EFFECT OF HEXYTHIAZOX ON THE DEVELOPMENT OF TWOSPOTTED MITE

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SUMMARY

The miticide hexythiazox interrupts the development of immature two spotted mite, *Tetranychus urticae*, by preventing emergence from quiescent stages. This occurs when larvae and nymphs are exposed to residues and direct sprays and when quiescent stages are directly sprayed at recommended field concentrations.

INTRODUCTION

When using miticides to control spider mites, recognition of the presence of susceptible stages is essential to ensure effective control. Miticides like azocyclotin and propargite are reputedly most toxic to larvae and nymphs and less effective against adults and eggs (Hartlev and Kidd 1983). Therefore, applications should be timed to coincide with peak numbers of immature stages (Walker *et al* 1979). Recently two new miticides, clofentezine and hexythiazox, which have ovicidal activity have proven to be very effective against the major spider mite pest species (Read 1985; Anon. 1984). To date, their effectiveness has been largely attributed to their contact and residual activity against eggs although Chapman and Marris (1986) have shown both miticides can temporarily sterilise females causing them to lay fewer viable eggs.

The main objective of this study was to determine whether hexythiazox had any effect on the development and survival of the larval, nymphal and chrysalis stages of twospotted mite (TSM). Knowledge of any effects on these stages could assist in defining appropriate spray timing for applications of hexythiazox to control TSM.

METHOD

Source of mites

A TSM colony was maintained on dwarf bean plants (*Phaseolus vulgaris* cv. 'Tendergreen') in a controlled environment room at 22-25 °C, 65-76% RH and a 16:8 light:dark photoperiod. To ensure a supply of larvae, nymphs and chrysalis stages of known age, 10-20 mature adult females selected from the colony were allowed to lay eggs on 18 cm diameter broad bean (*Vicia faba* cv. 'Exhibition Long Pod') leaf discs on damp cotton wool pads for 24 hours. The females were then removed and the discs held at 20 °C to allow development. The experiments described below were carried out when sufficient numbers of the required stages were available.

Effect of hexythiazox on larvae and nymphs

The effects of direct sprays and exposure to residues of hexythiazox were tested in two separate experiments. In both experiments, the mites or leaf discs were sprayed with the recommended field rate (0.025 g/litre), half the field rate (0.0125 g/litre) and twice the field rate (0.05 g/litre) using a 10% wettable powder formulation (Nissorun 10WP). Water-sprayed control groups of each stage tested were also prepared for each experiment. All treatments were applied in a Potter spraying tower operated at 102 kPa using 1.5 ml of spray suspension and allowing a 10 sec settling period. Post-treatment conditions for all experiments were 20 ± 2 °C, 65-75% RH and a 16:8 light:dark photoperiod.

For the direct-spray experiment, groups of at least 10 of each stage, larvae, protonymphs and deutonymphs, were placed separately on 18 cm diameter broad bean leaf discs on damp cotton wool. Five replicates for each stage were prepared and then sprayed under the Potter Tower. The developmental stages and mortality of the mites were recorded 5 days after treatment. Mites at any stage were considered to be dead if

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they were inactive when lightly prodded, shrivelled or if they had not proceeded through the succeeding chrysalis stage at a time equivalent to those in the control groups.

For the residue-exposure experiment, sets of five broad bean leaf discs were placed on damp cotton wool and sprayed under the Potter tower. After the discs had dried, groups of 10 of each of the three stages, larvae, protonymphs and deutonymphs were placed separately on the treated discs and held in the post-treatment conditions described above. The developmental stages and mortality were assessed in the same manner described for the direct-spray experiment.

Effect of hexythiazox on chrysalis stages

The methods used to determine the effect of hexythiazox on the chrysalis stages were similar to those previously described except that larvae and nymphs were allowed to enter the chrysalis stages before being sprayed. Twenty to 30 larvae or nymphs were placed on 18 cm diameter broad bean leaf discs and as soon as 10-15 had entered the required chrysalis stage, all surplus mites were removed. All chrysalis stages were less than 24 hours old when they were sprayed under the Potter tower. The numbers of mites emerging from each chrysalis stage was determined 3-7 days after treatment, depending on the stage being assessed.

TABLE 1: Mortality of TSM larvae and nymphs directly sprayed with hexythiazox.

Hexythiazox concentration g ai/litre	STAGE TESTED					
	larva		protonymph		deutonymph	
	PERCENTAGE MORTALITY					
	Mean	SD	Mean	SD	Mean	SD
0.05	96.4	5.0	98.4	3.6	100	0
0.025	98.0	4.5	100	0	96.0	5.5
0.0125	94.2	5.3	100	0	98.0	4.5
0	10.0	10.0	2.0	4.5	18.4	12.1
LSD _{0.05}	8.8		3.8		9.4	

TABLE 2: Mortality of TSM larvae and nymphs exposed to residues of hexythiazox.

Hexythiazox concentration g ai/litre	STAGE TESTED					
	larva		protonymph		deutonymph	
	PERCENTAGE MORTALITY					
	Mean	SD	Mean	SD	Mean	SD
0.05	96.4	4.9	100	0	100	0
0.025	100	0	100	0	100	0
0.0125	96.4	8.0	100	0	98.0	4.5
0	0	0	3.8	5.2	21.2	14.7
LSD _{0.05}	6.4		3.5		10.3	

TABLE 3: Mortality of TSM quiescent stages directly sprayed with hexythiazox.

Hexythiazox concentration g ai/litre	STAGE TESTED					
	nymphochrysalis		deutochrysalis		teliochrysalis	
	PERCENTAGE MORTALITY					
	Mean	SD	Mean	SD	Mean	SD
0.05	82.6	7.1	100	0	100	0
0.025	81.6	8.3	99.2	1.8	98.2	4.0
0.0125	80.6	20.0	98.4	3.6	93.2	6.3
0	0	0	4.2	6.2	2.2	4.9
LSD _{0.05}	15.4		5.0		16.9	

RESULTS

Effect of hexythiazox on larvae and nymphs

The effect of direct sprays of various hexythiazox concentrations on the mortality of TSM larvae and nymphs is shown in Table 1. All concentrations caused 100% or near 100% mortality by preventing emergence from the succeeding chrysalis stage. There was no significant difference ($P < 0.05$) between the rates of hexythiazox tested. Few larvae or nymphs were killed immediately by hexythiazox indicating that this miticide has little or no contact or knockdown action against these stages.

When larvae and nymphs were exposed to the same concentrations as residues on bean leaves, similar results were recorded (Table 2). Again, most hexythiazox concentrations caused 100% mortality by preventing emergence from the succeeding chrysalis stage. There was no significant difference ($P < 0.05$) between the rates of hexythiazox tested and few motile stages died during their period of exposure to the residues. The residues did not induce any noticeable irritancy responses such as repellency.

Effect of hexythiazox on chrysalis stages

The mortality of quiescent stages resulting from direct sprays of hexythiazox is shown in Table 3. High mortality ($>80\%$) was caused by all concentrations of hexythiazox tested but there was no significant difference ($P > 0.05$) between these treatments. Those nymphs that did emerge from treated chrysalis stages appeared normal but their subsequent development was not followed.

DISCUSSION

Hexythiazox is generally considered to be an ovicide that is effective against several spider mites species (Anon. 1984; Hoy and Ouyang 1986). It also temporarily sterilises female TSM causing them to lay fewer viable eggs, but this effect diminishes once females move off treated surfaces or the residue level declines (Chapman and Marris 1986). The results of this study have demonstrated that hexythiazox should also effectively control immature TSM.

Other miticides that are commonly regarded as ovicides, e.g., chlorfenson, cycloprate and clofentezine, have also been shown to be active against other spider mite life stages. Larvae have been shown to be more susceptible than eggs to chlorfenson (Ebling and Pence 1954) and cycloprate (Asano and Kamei 1977), but eggs of TSM have been found to be 39-fold more susceptible than larvae to clofentezine (Aveyard *et al* 1986). Generally as development proceeds the life stages tend to become more tolerant of these ovicides with the highest level of tolerance being found in adult females (Ebling and Pence 1954; Asano and Kamei 1977; Anon. 1984; Aveyard *et al* 1986).

To date the mode of action of hexythiazox has not been explained but these experiments have shown it is relatively slow acting and has no direct knockdown action against TSM larvae and nymphs. In fact, it is not until an immature mite enters a quiescent stage that mortality occurs. The same was found to occur when *Panonychus citri* was treated with cycloprate (Asano and Kamei 1977). This effect occurs irrespective of how the larvae or nymphs come in contact with hexythiazox (direct spray or residue, Tables 1 and 2); it also occurs when the chrysalis stages are sprayed directly (Table 3). These results indicate that hexythiazox applied at recommended field rates should effectively control TSM by preventing the development of immature stages. Spray timing would then not have to coincide with peak egg laying periods, a task which becomes increasingly more difficult as mite generations begin to overlap later in the season.

From this and other studies (Chapman, unpublished) it is evident that the effectiveness of hexythiazox applications will result from its activity against eggs, larval and nymphal stages. Welty *et al* (1988) reached a similar conclusion when they used hexythiazox to control European red mite, *Panonychus ulmi*, in New York apple orchards.

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