactory and was employed throughout the study. Apholate and tepta were toxic at sterilizing dosages. Metepa, tepta, and Compound I ($N,N'$-hexamethylene bis-l-aziridinyl carboxamide) were the most effective sterilants; hempa was the least effective. Because of high sterilant activity and low toxicity, Compound I was selected as a model compound for detailed study. Male leafhoppers were somewhat more susceptible than females to the toxic as well as to sterilant action of Compound I. Susceptibility was highest in late-stage nymphs and it decreased in both sexes with advancing age. High degree of sterility was evident when matings were performed immediately after a 24-hour acquisition period, and it increased to a plateau at 48 hours, remaining constant for the entire 1-month period of observation. Females which mated to sterile males remained monogamous provided the 1st copulation was long enough (approximately 1.6 minutes) to insure passage of seminal fluid. Chemosterilized males, when confined at various ratios with normal males and females, were found to be sexually as competitive as nonsterile individuals, both under optimum environmental conditions and under temperature stress.

Sterilization of the insect by $^{60}$Co irradiation was also demonstrated. 85% sterility having been obtained with doses of 16–20 krad for males and 4–6 krad for females.

The beet leafhopper, Circulifer tenellus (Baker), is the only known vector of the curly top virus in western North America. The disease affects 85 economically important crops, causing especially heavy losses in sugar beets, beans, squash, watermelon, cantaloup, and tomatoes (Cook 1967). The State of California incurs an annual expenditure of $200,000 to $300,000 in suppressing the population of this insect, mainly by application of insecticides to overwintering grounds.$^5$ The objective of this study was to investigate the amenability of the insect to sterilization as an alternative to use of insecticides.

Information on chemical sterilization of Hemiptera is limited to Oncopeltus fasciatus (Dallas) (Simko over 1964), Acyrthosiphon pisum (Harris) (Bhalla and Robinson 1968), and Psylla pyricola Foerster (Kaloostian 1968). Radiation sterilization of Hemip-