EFFECT OF LEAF TYPE ON THE OVICIDAL ACTIVITY OF HEXYTHIAZOX

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SUMMARY

Laboratory tests to determine the effect of leaf type on the toxicity of hexythiazox to two-spotted mite eggs were carried out. Hexythiazox was most toxic to eggs laid on broad bean leaves, least toxic to those laid on the leaves of the apple cultivars 'Red Delicious' and 'Granny Smith' and of intermediate toxicity to those laid on raspberry and strawberry leaves. Possible reasons for this variation in toxicity are discussed.

INTRODUCTION

Spider mites are frequent pests on many horticultural crops and commonly require regular applications of miticide to maintain their numbers below damaging levels. Several new ovicidal miticides have been introduced recently (Read 1983; Chapman and Marris 1986) but as yet little is known about what influences their efficacy. One possible factor is the effect of leaf type. Asano and Kamei (1982) observed variation between the responses of *Panonychus citri* and *Tetranychus urticae* to the ovicide cycloprate on different leaf types and forwarded several explanations for their results. Because the eggs of spider mites are mostly laid on the under surfaces of leaves and surface morphology of leaves can vary quite markedly between plant species and cultivars, an experiment evaluating the effect of leaf type on the toxicity of hexythiazox to two-spotted mite (TSM) eggs was carried out.

METHODS

TSM were reared in the laboratory on French dwarf beans (*Phaseolus vulgaris* cv. 'Tendergreen'). The TSM strain (AKI) originated from a commercial rose house in Auckland where an intensive pesticide spray programme had been used. Laboratory tests had earlier shown the mites to be moderately resistant to organophosphorus insecticides but not resistant to common miticides, e.g. cyhexatin (Chapman, unpublished).

A modified leaf disc technique (FAO 1974) was used to determine the toxicity of hexythiazox (Nissorum 10 WP, 100 g ai/kg) to TSM eggs laid on leaves of the different leaf types. The leaf types used were broad bean (*Vicia faba* cv. 'Exhibition Long Pod'), strawberry (*Fragaria ananassa* cv. 'Red Gauntlet'), raspberry (*Rubus idaeus* cv. 'Glen Prosen') and apple (*Malus* sp. cv. 'Red Delicious' and 'Granny Smith'). Ten leaf discs of 10 mm diameter were placed upper surface down on damp cotton wool in petri dishes. Ten to 15 adult TSM females were placed on each disc and allowed to oviposit for 24 h at $25 \pm 0.5^\circ\text{C}$ and $85 \pm 5\%$ RH in a 16:8 h L:D photoperiod. Females were removed after this period and the numbers of eggs counted.

The leaf discs were then sprayed under a Potter tower (102 kPa, 10 sec settling time) with 1.5 ml aqueous suspensions of hexythiazox. A range of five concentrations and a water-sprayed control were prepared for each leaf type. After spraying, the leaf discs were air dried for 30 min before being placed in covered plastic trays in a controlled environment cabinet where they remained for 5 to 6 days under the conditions described above. Egg mortality was assessed after this period.

The data were analysed by probit analysis using the computer programme POLO (Russell *et al* 1977). The LC_{50} , 95% confidence interval, slope of the regression line and its standard error were calculated for each leaf type. Significant difference between LC_{50} values were determined by non-overlap of 95% confidence intervals.

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To gain some information on the surface morphology of each leaf type, discs on which TSM had laid eggs were examined using a scanning electron microscope at magnifications up to ca. 360 times.

RESULTS

The relationships between log concentrations and probit mortality for each leaf type are shown in Figure 1. A summary of the probit analyses is presented in Table 1.

Plots of the regression lines (Figure 1) immediately indicated that there were differences between the susceptibility of TSM eggs to hexythiazox on different leaf types. Eggs laid on broad bean were the most susceptible whereas those laid on 'Granny Smith' were the most tolerant. When LC_{50} values were compared (Table 1), this difference is a factor of 6.2. There was no significant difference between the LC_{50} values of the two apple cultivars or between raspberry and strawberry, but these two groups were significantly different from each other and from the LC_{50} for broad bean.

Fig. 1: Responses of two-spotted spider mite to hexythiazox on different leaf types. (1 = broad bean, 2 = raspberry, 3 = strawberry, 4 = 'Red Delicious', 5 = 'Granny Smith').

TABLE 1: Toxicity of hexythiazox to two-spotted mite eggs on different leaf types.

Leaf Type	No. eggs tested	LC_{50} % ai x 10^{-4}	95 % CI	Slope	SE
broad bean	2364	0.34 a ¹	0.30-0.40	2.79	0.18
raspberry	4799	1.03 b	0.93-1.15	3.38	0.16
strawberry	5802	1.14 b	0.94-1.21	2.97	0.14
apple 'Red Delicious'	6095	1.87 c	1.54-2.26	2.64	0.11
apple 'Granny Smith'	3832	2.12 c	1.61-2.86	2.37	0.17

¹ Values with the same letters are not significantly different as 95% confidence intervals overlap.

DISCUSSION AND CONCLUSIONS

Leaf type has been shown to be an important factor influencing the toxicity of hexythiazox to TSM eggs. Ovicidal activity for the different leaf types decreased in the following order: broad bean, raspberry, strawberry, 'Red Delicious' apple, 'Granny Smith' apple. The 6.2 fold difference in LC_{50} values between broad bean and 'Granny Smith' was greater than that found by Asano and Kamei (1982) for TSM eggs on a

range of leaf types treated with cycloprate. They concluded that leaf hair density could be one factor influencing the results of their experiment as lower LC_{50} values were always recorded for relatively hairless leaves like peach and pear compared with apple. Furthermore, the ovicidal activity of cycloprate against TSM eggs on apple was three times higher on the upper than on the lower surface and this was again attributed to the relative difference between leaf hair densities. Precisely why leaf hair density should influence the toxicity of an ovicide to TSM eggs was not determined but it could presumably be related to the penetration, distribution or movement of the active ingredient on a leaf surface.

Our results from this study with hexythiazox cannot be entirely explained by relative differences in leaf hair densities. Examination of electron micrographs of the various leaf surfaces showed broad bean to have relatively few leaf hairs (glabrate vestiture) on the lower surface whereas both apple cultivars had relatively more leaf hairs of a pilose nature. However, raspberry had an extremely dense profusion of hairs on the lower surface (tomentose vestiture) yet on this hexythiazox was intermediate in toxicity between broad bean and the apple cultivars. It was also interesting to note that TSM eggs were invariably laid on the leaf surface between leaf hairs on all leaf types except raspberry where they were laid on the dense mat of leaf hairs. Therefore, both leaf hair type and density as well as oviposition site may well be factors influencing the efficacy of ovicides.

Eggs laid on relatively hairless leaf surfaces would be more exposed to direct contact by spray droplets. However, evidence by Munthali and Wyatt (1986) indicates this may not be such an important factor as they found less than 5% of TSM eggs were directly hit by dicofol-in-oil droplets of 100 μ m diameter. They concluded more egg deaths resulted from dicofol being transported across the leaf surface and that droplet spacing and perimeter were the two most important factors influencing the spread of toxicant. In this study, the Potter tower produced a volume median droplet diameter of 42 μ m, and a deposit of 0.00087 ml/cm² wet spray. Hexythiazox also has some translaminar activity (Anon 1984), which could be significant in the poisoning of TSM eggs.

Applied spray volume may be a further factor affecting the toxicity of the ovicide to TSM eggs since different spray volumes will deposit different amounts of active ingredient on the leaf surface. Wakou and Sugawara (1974) found the LC_{50} values for dicofol varied between leaf type (apple, bean, peach) and spray volume applied. The greatest difference between leaf types was found with the lowest spray volumes. Indirectly this suggests, for a given concentration, droplet density is a primary determinant of miticide efficacy on different leaf types. It also indicates that the results of such bioassays are very technique dependent and may not reflect field conditions.

While the results of this study illustrated significant differences in the efficacy of hexythiazox on different leaf substrates, such differences are unlikely to be important in field situations as the recommended field concentration (0.025 g ai/litre) far exceeds the values in Table 1. However, they do indicate the necessity to evaluate a product such as hexythiazox on a range of TSM host plants to be assured the desired control can be achieved.

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