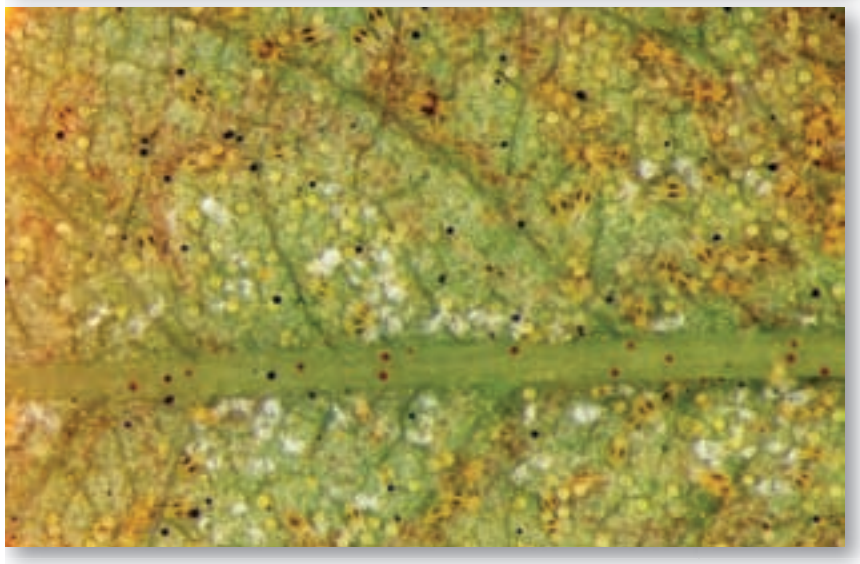
Effect of Translaminar Miticides on Twospotted Spider Mites



Top Right: *Twospotted spider mites on leaf underside (Photo: Whitney Cranshaw).* ***Top:*** *Twospotted spider mite adults (Photo: David Shetlar).* ***Middle:*** *Twospotted spider mite adults (Photo: Whitney Cranshaw).* ***Bottom:*** *Twospotted spider mites on marigold (Photo: Raymond Cloyd).*

This study analyzes the effectiveness and longevity of miticides with translaminar properties on test plants under greenhouse conditions.

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Twospotted spider mite (*Tetranychus urticae*) is a major arthropod pest of greenhouses feeding on more than 300 plant species. Twospotted spider mite (TSM) feeds within plant cells, damaging the spongy mesophyll, palisade parenchyma and chloroplasts, reducing chlorophyll content and the plants' ability to photosynthesize. This results in characteristic symptoms such as leaf bleaching, yellow stippling and bronzing of leaves.

The primary means of controlling TSM populations in greenhouses is the use of commercially available miticides that either have contact or translaminar activity. Miticides with contact activity include acequinocyl, bifenazate, clofentezine, fenbutatin-oxide, fenpyroximate, hexythiazox and pyridaben. These miticides, in general, provide minimal residual activity once spray residues have dried. However, a number of miticides have translaminar properties, which indicates that the material penetrates the leaf cuticle and the active ingredient resides within the leaf tissue including the spongy mesophyll and palisade parenchyma cells, providing a reservoir of active ingredient. This allows for extended residual activity against TSM even after spray residues have dried.

Twospotted spider mites feeding on the leaves, even after spray residues have dissipated, may ingest a lethal dose of the active ingredient. This may lead to a decrease in the number of miticide applications, thus reducing worker exposure and minimizing the potential for resistance development. Futhermore, fewer miticide applications will decrease any harmful effects on natural enemies such as predatory mites. Miticides registered for use in greenhouses that have translaminar activity include abamectin (Avid), chlorfenapyr (Pylon), spiromesifen (Judo), and etoxazole (TetraSan). This study was designed to quantify the longevity or residual activity of currently available miticides with translaminar activity for control of the TSM under greenhouse conditions.

Two replicated experiments were conducted to determine the effectiveness and longevity of miticides with translaminar properties for various lengths of time after test plants had been treated, prior to being artificially infested with TSM. The first experiment determined miticide efficacy on the nymphs and adults, which were pooled in the final analysis, whereas the second experiment assessed miticide efficacy specifically on both the nymph and adult life stages.

Conducting the Study

We evaluated two different formulations of the active ingredient etoxazole because

Experiment 1

Miticide[a] Common name[b]	Formulation	Label rate	Rate used
Etoxazole	5WD	8 oz/100 gallons	1.2 g/L
Etoxazole	7–8 microns	8 oz/100 gallons	1.2 g/L
Etoxazole	10–12 microns	8 oz/100 gallons	1.2 g/L
Chlorfenapyr	SC	4 fl. oz/100 gallons	0.62 mL/L
Untreated Check	----	-----	-----

a Etoxazole (TetraSan: Valent U.S.A. Corporation, Walnut Creek, CA); Chlorfenapyr (Pylon: OHP, Inc., Mainland, PA).
b Common name=Active ingredient

*Table 1. Miticides, formulations, and recommended-label rates used to assess effects on the twospotted spider mite (*Tetranychus urticae*) under greenhouse conditions for experiment 1.*

although the composition of the etoxazole formulations was similar, the milling of the particle size was different. The initial formulation of etoxazole contains a high percentage of clay filler. The milling process reduced the particle size of both the clay and etoxazole technical grade together. However, the clay filler is difficult to mill down to small particle sizes, so we wanted to determine whether particle size influenced efficacy of the active ingredient in providing control of TSM. In the first experiment, both etoxazole and chlorfenapyr provided control, based on percent mortality, of TSM up to 28 days after plants had been artificially infested with TSM or 42 days after ➧

Experiment 2

Miticide[a] Common name[b]	Formulation	Label rate	Rate used
Etoxazole	5WG	16.0 oz/100 gallons	1.19 g/L
Acequinocyl	15SC	12.8 fl oz/100 gallons	1.0 ml/L
Abamectin	0.15EC	4.0 fl oz/100 gallons	0.31 ml/L
Chlorfenapyr	SC	2.6 fl oz/100 gallons	0.20 ml/L
Spiromesifen	4SC	2.0 fl oz/100 gallons	0.15 ml/L
Water Control	----	-----	-----

a Etoxazole (TetraSan: Valent U.S.A. Corporation, Walnut Creek, CA); Acequinocyl (Shuttle: Arysta Life Science, San Francisco, CA); Abamectin (Avid: Syngenta Professional Products, Greensboro, NC); Chlorfenapyr (Pylon: OHP, Inc., Mainland, PA); and Spiromesifen (Judo: OHP, Inc., Mainland, PA)
b Common name=Active ingredient

Table 2. Miticides, formulations, and recommended-label rates used to assess effects on the twospotted spider mite for experiment 2.

Average TSM Mortality

Experiment 1 Treatments*	Formulation	Percent Mortality (mean ± SE)z
Etoxazole	5WD	1.22 ± 0.071a
Etoxazole	7-8 microns	0.92 ± 0.055b
Etoxazole	10-12 microns	1.23 ± 0.069a
Chlorfenapyr	SC	1.06 ± 0.061ab
Untreated Check	----	0.30 ± 0.058c
Experiment 2 Treatments	Formulation	Percent Mortality (mean ± SE)z
Nymphs		
Etoxazole	5WG	1.21 ± 0.037b
Acequinocyl	15SC	0.81 ± 0.037c
Chlorfenapyr	SC	0.75 ± 0.037cd
Spiromesifen	4SC	1.39 ± 0.037a
Abamectin	0.15EC	0.68 ± 0.037d
Water Control	----	0.21 ± 0.037e
Adults		
Etoxazole	5WG	0.60 ± 0.053b
Acequinocyl	15SC	0.27 ± 0.051c
Chlorfenapyr	SC	0.54 ± 0.053b
Spiromesifen	4SC	0.92 ± 0.060a
Abamectin	0.15EC	0.54 ± 0.051b
Water Control	----	0.15 ± 0.051c

z Means not followed by a common letter are significantly different (P≤0.05) as determined by a Fisher's protected least significant difference (LSD) test.
* Refer to tables 1 and 2 for information associated with the treatments.

Table 3. Overall mean (± SE) percent twospotted spider mite mortality for all treatments in experiment 1 (nymphs and adults pooled together) and experiment 2 (nymphs and adults analyzed separately) across all three evaluation periods.

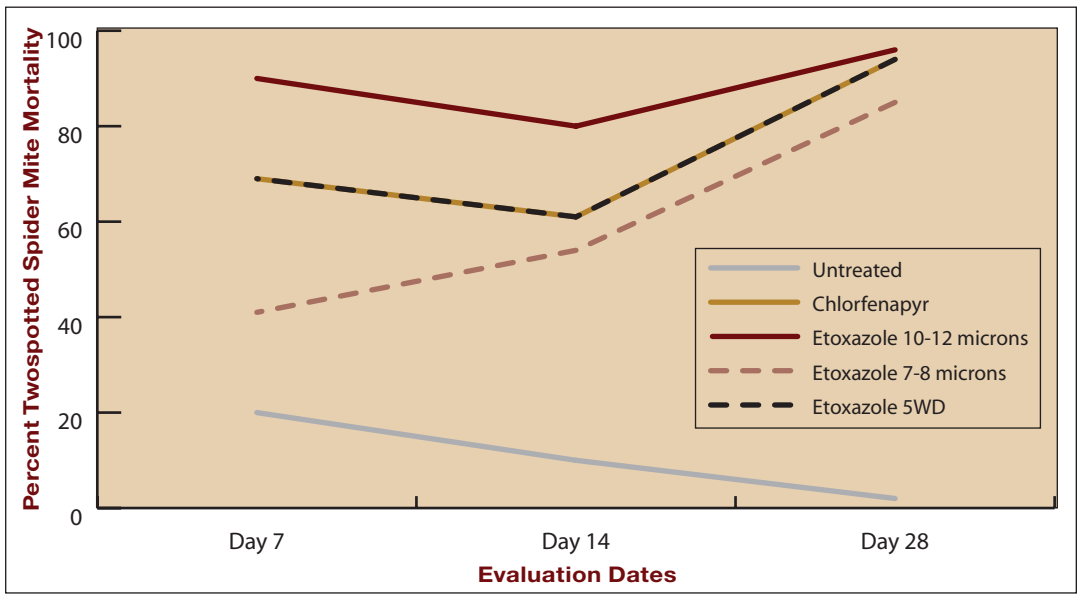

*Figure 1. Mean percent twospotted spider mite, (*Tetranychus urticae*) mortality for all miticide treatments 7, 14 and 28 days after butterfly bush (*Buddleia davidii*) plants had been artificially infested with twospotted spider mites.*

treatments had been applied, indicating that the active ingredient of both miticides was still present at a lethal dose.

Although plants treated with the etoxazole 7–8 micron formulation had higher numbers of live TSM (range: 24 to 31) after seven and 14 days, and a lower percent mortality (40 percent) than the other treatments, eventually this treatment resulted in 88 percent mortality of TSM (Figure 1). This suggests that the smaller particle sizes may have affected penetration of the active ingredient into the leaf tissues, thus delaying the translaminar effect and control of the TSM.

In experiment one, all of the treatments provided control of TSM up to at least 28 days (from the day of artificial infestation to first count). However, because a majority of the TSM may have been killed at seven days, thus significantly reducing the TSM population, it is difficult to speculate that the treatments were still actually active up to 28 days, although the mean numbers of live TSM (1.6 ± 0.07: mean ± SE) after 28 days for the etoxazole 7–8 micron formulation treatment indicates that the other treatments were still active up to 42 days (from treatment application to final count).

Lasting Effects

The miticides evaluated provided control of TSM even after having been applied ➧

to plants 14 days prior to artificial infestation of TSM. This suggests that the miticides have extended residual activity, with the active ingredient remaining in the plant tissues for at least 42 days (based on the first experiment) and up to 70 days (based on the second experiment).

In our study, we did not use the new growth that had developed after infesting the plants with TSM because any new growth may not have had any TSM, and we were uncertain that the active ingredient would have been present in the new leaves at a lethal concentration. In fact, the chlorfenapyr label indicates that the active ingredient may be diluted in new expanding leaves compared to concentrations of active ingredient in the leaf tissues after application. In order to quantitatively assess that there was residual activity at 49 or 70 days, it would have been necessary to reinfest the test plants with TSM at the appropriate time intervals. However, by this time, the test plants would have grown substantially.

Individual Miticides Results

Based on our results, etoxazole and spiromesifen were more effective on TSM nymphs (Figure 2) and provided extended residual activity with the active ingredient in both miticides, apparently remaining in plant leaves at a lethal dose up to 70 days. Etoxazole is a mite growth regulator acting as a chitin synthesis inhibitor. It is effective on eggs, larvae and nymphs but not adults, which was evident based on our results (Figure 3).

Although both abamectin and chlorfenapyr have translaminar activity, these miticides failed to provide control of either TSM nymphs or adults. It is possible that the TSM population in our colony may have evolved resistance to abamectin. In fact, TSM populations throughout the United States are less susceptible to abamectin because it was introduced in the 1980s.

Chlorfenapyr is active on all life stages of TSM but may not remain viably active in leaf tissues beyond 28 days, which may be a consequence of the active ingredient being metabolized by the plants.

Acequinocyl (Shuttle) is a contact miticide that is active on all life stages including eggs; however, it does not have translaminar activity, which was apparent based on the low percent mortality of TSM nymphs and adults 35 and 49 days after plants had been artificially infested with TSM or 56 and 70 days after the treatments had been applied. The reason for this may be that the high initial percent mortality (93 percent) killed all or most of the TSM, thus reducing the numbers on the plants, which may have lowered the numbers that could be recorded after sampling. Moreover, it has been suggested that miticide applications may influence or alter the dispersion of TSM, thus biasing estimates of TSM populations.

Spiromesifen resulted in 87 percent TSM adult mortality 35 days after the test plants had been artificially infested with TSM, then mortality declined to 37 percent at 49 days. This also may be due to a lack of or low number of TSM present after 35 days, thus influencing our ability to detect TSM populations during sampling. In fact, plants ➧

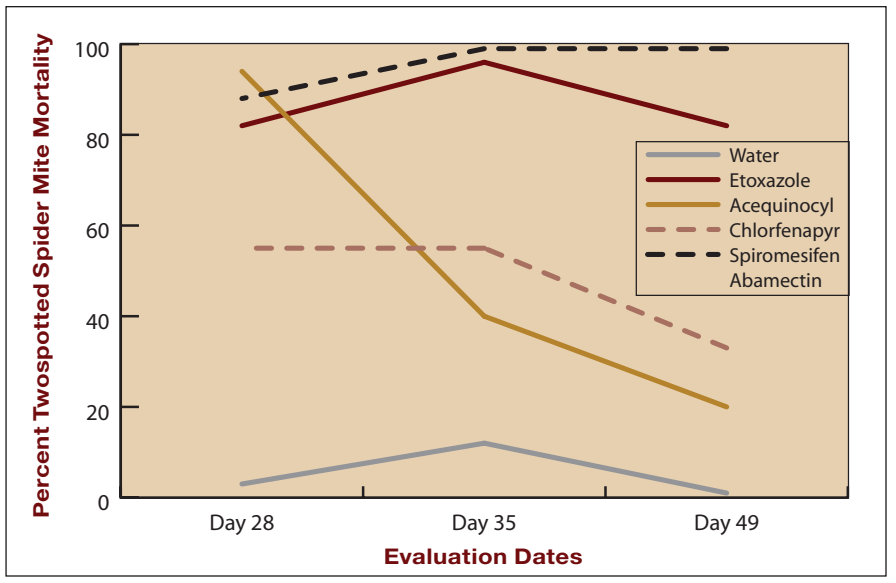

*Figure 2. Mean percent twospotted spider mite, (*Tetranychus urticae*) nymphal mortality for all miticide treatments 28, 35 and 49 days after marigold (*Tagetes erecta*) plants had been artificially infested with twospotted spider mites.*

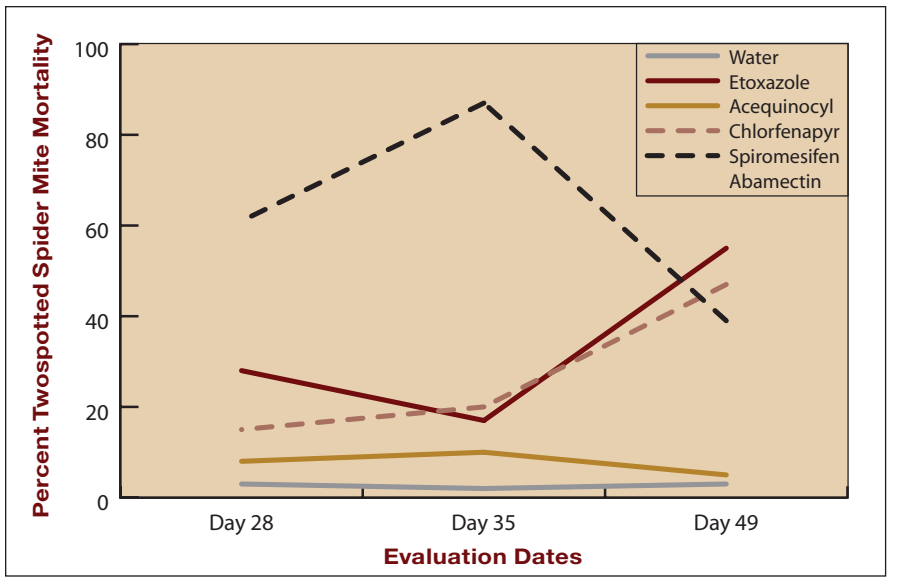

*Figure 3. Mean percent twospotted spider mite, (*Tetranychus urticae*) adult mortality for all miticide treatments 28, 35 and 49 days after marigold (*Tagetes erecta*) plants had been artificially infested with twospotted spider mites.*

treated with spiromesifen had the highest instances of zero TSM recovered per plant. Spiromesifen is more effective on the juvenile stages (larvae and nymphs) than adults, which may be associated with adult feeding behavior, compared to the juvenile stages, thus influencing the amount of active ingredient withdrawn from plant tissues.

Promising Findings

This study has demonstrated that translaminar miticides may be more effective on particular life stages of the TSM — for example, nymphs over adults — which means that the age structure of TSM at the time of application may influence effectiveness. GPN

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