THE BEHAVIOUR AND REPRODUCTIVE RESPONSE OF EUROPEAN RED MITE TO FLUVALINATE

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SUMMARY

The effect of fluvalinate on dense European red mite, *Panonychus ulmi*, colonies on peach branches and the subsequent fate of those mites was examined in the laboratory. Fluvalinate caused immediate dispersal of mites down the branch with a peak of activity 80 minutes after spraying. Survival and fecundity of dispersing mites was reduced compared with untreated mites.

INTRODUCTION

Pyrethroid insecticides have been found to cause spider mite outbreaks and this may be due to a number of factors. Differences in toxicity to predatory phytoseiids and spider mites, and changes in dispersal, reproduction, development and diapause are suggested as the main explanations. The repellent action of pyrethroids is also well documented and was reviewed by Penman and Chapman (1988), but the fate of dispersing mites is at present unknown. Spider mite reproduction has been found to be affected by pyrethroids, although different pyrethroids produce different effects. For example, flucythrinate reduced reproduction by 96% compared to untreated mites (Penman and Chapman, unpublished) whereas permethrin induced no such effect on two-spotted spider mite, *Tetranychus urticae*, (Iftner and Hall 1984). In contrast Jones and Parella (1984) found permethrin enhanced reproduction in the citrus red mite (*Panonychus citri*).

The pyrethroid fluvalinate is being marketed as an insecticide and miticide for horticultural crops. Fluvalinate has a high repellency and low toxicity to the two-spotted spider mite (Penman *et al* 1986) and could thereby promote spider mite outbreaks by inducing dispersal and reducing density-dependent competition.

Initial studies (J.M. Holland unpublished) with European red mite (ERM) indicated that fluvalinate was also highly repellent and of low toxicity to this species. The experiments reported here were initiated to examine the effect of fluvalinate on ERM colonies and to determine the fate and reproductive capabilities of dispersing mites.

METHODS

Single peach branches (var. 'Redhaven') approximately 0.5 metres long with 75-100 leaves and infested with up to 100 ERM/leaf (mostly adult females) were removed from the Lincoln Orchard and placed in water. After 24 hours a small black mark was made at the halfway point between the tip and the base of the branch. The number of female ERM crossing this mark in an upward and downward direction per minute was then recorded at 30 and 15 minutes before spraying and at nine predetermined intervals following spraying. Each branch was sprayed with 0.1 g/litre fluvalinate (water-based flowable formulation Mavrik Aquaflow 240 g/litre fluvalinate) or water until good coverage was achieved (approximately 8 ml) without spray run-off. Mites running off the branch onto the water container were removed at 0-30, 30-60, 60-90, 90-120, 150-180, and 210-240 minutes after spraying, and placed on separate unsprayed 18 mm peach leaf discs (3 mites/disc) lying on wet cotton wool. Mites that attempted to spin-down during this entire period were also collected and placed on separate leaf discs. The discs were stored at 23 °C, with 14 h dark: 10 h light period. Mite mortality (which included moribund mites) and run-off from each leaf disc were recorded after 1 and 3 days.

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Infested peach branches consisting of two stems were also used to study the extent of ERM movement. One of the stems was sprayed as described above and the other left untreated to see if nearby untreated foliage would be colonised by dispersing ERM. Mite movement was recorded at three positions; halfway down the treated stem, below the join of the two stems, and near the base of the untreated stem.

To examine the fecundity of dispersing mites, ERM were reared from eggs on peach leaves. On the first day of adulthood they were transferred to peach twigs with 5-6 leaves. There were 20 mites/twig and four twigs/treatment. The twigs were sprayed after 24 hours with a Potter tower nozzle operating at 83 kPa and positioned 40 cm from the twig. Two mls were applied to both the upper and lower surfaces. Treatments were a water control and fluvalinate 2F at 0.1 g/litre. Mites moving off the fluvalinate-treated twigs and off the water-treated twigs were collected over a 4 hour period and placed individually on untreated 18 mm peach leaf discs. Mite fecundity, mortality and run-off was assessed for the following 14 days. Daily ERM fecundity for the two treatments was compared for each day using one-way analysis of variance and 95% confidence intervals were calculated using Minitab (Minitab Inc. 1985).

Fig. 1: The movement of ERM on single- and double-stemmed branches before and after spraying.

RESULTS

The application of fluvalinate to single peach branches caused a rapid net movement of mites down the branch, with a mean peak of 20 mites/minute moving downwards 80 minutes after spraying. On the water-sprayed branches, mite movement reached only 6 mites/minute (Figure 1a). In the two-stemmed branch experiment, up to 19 mites/minute moved down the treated stem. On the untreated stem the majority of movement was upwards with a net peak of 4.5 mites/minute moving up the stem (Figure 1b).

The survival of mites leaving the branches and placed on leaf discs is shown in Table 1. After 24 hours on the discs, mites which dispersed within 30 minutes of spraying had higher mortality and run-off (15 and 38% respectively) than mites which dispersed after 210-240 minutes (3.3 and 24.4% respectively). Similar trends were also noticeable after 72 hours when run-off from the disc was greater than mortality of the mites. The percentage survival of mites from the fluvalinate-treated branches (excluding mites which ran off the leaf discs) was 74-92% and 46-71% after 24 and 72 hours respectively, compared to 98% and 97% in the untreated control. The majority of surviving mites were observed feeding and ovipositing after 72 hours although some hyperactive mites remained.

TABLE 1: The response of ERM dispersing from a single peach branch after treatment with either 0.1 g/litre fluvalinate or water and placement on unsprayed peach leaf discs.

Time after spray (minutes)	Total ERM collected	% Alive on disc	% Mortality on disc (including moribund)	% Run-off disc
24 HOURS				
0-30	162	47.0	15.0	38.0
30-60	203	56.3	9.3	33.4
60-90	227	67.0	8.6	24.4
90-120	211	59.7	6.6	33.7
150-180	203	67.3	4.7	28.0
210-240	168	72.3	3.3	24.4
spun-off 0-240	121	55.3	9.0	35.7
untreated 0-240	110	91.0	2.0	7.0
72 HOURS				
0-30	162	23.7	30.0	46.3
30-60	203	36.3	19.7	44.0
60-90	227	40.7	26.3	33.0
90-120	211	34.3	23.0	42.7
150-180	203	45.0	21.0	34.0
210-240	168	53.3	22.0	24.7
spun-off 0-240	121	46.7	13.3	40.0
untreated 0-240	110	84.0	3.0	13.0

Mite dispersal from the branches was mainly by run-off down the stem. The mean number of mites caught spinning down from fluvalinate-treated branches was only 121 over the 240 minutes.

The fecundity of mites dispersing from fluvalinate-treated twigs was reduced by approximately 50% for each of the first 5 days after treatment compared to that of mites from untreated twigs. These differences were significant ($P < 0.05$) as shown by the non-overlap of 95% confidence intervals for daily fecundity (Figure 2). Cumulative fecundity for the fluvalinate-treated ERM showed an increasing reduction over 14 days compared to that of the water-treated ERM (Figure 2).

Fig. 2: Daily and cumulative fecundity of ERM which dispersed from fluvalinate- or water-treated foliage and were placed on unsprayed peach leaf discs.

DISCUSSION

These studies with peach branches were a compromise between field experiments, in which mite behaviour is difficult to observe, and laboratory experiments with leaf discs, which offer too small an arena for mite dispersal behaviour. Fluvalinate caused almost immediate dispersal when applied to ERM colonies in these experiments. The majority of ERM had dispersed within 3 hours by walking down the stem and few ERM were inclined to move up the untreated stem when this option was offered. Therefore it is unlikely that ERM exposed to fluvalinate will colonise untreated areas in their immediate vicinity, but this massive dispersal of ERM following spraying could pose a threat to untreated and previously uninfested areas within the dispersal range. The extent of fluvalinate-induced dispersal of ERM needs to be examined further. The survival of dispersing ERM will depend on the dose they receive which is related to the time they remain on the insecticide residues. ERM that dispersed first had lower survival rates which may indicate that they received a direct droplet hit and therefore a higher dose of fluvalinate. McKee *et al* (1987) came to the opposite conclusion that TSM which dispersed first had received lower doses of flucythrinate and were therefore less affected, as determined by subsequent fecundity. More detailed analysis of fecundity in this experiment could not be made because the ERM were beginning overwintering oviposition behaviour and fecundity was naturally reduced. Mites which spun-down were found to have average survival rates compared to mites which walked-off, whereas Schiffhauer and Mizell (1988) found with various acaricides, that the mortality of TSM which spun-down was higher than for those which walked-off.

Daily fecundity was reduced in mites which dispersed from fluvalinate-treated peach leaves within 4 hours of spraying but these reductions remained significant for only 5 days after spraying. Similar reductions were found by McKee *et al* (1987) with TSM and flucythrinate although the degree of fecundity reduction was dependent on the concentration applied.

The reduction in fecundity caused by fluvalinate may delay population build up by dispersing mites and minimise mite outbreaks through repellency and loss of density dependent competition. The ability of ERM to detect unsprayed areas within the crop, the distance they travel when repelled by fluvalinate and the dose received will all

influence the outcome of spraying. Moreover conclusions from one study cannot be applied to all pyrethroid insecticides and spider mite species combinations because subtle differences occur with each.

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