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Fenbutatin Oxide and Chlorfenvinphos Effects on the Entomophagous Arthropod Fauna of Citrus

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Intensive citrus culture requires the frequent use of insecticides and acaricides to control the pest complex associated with the crop. In order to rationalise such pesticide use in Europe, the possibilities offered by integrated and biological pest control programmes have been intensively investigated (eg Argyriou, 1980; Barbagallo et al., 1981; Hurpin, 1975; Krambias and Kontzonis, 1980; Melia and Blasco, 1980). Clearly, the use of pesticides in integrated control programmes requires comprehensive data concerning their effects on non-target organisms, particularly entomophagous arthropods. The aim of this study was to investigate the effects of the acaricide fenbutatin oxide (TORQUE[1]: bis [tris(2-methyl-2-phenylpropyl)tin]oxide) and the insecticide chlorfenvinphos (BIRLANE[1]: 2-chloro-1-(2,4-dichlorophenyl)vinyl diethyl phosphate) on the entomophagous arthropod fauna associated with citrus in Italy.

MATERIALS AND METHODS

Fieldwork was carried out between 7 and 13 June, 1985, in two orange groves on a citrus farm near Catania, Sicily. The sites will henceforth be referred to as orchards 1 and 2. The cultivars in these groves were 'Sanguinello' and 'Ovale', respectively. Preliminary sampling indicated that both orchards supported relatively abundant populations of entomophages which had developed in response to aphid infestations. These infestations had not been treated in either orchard. At the time of the study, aphid numbers had declined to extremely low levels and the entomophagous insects present in the orchards represented residual populations.

Details of the treatments are shown in Table 1. Methidathion (S-2,3-dihydro-5-methoxy-2-oxo-1,3,4-thiadiazol-3-ylmethyl O,O-dimethyl phosphorodithioate) was included as a reference compound.

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[1] TORQUE and BIRLANE are Shell registered trade marks.

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Ten trees in each orchard were treated with each compound. A further ten trees were treated with water to serve as controls. Each sprayed tree was surrounded by untreated guard trees.

Table 1. Details of the treatments

Treatment	Formulation	Dose rate (g ai hl^{-1})
fenbutatin oxide	500 g kg^{-1} WP	50
chlorfenvinphos	200 gl^{-1} EC	60
methidathion	200 gl^{-1} EC	47.5

All four treatments were applied using motor-driven single nozzle hand-held lances, spraying to run-off and treating both the inside and outside of the canopy. The weather during spraying was warm and sunny (26-30°C; 40-50% RH).

Populations of arthropods were sampled using a 0.8 m x 1.2 m beating tray. One sample was collected from each of the treated trees. Each sample comprised three sub-samples taken at different points around the tree. These sub-samples were collected by holding the tray under the canopy while a branch was firmly struck three times with a padded metal rod. Entomophages falling onto the tray were transferred to labelled tubes and taken to the laboratory for identification and counting. Samples were collected from orchard 1 24 h after treatment and from orchard 2 48 h after treatment.

Leaves were collected from sprayed trees in orchard 1 8 h, 24 h and 72 h after application and taken to the laboratory for use in tests to determine the residual toxicity of the treatments to a range of entomophagous insects. The animals used in these tests were Scymnus spp (mainly S. subvillosus Goeze; Coleoptera : Coccinellidae), Leptomastix dactylopii How. (Hymenoptera : Encyrtidae) and Leptomastidea abnormis Gir. (Hymenoptera : Encyrtidae). The coccinellids were field-collected from an untreated orchard on the farm. The Hymenoptera were obtained from a mixed-species laboratory culture.

The chambers used for Scymnus were ventilated 50 mm diameter plastic petri dishes, the bottoms of which were lined with moist filter paper. Leaves were placed underside down on the filter paper prior to introduction of the test animals. These animals were not provided with food. The chambers used for the Hymenoptera were 55 mm diameter x 65 mm high plastic pots covered with fine gauze. Leaves were kept fresh by wrapping their stems in moist cotton wool. The animals were provided with honey as food.

The coccinellids were exposed to residues on leaves collected 24 h after spraying. Mortality was assessed 24 h and 48 h after initial exposure. Tests with the Hymenoptera were carried out with leaves collected 8 h and 72 h after treatment. Mortality was assessed 24 h after initial exposure. Mortality among control animals precluded extending the duration of these experiments. Details of the numbers of animals and degree of replication involved in these studies are shown in Tables 5 to 7. All these tests were carried out under ambient conditions in a shaded laboratory (Temp 20–23°C).

RESULTS AND DISCUSSION

The most abundant entomophages at the site were _Scymnus_ spp. (predominantly _S. subvillosus_), Araneae (mainly Thomisidae and Salticidae) and larval _Chrysoperla carnea_ Steph. _Scymnus_ spp. and Araneae were relatively abundant in both orchards; _C. carnea_ larvae were only abundant in orchard 2. Data for these taxa were analysed using one-way analysis of variance followed by Dunnett's test. Data were transformed to base ten (n+1) logarithms prior to analysis.

Results for _Scymnus_ are summarised in Table 2 and indicate that none of the treatments had any significant impact on this group. Results for spiders are shown in Table 3. The fenbutatin oxide treatment had no effect on these animals in either orchard. In contrast, the methidathion treatment clearly had a significant impact on this group. These results suggest that chlorfenvinphos was less toxic to spiders than methidathion. Finally, results for _C. carnea_ larvae are shown in Table 4. The fenbutatin oxide treatment had no effect on this group. As with the Araneae, methidathion appeared to be more toxic to these animals than chlorfenvinphos.

Table 2. Mean number of _Scymnus_ spp. per sample.

	Treatment			
	control	fenbutatin oxide	chlorfenvinphos	methidathion
Orchard 1	1.8	4.5	0.9	1.3
Orchard 2	8.2	6.8	4.7	5.5

(* denotes significant difference from control with $P < 0.05$)

Table 3. Mean number of Araneae per sample.

	Treatment			
	control	fenbutatin oxide	chlorfenvinphos	methidathion
Orchard 1	5.7	6.8	2.7	0.5*
Orchard 2	5.9	7.0	3.6	1.4*

(* denotes significant difference from control with $P < 0.05$)

Table 4. Mean number of Chrysoperla carnea per sample.

	Treatment			
	control	fenbutatin oxide	chlorfenvinphos	methidathion
Orchard 2	6.7	7.6	3.7	2.7*

(* denotes significant difference from control with $P < 0.05$)

Results for Scymnus are summarised in Table 5 and indicate that none of the treatments had any effects on these animals.

Table 5. Laboratory residual toxicity tests: Survival of Scymnus spp. exposed to sprayed leaves collected 24 h after treatment.

Treatment	No. of replicates	No. of animals per replicate	Mean % survival after 24 h	Mean % survival after 48 h
control	2	5	100	100
fenbutatin oxide	2	5	100	100
chlorfenvinphos	2	5	100	100
methidathion	2	5	100	90

Results for the Hymenoptera are shown in Tables 6 and 7. Table 6 summarises survival following exposure to treated leaves collected 8 h after spraying. These results indicate that neither fenbutatin oxide nor chlorfenvinphos had any effects on these animals. In contrast, methidathion appears to have been relatively toxic, although it will be noted that the number of animals involved in this test was limited. Table 7 summarises survival following exposure to leaves collected 72 h after treatment. These results confirm the lack of effect of fenbutatin oxide and chlorfenvinphos. Some mortality appears to have occurred among animals exposed to methidathion residues, but the percentage survival was considerably higher than that found with animals exposed to leaves collected 8 h after spraying. It is assumed that this difference was due to degradation of the methidathion residues between 8 and 72 h after treatment.

Table 6. Laboratory residual toxicity tests: Survival of *Leptomastix dactylopii* and *Leptomastidea abnormis* exposed to sprayed leaves collected 8 h after treatment

Treatment	Replicate	No. of test animals	% Survival after 24 h
control	1	28	96
	2	27	81
fenbutatin oxide	1	21	95
	2	21	100
chlorfenvinphos	1	30	76
	2	19	95
methidathion	1	11	9

Table 7. Laboratory residual toxicity tests: Survival of *Leptomastix dactylopii* and *Leptomastidea abnormis* exposed to sprayed leaves collected 72 h after treatment

Treatment	Replicate	No. of test animals	% Survival after 24 h
control	1	43	95
	2	41	90
	3	31	90
fenbutatin oxide	1	36	97
	2	26	81
	3	35	89
chlorfenvinphos	1	48	85
	2	41	93
	3	44	91
methidathion	1	46	93
	2	21	71
	3	34	56

Scymnus spp., C. carnea, L. dactylopii and L. abnormis are all important natural pest control agents in European citrus orchards (Argyriou 1970; Barbagallo et al. 1981; Iperti 1983; Liotta 1982; Luppino 1979). The role of spiders is less clearly defined. However, these animals are recognised as important predators in other orchard crops (eg Naton 1974) and it is likely that their beneficial role extends to citrus. The results of this study demonstrate that fenbutatin oxide had no adverse effects on any of these taxa, while chlorfenvinphos had no effect on Scymnus and the parasitic Hymenoptera, and appeared to be less toxic than methidathion to spiders and Chrysoperla larvae.

Information concerning the effects of fenbutatin oxide on predatory and parasitic arthropods has recently been reviewed by Inglesfield (1986). Extensive laboratory and field studies have shown that this product can be considered to be non-toxic at recommended field dose rates to a broad spectrum of entomophagous arthropods, including predatory mites, parasitic Hymenoptera, Coccinellidae, Neuroptera and predatory Heteroptera.

The effects of chlorfenvinphos on entomophagous arthropods have been less well documented. However, available information indicates that this product is relatively 'soft' to Chrysoperla carnea (pers. comm. Dr. F. Bigler, FAP, Zurich), Coccinellidae (Winiarska 1976), predatory Heteroptera (Ziarkiewicz 1976) and parasitic Hymenoptera (Hassan 1973). The selectivity of chlorfenvinphos to parasitic Hymenoptera should be noted, since this group contains taxa which are extremely important as natural pest control agents in citrus (Barbagallo et al. 1981; Liotta 1980). To conclude, the results of this study indicate that both fenbutatin oxide and chlorfenvinphos offer potential as selective pesticides for use in citrus.

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