THE STERILISING EFFECT OF CLOFENTEZINE AND HEXYTHIAZOX ON FEMALE TWOSPOTTED MITE

R.B. CHAPMAN and J.W.M. MARRIS

Entomology Department, Lincoln College, Canterbury

SUMMARY

Laboratory studies investigating the acute toxicity and sterilising action of clofentezine (500 g ai/litre suspension concentrate) and hexythiazox (100 g ai/kg wettable powder) on adult female twospotted mite were carried out. Females exposed to direct sprays or residues on leaf discs laid fewer eggs and their viability was lower than those in untreated controls. These effects, although generally short-lived, were greater from direct sprays than from exposure to residues.

INTRODUCTION

Miticides are regularly included in the spray programmes for many horticultural crops in New Zealand to control the main spider mite pest species, twospotted mite (TSM), *Tetranychus urticae*, and European red mite, *Panonychus ulmi*. Although integrated control programmes involving pesticide-resistant predator mites and selective miticides have successfully been adopted in a number of crops, miticides remain the only reliable control method for spider mites on other crops.

Recently, two new miticides have been evaluated in New Zealand; they are clofentezine and hexythiazox. Both miticides are ovicides and exert some action against immature motile stages, but they do not control adult mites at recommended or suggested field rates (Read 1983; Anon. 1984). One possible effect of these miticides that has not been fully investigated is the sterilising effect on adult females. Several other miticides are known to sterilise female spider mites and prevent them laying viable eggs (e.g. Asano and Kamei 1977).

The aim of this study was to determine whether clofentezine and hexythiazox will sterilise female TSM exposed to direct sprays or residues.

METHODS

Three separate experiments with clofentezine and hexythiazox were performed to determine their acute toxicity to adult female TSM, and to measure the effects of direct sprays and varying periods of exposure to residues on the numbers and viability of eggs laid by TSM females. In all experiments, clofentezine in the form of a suspension concentrate (Apollo 500 g ai/litre) and hexythiazox as a wettable powder (Nissorun 100 g ai/kg) were used. Female TSM were selected from a colony of mixed origin which had been reared on dwarf bean plants.

Toxicity to adult females

The slide dip technique was used to determine the acute toxicity of the miticides to adult females. Twenty mites were attached by their dorsal surface to double-sided adhesive tape on glass microscope slides and dipped for 5 seconds in a range of aqueous concentrations to produce mortalities in the range of 5-95%. A control group was dipped in water. After treatment, the mites were maintained at $25 \pm 2^\circ\text{C}$ and 70-80% RH for 24 hours after which mortality was assessed. Tests were repeated on three occasions and the data were pooled for probit analysis (Russell *et al* 1977).

Exposure of females to direct sprays

Recently mated females were individually established on 1.0 cm diameter broad bean (*Vicia faba*) leaf discs on damp cotton wool in petri dishes. A total of 20 females per treatment were sprayed under a Potter tower (1.5 ml aqueous suspension; 102 kPa, 10 second settling time) with the recommended or suggested field concentrations and

Proc. 39th N.Z. Weed and Pest Control Conf.

one tenth the recommended or suggested field concentration of each miticide (Table 2). A control group was sprayed with water. One hour after treatment, the females were transferred to fresh discs free from spray residues and held for 21 days at $25 \pm 2^\circ\text{C}$ and 70-80% humidity. Every 2 days, the mites were transferred to fresh discs and the number of eggs laid was recorded. The hatching of eggs was recorded 3-5 days later.

Exposure of females to residues

Broad bean leaf discs (1 cm diam.) were placed on damp cotton wool in petri dishes and sprayed under the Potter tower as previously described with the recommended or suggested field concentration of each miticide. Once residues had dried, a recently-mated female was transferred to each disc. There were 20 mites per treatment and they remained on the residues for 1, 3 or 5 days (Table 3). They were then transferred to residue-free discs for 10 days to lay eggs. Fresh discs were supplied every 2 days. Post-treatment conditions were similar to the previous experiment and records of egg laying and hatching were made in the same way.

RESULTS

Toxicity to adult females

A summary of the analyses of results from the slide dip tests is presented in Table 1. By comparing median lethal concentrations (LC_{50}), hexythiazox is approximately 32 times more toxic to adult females of this strain than clofentezine. These miticides do not kill adult females at recommended or suggested field concentrations because the ratio of LC_{50} to recommended field concentration is 192 for clofentezine and 59 for hexythiazox.

TABLE 1: Toxicity of clofentezine and hexythiazox to twospotted mite females in the slide dip test.

Miticide	Number tested	LC_{50} g ai/litre	95% CI	Slope	SE
clofentezine	565	48.17	39.5-58.2	5.41	0.56
hexythiazox	400	1.48	1.37-1.57	8.18	1.62

Exposure of females to direct sprays

The effects on egg laying and hatching of exposing females to direct sprays of clofentezine and hexythiazox are summarised in Table 2. Both miticides significantly reduced ($p < 0.05$) the rate of egg laying compared with untreated females. There were no significant differences between the effects of miticides or the rates of miticides on egg production.

TABLE 2: Effect of direct sprays of clofentezine and hexythiazox on egg laying and hatching of twospotted mite.

Miticide	Concentration g ai/litre	Mean eggs laid/female /day	SD	Mean eggs hatched /day	SD	Percentage hatch
clofentezine	0.25	2.78	1.21	0.18	0.26	6.5
clofentezine	0.025	2.55	0.96	1.63	0.99	63.9
hexythiazox	0.025	2.41	0.99	0.82	0.78	34.0
hexythiazox	0.0025	2.41	1.07	1.42	0.86	58.9
untreated control		3.42	0.98	2.81	0.84	82.2
LSD 0.05		0.66		0.49		

Both miticides significantly ($p < 0.05$) reduced the total numbers of eggs that hatched by comparison with eggs laid by untreated females. Based on the percentage and number of eggs that hatched, the higher rate of clofentezine (0.25 g ai/litre) was the most effective treatment followed by the higher rate of hexythiazox (0.025 g ai/litre). By

comparing the effects of equal concentrations (0.025 g ai/litre) of the two miticides, hexythiazox was relatively more effective at inhibiting egg hatch when females were directly sprayed ($p < 0.05$).

Exposure of females to residues

The effects on egg laying and hatching of exposing females to residues of clofentezine and hexythiazox for varying periods are summarised in Table 3. Significant reductions ($p < 0.05$) in the rate of egg laying occurred only when females were exposed to clofentezine residues for 5 days, compared with females contained on untreated leaf surfaces. Similarly, the rate of egg hatching was lowest in the 5 day exposure treatment. However, when the percentages of eggs hatched in all treatments were compared, they were equivalent to or only slightly lower than the untreated control.

TABLE 3: Effect of different periods of exposure to residues of clofentezine and hexythiazox on egg laying and hatching of twospotted mite.

Miticide and No. of days	Mean eggs laid/female/day	SD	Mean eggs hatched/day	SD	Percentage hatch
clofentezine (0.25 g ai/litre)					
1 day exposure	5.52	2.00	4.81	2.07	87.1
3 days exposure	5.50	1.35	5.21	1.33	94.7
5 days exposure	3.63	1.34	2.75	1.60	75.8
hexythiazox (0.025 g ai/litre)					
1 day exposure	5.87	1.11	4.61	1.36	78.5
3 days exposure	5.25	1.93	4.03	1.96	76.8
5 days exposure	4.62	1.84	3.86	1.81	83.5
untreated control	5.66	1.88	5.12	1.85	90.5
LSD 0.05	1.05		1.08		

DISCUSSION AND CONCLUSION

Clofentezine and hexythiazox are proven ovicides against several spider mite species (Read 1983; Anon 1984). However, until recently little was known about their sterilising effects on adult females.

Clofentezine and hexythiazox showed low toxicity to adult female TSM (Table 1). These results confirm field observations that, at recommended or suggested application rates (clofentezine 0.25 g ai/litre; hexythiazox 0.025 g ai/litre), they cause little or no mortality to adult females. Even when females were exposed to residues for 21 days, there was no marked increase in mortality compared with untreated females (Chapman unpublished).

Notwithstanding their low adulticidal activity, these miticides may contribute overall to population suppression since they both caused female TSM to lay fewer viable eggs than untreated females. This effect was greatest when females were directly sprayed with clofentezine (0.25 g ai/litre), although it must be recognised that the recommended application rate for this miticide is 10 times that of the suggested rate for hexythiazox (Table 2). Moreover the overall percentage hatch values (Table 2) do not show the pattern of egg hatching after females were exposed to the miticides. Typically, eggs that were laid within 2 days of treatment did not hatch but, from then on, there was a gradual increase in the proportion that hatched. Recovery of egg viability to a level equivalent to those in the untreated control was more rapid at the lower application rates of each miticide.

Exposing adult females to residues of these miticides on leaf surfaces does not markedly influence egg viability although the numbers of eggs laid by females after 5 days exposure was significantly reduced (Table 3). In all miticide treatments, no eggs had hatched 2 days after exposure, but by 4-6 days, egg hatch was restored to a level equivalent to that in the untreated controls.

These experiments have demonstrated clofentezine and hexythiazox possess the potential to sterilise adult female TSM and reduce the numbers and viability of eggs

laid. However, irrespective of whether females are exposed to direct sprays or residues on leaf surfaces, the sterilising effects of these miticides appear to be relatively short-lived, reflecting similar results reported by other workers (Asano and Kamei 1977).

ACKNOWLEDGEMENTS

We gratefully acknowledge the generous financial assistance of Arthur Yates and Co. Ltd, and May and Baker New Zealand Ltd.

REFERENCES

- Anonymous, 1984. NISSORUN (NA-73); A new acaricide. *Japanese Pesiticide Information No. 44*: 21-24.
- Asano, S. and Kamei, M., 1977. Some biological activities of cycloprate to the citrus red mite, *Panonychus citri* (McGregor). *J. Pest. Sci.* 2: 439-444.
- Read, A.J., 1983. Bisclofentazine — a novel compound for control of phytophagous mites. *Proc. 36th N.Z. Weed and Pest Control Conf.* 265-268.
- Russell, R.M., Robertson, J.L. and Savin, N.E., 1977. POLO: A new computer program for probit analysis. *Bull. Ent. Soc. America* 23: 209-213.