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Toxicity of Pesticides Commonly Used
in Japanese Apple Orchards to the
Predatory Mite *Typhlodromus pyri*
SCHEUTEN (Acari: Phytoseiidae)
from New Zealand¹

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Integrated mite control programs have been established in many fruit growing regions overseas (CROFT, 1975; HOYT, 1969; WEARING et al., 1978). Their success in providing an effective and less costly control of mites has largely been the result of the widespread development of resistance to pesticides in predatory mite species. In New Zealand, for instance, a strain of *Typhlodromus pyri* SCHEUTEN resistant to azinphos-methyl was first found at Nelson in 1967. The distribution and resistance of this strain has increased since that time and with it its potential for use in an integrated mite control program (WEARING et al., 1978). Two other species, *T. occidentalis* NESBITT and *Amblyseius fallacis* GARMAN, have also been evaluated in commercial orchards (THOMAS and CHAPMAN, 1978). Both of them originated from the United States and are resistant to azinphos-methyl to varying degrees.

In Japan, as no predators resistant to pesticides have been recovered in apple orchards, mite control has relied solely on miticide application. Should resistant predatory mites be introduced to Japan in order to establish an integrated control system, it would be desirable to check all pesticides in advance so that applications for the control of other pests and diseases could be replaced if necessary to improve the survival chance of the predatory mites.

While studying at Entomology Division, DSIR,

Auckland, I investigated the toxicity of pesticides which are commonly used in the apple orchards of Japan. As it is the most important phytoseiid predator on pipfruit in New Zealand, *T. pyri* was chosen for the present tests.

MATERIALS AND METHODS

The predatory mite, *T. pyri*, was collected on the DSIR Appleby Research Orchard in Nelson. Whole leaves infested by predator and prey were air-freighted in polyethylene bags to Entomology Division, DSIR, Auckland, for testing once a week from December 20, 1984 to January 29, 1985. The test was performed within a few days of the mites arrival, and only vigorous active females were selected. As the number of live predators recovered varied considerably depending on the time of collection, the number of pesticides tested in a day varied accordingly.

Depending on availability, 10 to 20 adult females were stuck on their backs on double-sided adhesive tape attached to a microscope slide. Each slide was dipped for five seconds in a prepared suspension of one of the pesticides. All pesticides tested were wettable powder formulations and they were diluted according to the Aomori prefectural standard spray programs. After treatment the slides were air-dried for 15 min to remove excess liquid, and then they were held for 24 hr at 28°C and 80% RH. Mortality was assessed by examination under a stereoscopic microscope. Mites which failed to move their appendages when touched by a fine brush were counted as dead.

Each test was replicated four or five times on different days. The percentage mortality for each sample was corrected by ABBOT's formula using the result of untreated control carried out on each treatment date.

RESULTS AND DISCUSSION

Average percentage mortalities are presented in Table 1, with the dilutions of the pesticides and the

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Table 1. The percentage mortality of *T. pyri* in dip tests of various pesticides

Common name ^a	Dilution	No. mites	Mortality (%) ^b
Fungicides			
1. Oxine-copper (40)	600	60	1.3
2. Manzeb (66) + dinocap (15)	500	59	4.4
3. Thiram (30) + ziram (50)	600	60	3.1
4. Thiophanate methyl (70)	1,500	65	1.3
5. Chlorothanoni (75)	500	60	7.5
6. Binapacryl (50)	2,000	58	6.4
7. Propineb (70)	500	70	14.0
8. Captan (80)	800	60	5.3
9. Mepronil (75)	1,000	80	10.3
10. Iprodione (50)	1,200	69	8.0
11. Polyoxin (10)	1,000	60	3.8
12. Captan (60) + binapacryl (15)	600	67	14.4
13. Benomyl (50)	3,000	58	10.4
14. Fluoromide (75)	1,000	67	12.9
15. Oxine-copper (30) + captan (20)	500	60	8.8
Insecticides			
16. Chlorpyrifos (25)	1,000	50	17.9
17. Methidathion (36)	1,500	47	72.6
18. Fenvalerate (10) + fenitrothion (30)	1,000	60	88.8
19. Salithion (25)	1,000	61	100.0
20. Carbaryl (85)	1,200	71	20.3
21. Fenitrothion (40)	800	70	18.0
22. Diazinon (34)	1,500	61	9.8
23. CYAP (40)	1,000	70	8.8
Miticides			
24. Cyhexatin (25)	1,000	70	0.0
25. Fenbutatin oxide (25)	1,000	70	5.9
26. Propargite (30)	750	70	1.3

^a Numeral in parenthesis is the percentage of active ingredient.

^b Corrected by ABBOT's formula. Percentage mortality of the untreated control averaged 10.5% for the 12 replications and ranged from 0 to 25%.

total number of the predatory mites used in all replications. The toxicity of the 15 fungicides and three miticides tested were all relatively low, ranging from 1.3 to 14.4% in the former and from 0.0 to 5.9% in the latter. However the toxicity of the eight insecticides varied from 8.8 to 100.0%. Those pesticides tested which are regarded as compatible with integrated mite control in New Zealand are oxine-copper, captan, thiophanate-methyl, benomyl, chlorpyrifos, carbaryl, cyhexatin and propargite (WEARING and ASHLEY, 1982). Of these, carbaryl was the most toxic in the present tests, causing a 20.3% mortality. Thus the pesticides which caused a mortality lower than this level

could be regarded as relatively safe on a provisional basis. Based on this critical value, all the pesticides other than methidathion, fenvalerate and salithion would be considered as safe to *T. pyri*. Those not regarded as safe were extremely toxic causing mortalities more than three times higher than the critical level. These results suggest that *T. pyri* will survive the pesticide applications in Japan with a slight modification to the present system.

We should be cautious, however, because of the limitations inherent to the present method of slide dipping. The method lacks the sensitivity necessary to detect the following important cases; (1) adult sterility such as has been shown by the

benzimidazol fungicides with *T. occidentalis* and *A. fallacis*, although not with *T. pyri* (WEARING and ASHLEY, 1982), and (2) oviposition suppression. MARKWICK (personal communication) found that in a laboratory strain of *T. pyri* with resistance to synthetic pyrethroids (SP), females which survive the SP treatment will not produce eggs on SP-treated leaves for a considerable period of time, even though they commence egg production immediately after being transferred to leaves free from the SP deposits. Other methods should be used to determine factors other than direct mortality; factors that would be affected by the deposition and persistence characteristics of the pesticides.

Under the conditions of the spray program in Japan, where pesticides belonging to different groups have been used in rotation in order to delay the development of resistance in the pest species, there seems to be only a slight possibility that the indigenous species of predator mites will soon develop resistance. As long as there is a strong likelihood that predatory mites from overseas will survive the pesticide applications with only a slight modification of the present system, it would be worthwhile introducing them for further evaluation. A reduction in the use of miticides

through the integration of such predators into the present system would reduce direct costs to the grower and also delay the development of resistance in the mite pests.

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Pre-Mating Flight of Rice Planthopper Migrants (Homoptera: Delphacidae) Collected on the East China Sea¹

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Rice planthoppers show long distance migration to Japan during the Bai-u (rainy) season (KISIMOTO, 1971). Studies have revealed synchronous immigration in different localities in Japan and a close relation between immigration and weather (KISIMOTO, 1971, 1976; HIRAO and ITO, 1980; KISIMOTO et al., 1982; OYA and HIRAO, 1982). This paper reports the results of collection of rice

planthoppers on the East China Sea in 1984 and the mating experience of migrant females.

The author was on board a weather observation ship of the Japan Meteorological Agency, the "Keifu-maru," which stayed on the East China Sea (31° N, 126° E) from June 25 to July 3 1984. Planthoppers were collected in three airborne nets (1 m in diameter) fastened on the main mast. The nets were usually emptied every three hours. Insects attracted to light on board were also collected by an aspirator for studies of endoparasites and mating experience.

The total number of rice planthoppers collected by the three nets in 9 days were as follows: *Sogatella furcifera*, 135 males and 97 females; *Nilaparvata lugens*, 53 males and 32 females; and *Laodelphax striatellus*, 22 males and 29 females. *S. furcifera* is the dominant migratory species on the East China Sea as shown by other authors (HIRAO and

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