

Susceptibilities of northern fowl mite, *Ornithonyssus sylviarum* (Acarina: Macronyssidae), and chicken mite, *Dermanyssus gallinae* (Acarina: Dermanyssidae), to selected acaricides

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ABSTRACT

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The relative toxicities of ten acaricides to northern fowl mite, *Ornithonyssus sylviarum* (Canestrini and Fanzago), and the chicken mite, *Dermanyssus gallinae* (De Geer), were determined simultaneously by holding the mites inside disposable glass Pasteur pipettes previously immersed in acetone solutions of various concentrations (*w/v*) of technical grade acaricides. The LC_{90s} (parts per million) of the acaricides after 24 h exposure for the northern fowl mite and the chicken mite, respectively, were: bendiocarb (13.1, 0.18), tetrachlorvinphos (14.5, 4.07), carbaryl (15.0, 0.83), pirimiphos methyl (18.3, 2.03), permethrin (23.1, 8.46), lambda cyhalothrin (80.7, 11.4), dichlorvos (252.8, 3.75), malathion (238.4, 6.59), amitraz (6741, 9430) and fenvalerate (> 10 000, 60.2). After 48 h exposure there were only slight increases in mortalities of both species except for increased mortalities for the northern fowl mite with lambda cyhalothrin, amitraz and fenvalerate, and for the chicken mite with amitraz.

INTRODUCTION

The northern fowl mite, *Ornithonyssus sylviarum* (Canestrini and Fanzago) (Acarina: Macronyssidae), and the chicken mite, *Dermanyssus gallinae* (De Geer) (Acarina: Dermanyssidae), are ectoparasites which can reach economically damaging numbers in commercial poultry flocks and often require chemical control (Axtell and Arends, 1990). Although susceptibility data for some acaricides used on poultry have been reported for the northern fowl mite (Arthur and Axtell, 1983; Crystal and DeMilo, 1984) and for the

chicken mite (Zeman and Zelezny, 1985), the data were obtained with a variety of procedures, at different times over several years and with mites from various geographic areas. Consequently, the data are not suitable for comparisons of the toxicities of the chemicals within and between species. We exposed northern fowl mites and chicken mites simultaneously to compare their relative susceptibilities to ten acaricides using one procedure (treated pipettes).

MATERIALS AND METHODS

Mite cultures. The northern fowl mites, originally collected from White Leghorn laying hens near Raleigh, North Carolina, were maintained on White Leghorn hens by transfer to pullets every 3 months for approximately 1 year prior to testing. Adult mites were randomly collected for the tests by removing infested feathers from the colony birds, placing them into an enamel pan, and aspirating the dispersing mites into a holding container.

The chicken mites were originally collected from pigeon nests (Raleigh, NC) and were in culture for approximately 5 months at the start of the tests. The culture was in 15-l plastic containers with a fine mesh screen lid and lined on the inside with corrugated cardboard. Blood meals were provided three times a week (Monday, Wednesday and Friday) by allowing the mites to feed on a 1-week-old chick. The mites were aspirated into a collection container from the top of the corrugated cardboard lining. Adult mites were collected and tested on Tuesday and Thursday, to make the mites as homogeneous as possible in regard to time post-feeding.

Chemicals. The technical grade acaricides, percentage purities, and sources were: 99.0% amitraz, 97.9% bendiocarb (Nor-Am Chemical Co., Wilmington, DE); 99.0% carbaryl (Rhone-Poulenc, Research Triangle Park, NC); 98.2% dichlorvos, 98.0% fenvalerate, 99.0% tetrachlorvinphos (Fermenta, Kansas City, MO); 84.1% lambda cyhalothrin, 92.0% permethrin, 90.8% pirimiphos methyl (Pittman Moore, Kansas City, MO); and 98.0% malathion (Chem Service, West Chester, PA).

Treatment methods. Toxicities of each acaricide were determined simultaneously for the northern fowl mite and chicken mite by the pipette technique (Fouk and Matthyse, 1964). Disposable Pasteur pipettes (0.5-cm inside diameter \times 11-cm length with a fine mesh cloth attached to the large end by a latex band) were placed cloth end down and completely immersed for 60 s in a weight to volume acetone dilution of acaricide. Five to eight dilutions, causing 10–90% mortalities in preliminary tests, were used for each acaricide in a test. Control pipettes were immersed in acetone only.

After the pipettes were dry (12 h), 20 mites of a species were aspirated at

random from the collection container into a pipette, and the narrow end was plugged with modelling clay. Both species were tested on the same day with six pipettes per species per acaricide concentration. The pipettes were held in glass desiccator jars under constant indirect light at 27°C and 80% RH (obtained by a saturated solution of Na₂HPO₄ in the desiccator). Each test of a chemical was repeated twice on different days for a total of 12 pipettes (240 mites) per dilution. Mortality was determined 24 h after treatment for both tests and at 48 h for the first test of each chemical. If the difference between 24-h and 48-h mortalities was significant (as determined by comparison of the 95% fiducial limits for the LD₅₀s), the 48-h mortality was also monitored for the second test. Each pipette was examined under a stereo microscope and mites were considered dead if they were unable to move or had only a slight twitching motion of the legs. All of the chemicals were tested during a 3-month period. The combined data for each chemical for each species were analyzed using a probit procedure (PROC PROBIT, SAS Institute, 1985).

RESULTS AND DISCUSSION

Northern fowl mites. Four of the ten chemicals had not been reported previously for northern fowl mites and their 24-h LC₉₀s were: bendiocarb (13.1 ppm), pirimiphos methyl (18.3 ppm), lambda cyhalothrin (80.7 ppm) and amitraz (6741.5 ppm) (Table 1). After 48 h exposure the LC₉₀s of lambda cyhalothrin and amitraz reduced to 7.6 ppm and 12.3 ppm, respectively. After 24 h exposure, bendiocarb was the most toxic to northern fowl mites with LC₉₀s of 13.1 ppm. After 48 h lambda cyhalothrin was the most toxic to northern fowl mite (LC₉₀ = 7.6 ppm).

The 24-h LC₅₀s for northern fowl mites exposed to carbaryl, tetrachlorvinphos, permethrin and malathion were consistent with results obtained by Hall et al. (1978) and Arthur and Axtell (1983) using the same procedure. Matthysse et al. (1975) tested carbaryl, tetrachlorvinphos, malathion and dichlorvos against the northern fowl mite using the same procedure and obtained lower 24-h LC₅₀ values than reported here and by Hall et al. (1978) and Arthur and Axtell (1983). In our tests fenvalerate gave 48-h LC₉₀ of 5193.9 ppm. Crystal and DeMilo (1984) considered fenvalerate ineffective against northern fowl mite because it failed to give 100% control at 1000 ppm when the mites were exposed to residues on filter paper. However, in field tests, aqueous sprays of fenvalerate gave control of northern fowl mites on chickens for 53–57 days (Hall et al., 1978; Loomis et al., 1979; Williams and Berry, 1980). It would appear that the pipette and filter paper procedures do not adequately predict the potential of some compounds, such as fenvalerate.

For the northern fowl mite, based on the LC₉₀s after 48 h exposure, the chemicals can be divided into two groups: (1) high toxicity: lambda cyhalothrin, tetrachlorvinphos, pirimiphos methyl, bendiocarb, permethrin, ami-

TABLE 1

LC₉₀s and LC₅₀s, with 95% fiducial limits (FL), in parts per million for the northern fowl mite and chicken mite when exposed for 24 and 48 h (in parentheses) to residues of selected acaricides in glass pipettes. The ranking is most to least toxic based on LC₉₀

Acaricide	Northern fowl mite					Chicken mite				
	Rank	LC ₉₀	LC ₅₀	LC ₅₀ 95% FL		Rank	LC ₉₀	LC ₅₀	LC ₅₀ 95% FL	
				Lower	Upper				Lower	Upper
Bendiocarb ¹	1 (4)	13.1 (9.8)	6.4 (6.1)	5.0 (-) ²	7.4 (-)	1 (1)	0.18 (0.11)	0.8 (0.080)	0.6 (0.075)	0.10 (0.083)
Tetrachlorvinphos ¹	2 (2)	14.5 (8.5)	8.3 (5.4)	5.1 (1.5)	10.1 (6.5)	5 (5)	4.07 (1.54)	1.34 (0.46)	1.24 (-)	1.46 (-)
Carbaryl ^{1,3}	3 (7)	15.0 (14.5)	6.2 (3.5)	4.7 (2.2)	7.6 (4.7)	2 (2)	0.83 (0.43)	0.33 (0.21)	0.27 (-)	0.42 (-)
Pirimiphos methyl ⁴	4 (3)	18.3 (8.8)	8.3 (4.5)	7.0 (2.6)	9.7 (5.8)	3 (3)	2.03 (<0.5)	0.58 (-)	0.34 (-)	0.77 (-)
Permethrin ³	5 (5)	23.1 (12.0)	2.8 (1.5)	2.2 (1.0)	3.7 (2.1)	7 (8)	8.46 (7.29)	3.25 (2.48)	3.10 (2.32)	3.42 (2.63)
Lambda cyhalothrin	6 (1)	80.7 (7.6)	5.4 (0.1)	2.8 (0.03)	9.4 (0.2)	8 (6)	11.38 (1.98)	1.6 (0.62)	1.45 (0.47)	1.78 (0.76)
Malathion ¹	7 (9)	238.4 (238.5)	95.5 (63.9)	74.4 (53.3)	117.5 (73.2)	6 (4)	6.59 (0.89)	1.34 (0.38)	1.01 (0.31)	1.74 (0.43)
Dichlorvos ³	8 (8)	252.8 (151.0)	86.9 (73.7)	67.8 (46.2)	105.1 (92.7)	4 (7)	3.75 (3.30)	1.41 (1.20)	1.17 (0.93)	1.75 (1.53)
Amitraz ³	9 (6)	6741.5 (12.3)	54.6 (1.5)	41.4 (1.2)	74.6 (1.8)	10 (10)	9430.64 (68.24)	149.00 (12.06)	58.58 (9.93)	454.18 (14.88)
Fenvalerate	10 (10)	452 016.5 (5193.9)	2191.7 (229.1)	1151.7 (160.0)	4565.3 (309.8)	9 (9)	60.15 (19.94)	14.60 (6.43)	11.63 (3.52)	17.93 (8.81)

¹48-h mortality based on one test (six pipettes = 120 mites) instead of two tests.

²Valid fiducial limits could not be calculated.

³48-h control mortality > 10% for carbaryl (14.2), permethrin (16.6) and dichlorvos (12.5), for northern fowl mite, and amitraz (12.5) for chicken mites.

⁴For chicken mites > 90% mortality occurred at lowest dilution (0.5 ppm).

traz and carbaryl which had $LC_{90s} \leq 14.5$ ppm; (2) low toxicity: dichlorvos, malathion and fenvalerate which had $LC_{90s} \geq 150$ ppm.

Chicken mite. Data on the susceptibility of chicken mites to three of the ten chemicals have not been previously reported. The LC_{90s} 48 h after exposure were tetrachlorvinphos (4.05 ppm), pirimiphos methyl (2.03 ppm) and lambda cyhalothrin (11.38 ppm) (Table 1). The toxicities, based on LC_{90s} , of the chemicals for chicken mites (but not for northern fowl mites) were related to chemical class. The carbamates (bendiocarb, carbaryl) were most toxic, the organophosphates (tetrachlorvinphos, pirimiphos methyl, malathion and dichlorvos) were second, the pyrethroids (permethrin, lambda cyhalothrin, fenvalerate) were third, the diamidide (amitraz) was least toxic (Table 1). Amitraz was the only acaricide to have an LC_{90} after 24 h exposure > 100 ppm; the 48-h LC_{90} was reduced to 68.2 ppm.

Zeman and Zelezny (1985) used a similar treated-tube technique but removed the mites after 24 h and held them in clean tubes for an additional 24 h before determining mortality. Their tests included bendiocarb, carbaryl, dichlorvos, permethrin, fenvalerate and amitraz, and the results were relative toxicities similar to ours. The exception was dichlorvos which was least toxic in their test, probably due to the 24-h recovery period compared to our procedure in which the mites had no recovery period.

The chicken mites were more susceptible (lower LC_{90s}) than the northern fowl mites to all the acaricides except amitraz. All the acaricides tested against the chicken mites, after 48 h exposure, could be classified as moderate to high toxicity ($LC_{90s} \leq 70$ ppm) compared to northern fowl mites.

This is the first report of data for those ten chemicals using the pipette method with the chicken mite. This report contains the first published dose-response data for northern fowl mites exposed to bendiocarb, pirimiphos methyl, lambda cyhalothrin and amitraz, and for chicken mites exposed to tetrachlorvinphos, pirimiphos methyl and lambda cyhalothrin. These data provide the first simultaneous comparison of acaricide susceptibility for these two species, from one geographic area. However, different results might be obtained with other strains of the mites, especially if acaricide-resistance is involved. The data further demonstrate the need for 48-h mortality data to adequately evaluate some chemicals by the treated-pipette technique.

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