Evaluation of Various Miticidal Products for Two-Spotted Spider Mite, Alfalfa Caterpillar and Beet Armyworm Control in Alfalfa

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Abstract

A number of products with miticidal activity were applied both in the spring and summer of 2002 to alfalfa in the Blythe, CA, area to evaluate their efficacy for two-spotted spider mite (Tetranychus urticae) control. These two application periods differed in regards to presence of western flower thrips (Frankliniella occidentalis), a predator of spider mites. Western flower thrips populations were high in the spring but essentially absent during the period following the summer application, providing contrasting data for effects of western flower thrips interactions with many miticides for spider mite control. Miticides tested included those currently utilized for mite control in alfalfa hay production as well as a number of new and/or potential products for alfalfa hay.

In the spring testing, most treatments had more spider mites than the untreated check at three days post treatment when western flower thrips were present and actively feeding on spider mites. Two fertilizer treatments that contained high amounts of sulfur also had more spider mites than the untreated check at three days post treatment, thought due to repellency of adult western flower thrips. Many of the treatments that had more spider mites than the check following the spring application are known to have thrips activity (Zephyr, Trilogy, Dimethoate, Lorsban, etc.). Fewer motile (adults and immatures, not eggs) spider mites than in the check were noted only from the Capture + Dimethoate 400, Capture, and the combination of the two Gowan numbered products (1528, 1549) at three days after treatment.

Products that provided excellent (90%+) control throughout the duration of the summer part of the experiment included two numbered compounds from Gowan (1528 and 1549), Capture + Dimethoate 400, Danitol, Zephyr + Trilogy, and a numbered compound from Valent USA (V-1283). The wide disparity in the two data sets indicate that western flower thrips presence/absence should be considered as part of the decision making process for spider mite control.

Introduction

Spider mites can be problematic in desert agricultural production, moving to and damaging spring crops such as cotton and melons as overwintering host plants desiccate and/or are harvested. In the past few years alfalfa hay in the Palo Verde Valley has experienced damaging spider mite populations, necessitating chemical applications to limit crop damage due to spider mite feeding. Alfalfa has few miticide products registered, and control of spider mites in alfalfa has become more difficult in recent years as product registrations have been withdrawn.

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The exact reason(s) for this noted increase in spider mite populations in not entirely clear but may involve several factors. During the past several falls cowpea aphids have infested area alfalfa, with populations high enough to often necessitate insecticide applications, and winters have noted temperatures cold enough to freeze the upper parts of alfalfa stems in fields. Both of these factors could also reduce numbers of beneficial insects present in area alfalfa fields that feed on spider mites in alfalfa during the winter. Damage and associated highest spider mite populations have been mainly reported in late winter and early spring as long curing times and dry winter season environments have been conducive to spider mite population increases.

Local professional crop advisors (PCAs) had commented about inconsistencies of products for mite control on alfalfa and/or lack of documented efficacy from local trials. A number of new chemistries with miticidal activity have also recently become available and may have a potential fit in alfalfa production. This study was initiated to evaluate potentially new products for alfalfa hay in regards to efficacy and comparison with current available chemistries, and to document spider mite control and populations on alfalfa grown in the Palo Verde Valley.

Methods and Materials

Two application timings were utilized which differed greatly in the number of western flower thrips present in the fields. The spring (May) application had abundant thrips, while the summer (July) application had very few thrips present. Alfalfa used for treatments at both applications also had spider mites present. The July application also had beet armyworms and alfalfa caterpillars present when plots were treated.

Treatments included miticides from several classes of active ingredient chemistries. These active ingredient classes and chemistries (active ingredient in parentheses) included:
Avermectin: Gowan 1549 (milbemectin); Zephyr (abamectin)
Carbazate: Acramite™ (bifenazate)
Fertilizers with high sulfur levels: Microthiol Disperss; Musol X-16
Mite Growth Regulators (MGRs): Gowan 1528 (hexythiazox); V-1283 (etaxazole)
Neem Oil: Trilogy
Organophosphates Dimethoate, Lorsban 4E (chlorpyrifos)
Pyrethroids: Capture® (bifenthrin); Danitol®(fenpropathrin); F-0570, Mustang (zetacypermethrin)

Twentytwo treatments were applied May 17, 2002, to plots in an alfalfa field utilizing bed production techniques that had been very heavily infested with spider mites prior to cutting on May 7 located northwest of Blythe, CA. The field was irrigated on May 15, 2002, and continued to be spider mite infested, especially on lower parts of the plant.
Fifteen treatments, most being the same as the previous application date, were applied July 15, 2002, to an alfalfa field that had significant spider mite numbers. All applications were made with a backpack CO_2 sprayer calibrated to deliver 22.1 gallons/acre at 20 psi using four T-Jet 8002 nozzles. Plots were 8 beds wide (26.67 feet) x 6 feet wide. Treatments were replicated four times utilizing a randomized complete block design. Alfalfa height varied at time of application by bed with shortest alfalfa where alfalfa had been laid down by the swathers and also when raked together, but overall averaged 10.25 inches tall at time of application in May and was of similar height in July.

Spider mites
Samples for the May application were collected at three and 11 days post treatment, and at 7, 14 and 21 days after treatment in July. Sampling consisted of collecting 12 stems per bed (two stems per bed from the center six of the eight beds). Samples were obtained by cutting at or just below the previous harvest level. Stems were then transferred to gallon size plastic food storage bags. Bags were then sealed and returned to the laboratory where they were placed in a refrigerator at 5°C to halt spider mite development.

Plant material was then examined using microscopes, and eggs, immatures and adult spider mites were counted and recorded at each node. All 12 stems were examined for the first replicate of treatments processes, but only 10 stems were examined thereafter due to the intensive time-consuming nature of the study. Only three of the four replicates were able to be finished for both sample dates (replicate number three was not counted for either stem collection date) following the May application, all four replicates were counted from the July application.

Mean numbers of eggs, immatures and adult spider mites per stem for each plot were then calculated. Treatment means were then analyzed using Fishers least significant difference (Statgraphics Plus for Windows, Manuguistics, Inc.) to determine if significant differences existed between the various treatments.

Beet armyworms and alfalfa caterpillars

Plots were sampled at two days after the July 15th application. Sampling consisted of 10 three-foot sweeps per plot with a 15 inch diameter insect net. Net contents were then transferred to plastic containers, marked with plot information, and returned to the laboratory where containers were placed in freezers. Containers were later examined, caterpillers identified to species, counted and data were recorded. Means were then analyzed with Fishers least significant difference to determine if significant differences existed between the various treatments.

Results

Data differed widely between the two application dates in regards to two-spotted spider mite control, due to the presence of western flower thrips during the May samping period which were actively feeding on two-spotted spider mites. These biological controls were not prevalent during the summer sampling period. The presence/absence of such biological controls in combination with miticide application allowed comparative contrasts for the 15 treatments common to both applications. Figures 1-4 depict mite populations for the first sample date after each of the two miticide applications for these 15 common treatments, and the differences noted for miticide efficacy with and without interactions with western flower thrips relative to the untreated check. As such differences exist, results for mite control are discussed separately for each application date as well as by miticide mode of action for the spring application as data indicate miticides interactions with western flower thrips.

Spring (May) application

At three days after the May application, only five treatments had fewer spider mites than the untreated check (Table 1). Many of the treatments that had higher mite numbers than the untreated check are known to have thrips activity (such as Zephyr, Trilogy, dimethoate, Lorsban, etc.) and have such on their labeled uses. Two fertilizer (Musol X-16, Microthiol Disperss) treatments that contained high amounts of sulfur also had more spider mites than the untreated check at three days post treatment. The high rate of V-1283 (etaxazole) also had significantly more adult mites than the lower rate of this product, thought due to a rate response repellency of adult western flower thrips as control of western flower thrips with this product is unknown. Spider mite numbers noted for the lower rate of this product were very similar to those noted for the untreated check however.

Numerically fewer motile spider mites than in the untreated control at three days post treatment were noted in both treatments containing Capture, the combination treatment of Gowan 1528 and Gowan 1549, the low rate (0.041 lbs/acre) of V-1283, and the dimethoate-F0570 combination treatment. Of these treatments only the dimethoate-F-0570 treatment and both treatments containing Capture had numerically fewer adult spider mites than the untreated check. Many treatments had significantly more spider mites than the untreated check due to western flower thrips feeding on and decreasing populations of spider mites in the untreated check plots.

By 11 days post spring treatment (Table 2), most treatments had significantly fewer spider mite eggs than the untreated check although two treatments (Acramite 50WS, Zephyr @ 2 oz./acre) had numerically more. Problems were encountered with the Zephyr @ 2 oz./acre application, and actual amount applied was probably closer to 1 oz/acre. Fewest eggs (90% less than the untreated check) were noted in treatments containing Gowan 1549 (active ingredient = milbemectin), Danitol @ 21 oz./acre, and a combination treatment of dimethoate 400@ 1 pt + 40 oz/acre of F-0570 (active ingredient = zetacypermethrin). Highest numbers of immatures were noted in the untreated check and the 2 oz./acre rate of Zephyr. Although a number of treatments had significantly fewer immature spider mites than the check, none of the treatments differed significantly from the untreated check for numbers of adults/stem. Fewest total motiles were noted in treatments containing Gowan 1549, and the combination of Dimethoate + F-0570.

Effects of various active ingredient groups - indications of western flower thrips interactions

Pyrethroids

As a group, the pyrethroid treatments (Danitol, Capture) had the fewest numbers of motile (non-egg forms) mites at three days post treatment (Table 1) with the exception of F-0570. Capture was a very effective miticide. Of all the treatments in this experiment only the Capture + Dimethoate combination and the 21 oz./acre rate of Danitol had fewer eggs/stem than the untreated check at three days post treatment. Only treatments containing Capture had fewer numbers of both immatures and adults than the untreated check on this sample date however. This may be in part due to little activity of pyrethroid insecticides on western flower thrips, although F-0570 (zetacypermethrin) has been documented to somewhat reduce numbers of western flower thrips adults for a few days immediately after application (Rethwisch et al., 2002).

Treatments containing pyrethroid chemistries all had significantly less eggs at 11 days post treatment (Table 2) and numerically less immatures and adults than the untreated check. Fewest motiles were noted in the combination treatment of dimethoate + 40 oz/acre of F-0570 treatment, but this level of F-0570 was 10x higher than expected for practical field applications.

Mite Growth Regulators

As the mite growth regulators (V-1283, Gowan 1528) stop eggs from hatching, it was expected that there would be more eggs than in the untreated check. Numbers of eggs were similar to the untreated check at 3 days post treatment, with the exception of the high (0.0625) rate of V-1283. It is thought that this high rate may have had some effect on western flower thrips, as significantly more spider mite adults were present than in the untreated check, and highest numbers of immatures numbers among mite growth regulators were noted in this treatment.

Fewer eggs were noted in these treatments than the untreated check at 11 days post treatment, and immatures numbers noted were only about 75% that of the untreated check. Slightly more adults/stem were noted Gowan 1528 than the untreated check, although slightly fewer adults were noted in the 0.0625 lb/acre of V-1283 than in the check. Fewest adult/stem among the mite growth regulator treatments were noted in the low (0.041 lb./acre) rate of V-1283, which represented about a 67% reduction when compared with the check on this sample date.

Avermectins

Numbers of spider mite eggs/stem were similar to those of the untreated check (11.63/stem) at three days post treatment with the exception of the 3 oz./acre rate of Zephyr, which had much higher numbers of eggs. Significantly more adults/stem were noted from the two lower rates (2, 3 oz./acre) of Zephyr than in untreated check and numerically more adults were noted in the 4 oz./acre rate of Zephyr and the combination treatment of 2 oz/acre of Zephyr + Trilogy than the untreated check. The active ingredient in Zephyr (abamectin) is known to have thrips activity as citrus thrips as well as *Thrips palmi* are listed as targeted pests on the label for AgriMek which also had abamectin as its active ingredient. High activity of abamectin against western flower thrips has also been documented (as Avid) on gerbera, with 100% control being noted in the initial (5 days post treament) sample (Lindquist et al., 1999).

Immature numbers were higher than the untreated check in all treatments containing Zephyr at this date, although numbers of immatures/stem were very similar in the Gowan 1549 treatment (2.01/stem) as noted in the check (2.11/stem) for this sample date. The combination treatment of Gowan 1549 when used with the mite growth regulator Gowan 1548 had very smilar numbers of eggs as the untreated check, but did have numerically fewer immatures and motiles. Effects of the Gowan products on western flower thrips is currently unknown.

At 11 days post treatment the combination treatment of Gowan 1549 and Gowan 1548 had 100% control of motiles noted, with most of this activity attributed to the milbemectin (Gowan 1549) chemistry as similiar numbers of motiles (0.1/stem) were noted with the 16 oz./acre rate of this chemistry. Two of the Zephyr treatments (3, 4 oz./acre rates) had significantly fewer immatures than did the untreated check. The combination treatment of Trilogy +2 oz./acre Zephyr had 97% less adults than the untreated check, but was not significantly different. The 2 oz./acre rate of Zephyr alone did have signficantly more spider mites (eggs, immatures, and motiles) than higher rates of this product.

Organophosphates, carbazates, neem oil

Application of all of these treatments (Dimethoate 400, Lorsban 4E, Acramite, Trilogy) by themselves resulted in numerical or signficiant increases (Trilogy, Acramite 50WS) of motile forms of spider mites at three days post treatment

(Table 1). A combination treatment of Lorsban + Dimethoate did have numerically fewer immature spider mites than the check, but did have slightly more eggs and adult mites than the untreated check at three days post treatment. Adding Hyperactive (an adjuvant from Helena Chemical) to the dimethoate-Lorsban mixture resulted in numerically more spider mites of all life stages on this sample date than noted from only the dimethoate-Lorsban combination.

Most of these chemistries have documented thrips activity. Both dimethoate and Lorsban 4E have labels indicating thrips control, while the Trilogy label indicates suppression of thrips. Activity of Acramite on thrips is currently unknown, but data suggest some activity, perhaps in the form of repellency.

Fertilizers

Fertilizer treatments (Musol X-16, Microthiol Disperss) resulted in higher numbers of all spider mite life forms at three days post treatment than did the untreated check. Several species of spider mites (Atlantic, red) are listed on the alfalfa section of the Microthiol Disperss for pests controlled, but two-spotted spider mites are not listed in this section. This is similar to the Kumulus DF label (a product from Micro Flo which also contains sulfur as active ingredient) for alfalfa which does not list two-spotted spider mite as being controlled, although Pacific, strawberry (Atlantic) and red spider mites are listed. Sulfur does have thrips activity, as thrips are listed on the both the Kumulus DF and Microthiol Disperss labels for citrus. It is expected that Musol X-16 would result in similar biological activity for both spider mites and thrips as it contains some sulfur as well as nitrogen, phophorus, potassium and 15 other elements, but the sulfur level is much less than the 80% contained in Microthiol Disperss. Much more Microthiol Disperss (15 lbs/acre) was applied than was Muxol X-16 (1 qt./acre). Alfalfa treated with Microthiol Disperss had more spider mites/stem than did the Musol X-16 treatment. At the 11 days post treatment sample both treatments had signficantly fewer immature mites than the untreated check, although numbers of eggs and adults were not significantly different than the untreated check.

Summer (July) treatment - thrips not prevalent

Data were quite different in the summer application compared with the spring application as western flower thrips were not prevalent during the summer sampling period, providing clear efficacy data for miticides. Higher numbers of spider mite eggs, immatures and adults were noted in the untreated check than any treatment at seven days after application (Table 3). High numbers of eggs were noted in both V-1283 treatments (etoxazole) and Gowan 1528 at seven days post treatment. Both of these miticides disrupt egg hatch (mite growth regulators), so eggs continued to accumulate due to lack of eclosion. Few immature two-spotted spider mites were noted in these treatments.

Treatments that had fewer immatures than the mite growth regulator treatments included both rates of Danitol alone, the Capture+Dimethoate combination, and treatments containing Gowan 1549. Many treatments provided 90+% reduction in mite numbers when compared with the check. Treatments having greater than 2.0 immature spider mites per stem included all dimethoate treatments (with the exception of combination treatments with Capture and Danitol), Acramite, and Microthiol Disperss.

All treatments reduced adult spider mite numbers by 50+% at seven days post treatment when compared with the untreated check with the exception of Acramite 50WS (38.9% fewer adult mites). This was not entirely unexpected as the label for this product notes that "Acramite-50WS is not systemic in action; therefore complete coverage of both upper and lower leaf surfaces is neccessary for effective control", and an 'over the top of the alfalfa plant' application was made. Acramite 50WS did signficantly reduce spider mite egg numbers per stem when compared with the untreated check however.

Mite numbers were lower in the untreated check plots at 14 days post treatment (Table 4) than at seven days, thought partially due to higher humidities as a result of greater crop canopy. Highest mite numbers continued to be in the untreated check, although numerical increases from the previous sample date (almost 100%) of adult mite numbers were noted in the Mustang + Dimethoate, Dimethoate, Dimethoate + Lorsban, and 14 oz./acre rate of Danitol (both with and without Dimethoate) treatments. Fewest spider mites were noted in treatments containing Gowan 1549 at 14 days post treatment, as treatments containing this chemistry resulted in 100% control of motile spider mites.

All treatments had significantly fewer spider mite adults than the untreated check at 14 days post treatment, as well as significantly fewer eggs with the exception of the dimethoate + Mustang combination (14.125 eggs/stem), and the Microthiol Disperss (10.95 eggs/stem) treatments. All treatments also had signficantly fewer immature spider mites per stem than the untreated check with the exception of the Lorsban + dimethoate combination.

At 21 days after application, numerically more eggs were noted in the Dimethoate 400 and Dimethoate + Mustang treatments than the untreated check (Table 5). Many treatments continued to have significantly less eggs than the check, with fewest noted in the treatment containing both Gowan 1549 and Gowan 1528. Fewest immature mites were noted in the treatments containing V-1283, the Capture + Dimethoate treatment, and the Gowan combination treatment. Treatments having at least 90% less adult mites than the untreated check at this sample date included both V-1283 treatments, Zephyr + Trilogy, Capture + Dimethoate, Danitol + Dimethoate, and treatments containing Gowan 1528. Two-spotted spider mite numbers in plots treated with Microthiol Disperss were not significantly different than the untreated check for any life stage, although slightly fewer spider mites were noted in the Microthiol Disperss treatment.

Beet Armyworms and Alfalfa Caterpillars

Many treatments significantly reduced numbers of alfalfa caterpillars in this study compared with the untreated check (Table 6). These treatments included any treatment containing dimethoate and/or a pyrethroid, as well as the combination treatment of Zephyr + Trilogy which had the fewest alfalfa caterpillars (96.2% reduction compared with the untreated check). Activity from the Zephyr/Trilogy combination may have been due to the Zephyr as the active ingredient (abamectin) is labeled for tomato pinworm control on the AgriMek formulation of this active ingredient.

A number of treatments had signficantly/numerically more alfalfa caterpillars than the untreated check however, with these treatments being the mite growth regulators (V-1283, Gowan 1528), Acramite, as well as Gowan 1549. The reason for an increase in numbers is unknown, but does not appear to be correlated with total number of beneficial insects in the plots. Numerically fewer alfalfa caterpillars as well as fewer beet armyworms were noted in the higher rate of V-1283 than the lower rate of this product however.

Beet armyworms were not as numerous in this study as were the alfalfa caterpillars, which made discernment of differences between treatments more difficult. The only treatment which had signficantly fewer beet armyworms than the untreated check was the dimethoate-Lorsban combination (each at 1 pt./acre). All treatments containing a pyrethroid and/or dimethoate reduced beet armyworms by 50%, numbers of beet armyworms from other treatments were similar to the untreated check. Highest numbers of beet armyworms were noted for the mite growth regulator treatments.

Literature Cited

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Table 1. Numbers of two spotted spider mites/alfalfa stem three days after treatment on May 17, 2002 (western flower thrips present and feeding on mites).

		Numbers of spider mite life stage per stem			
Treatment	Rate/acre	Eggs	Immatures	Adults	Total Motile
Treatments registered for usage on alfalfa hay as of April 1, 2003					
Dimethoate 400	1 pt	14.27abc	2.76abc	4.10 b--g	6.86 b--h
Lorsban 4E	1 qt	18.56abc	2.69abc	5.84 fg	8.53 d--i
Dimethoate 400 + Lorsban 4E	1 pt 1 pt	12.87abc	1.70abc	1.71abcd	3.41a--e
Dimethoate 400 + Lorsban 4E + Hyperactive	1 pt 1 pt 3 pts	18.86abc	3.40 bcde	2.27a--f	5.67a--h
Trilogy	1 qt	14.73abc	6.97 e	5.91 fg	12.87 i
Treatments not registered for usage on alfalfa hay as of April 1, 2003					
Acramite 50WS	1 lb	25.53 c	4.43 bcde	4.35 c-g	8.78 e--i
Capture 2 EC	6.4 oz	18.87abc	0.89ab	0.30a	1.19ab
Capture 2 + Dimethoate 400	6.4 oz 1 pt	7.97a	0.00a	0.23a	0.23a
Danitol 2.4 EC	14 oz	15.99abc	1.22ab	1.13abc	2.34abc
Danitol 2.4 EC	21 oz	8.63ab	1.90abc	1.93a--e	3.83a--f
Dimethoate 400 + F-0570 0.8 EW	1 pt 40 oz	18.04abc	1.86abc	0.47ab	2.33abc
Gowan 1528	8 oz	13.37abc	2.13abc	1.39abc	3.52a--e
Gowan 1549	16 oz	14.82abc	2.01abc	1.58abc	3.59a--e
Gowan 1528 + Gowan 1549	6 oz 12 oz	12.20abc	0.97ab	0.73abc	1.70ab
Microthiol Disperss	15 lbs	23.00abc	6.68 de	4.36 c--g	11.03 ghi
Musol X-16 fertilizer	1 qt	14.58abc	3.33abcd	3.00a--f	6.33 b--h
V-1283 72WDG	0.041 lbs	11.58abc	1.72abc	0.81abc	2.53abc
V-1283 72WDG	0.0625 lbs	24.89 bc	2.13abc	5.64 efg	7.77 c--i
Zephyr 0.15EC	2 oz*	11.71abc	4.19 bcde	5.41 d-g	9.6 f-i
Zephyr 0.15EC	3 oz	43.14 d	4.79 cde	7.14 g	11.94 hi
Zephyr 0.15EC	4 oz	11.13abc	3.13abc	1.79abcd	4.92a--f
Zephyr 0.15EC + Trilogy	2 oz 1 qt	19.76abc	3.56 bcde	2.83a--f	6.38 b--h
Untreated Check	------	11.63abc	2.11abc	0.66abc	2.76a--d

Means in columns followed by the same letter are not statistically different at the p<0.05 level (Fishers LSD test)

**This treatment had difficulty with application. Only about half of material was applied, rate was therefore closer to 1 oz/acre*

Table 2. Number of two spotted spider mites/alfalfa stem 11 days after treatment on May 17, 2002, (western flower thrips present and feeding on mites).

Treatment	Rate/acre	Numbers of spider mite life stage per stem			
		Eggs	Immatures	Adults	Total Motile
Treatments registered for usage on alfalfa hay as of April 1, 2003					
Dimethoate 400	1 pt	3.37 def	0.20ab	0.47a	0.67ab
Lorsban 4E	1 qt	5.50 b-f	0.00a	0.60ab	0.60a
Dimethoate 400 + Lorsban 4E	1 pt 1 pt	2.30 def	0.07a	0.47a	0.53ab
Dimethoate 400 + Lorsban 4E + Hyperactive	1 pt 1 pt 3 pts	1.73 def	0.37abc	0.87ab	1.23ab
Trilogy	1 qt	3.87 c-f	0.20ab	0.37a	0.57ab
Treatments not registered for usage on alfalfa hay as of April 1, 2003					
Acramite 50WS	1 lb	11.93a	0.23ab	1.10ab	1.33abc
Capture 2 EC	6.4 oz	1.30 def	0.50abc	0.37a	0.87ab
Capture 2 + Dimethoate 400	6.4 oz 1 pt	1.30 def	0.23ab	0.27a	0.50ab
Danitol 2.4 EC	14 oz	1.67 def	0.37abc	0.67ab	1.03ab
Danitol 2.4 EC	21 oz	0.53 ef	0.40abc	0.07a	0.47ab
Dimethoate 400 + F-0570 0.8 EW	1 pt 40 oz	0.80 def	0.00a	0.03a	0.03a
Gowan 1528	8 oz	6.60a-e	0.37abc	1.07ab	1.43abc
Gowan 1549	16 oz	0.13 f	0.00a	0.10a	0.10a
Gowan 1528 + Gowan 1549	6 oz 12 oz	0.47 ef	0.00a	0.00a	0.00a
Microthiol Disperss	15 lbs	9.97abc	0.07a	1.13ab	1.20ab
Musol X-16 fertilizer	1 qt	6.03a-f	0.17a	0.60ab	0.76ab
V-1283 72WDG	0.041 lbs	4.73 b-f	0.133a	0.33a	0.47ab
V-1283 72WDG	0.0625 lbs	6.80a-d	0.50abc	0.90ab	1.40abc
Zephyr 0.15EC	2 oz*	11.77a	1.40 c	1.80 b	3.20 c
Zephyr 0.15EC	3 oz	1.07 def	0.13a	0.10a	0.23a
Zephyr 0.15EC	4 oz	3.47 def	0.07a	1.10ab	1.17ab
Zephyr 0.15EC + Trilogy	2 oz 1 qt	2.73 def	0.33ab	0.03a	0.37ab
Untreated Check	------	10.37ab	1.23 bc	1.00ab	2.23 bc

Means in columns followed by the same letter are not statistically different at the $p<0.05$ level (Fishers LSD test)

**This treatment had difficulty with application. Only about half of material was applied, rate was therefore closer to 1 oz/acre*

Table 3. Number of twospotted spider mites/alfalfa stem 7 days after treatment on July 15, 2002 (thrips absent).

		Numbers of spider mite life stage per alfalfa stem			
Treatment	Rate/acre	Eggs	Immatures	Adults	Total Motile
Treatments registered for usage on alfalfa hay as of April 1, 2003					
Dimethoate 400 + Lorsban 4E	1 pt 1 pt	6.625ab	3.075a	0.60ab	3.675ab
Dimethoate 400	1 pt	20.45abc	6.30ab	0.775ab	7.075abc
Dimethoate 400 + Mustang 1.5 EW	1 pt 4.3 oz	14.70ab	4.15a	1.45 abc	5.60 ab
Treatments not registered for usage on alfalfa hay as of April 1, 2003					
Acramite 50WS	1 lb	14.825ab	11.15 b	3.575 cd	14.725 cd
Capture 2EC + Dimethoate 400	6.4 oz 1 pt	0.975a	0.05a	0.00 a	0.05a
Danitol 2.4 EC	14 oz	1.425a	0.25a	0.175ab	0.425a
Danitol 2.4 EC	21 oz	1.20a	0.125a	0.075ab	0.20 a
Dimethoate 400 + Danitol 2.4 EC	1 pt 14 oz	3.025a	1.675a	0.275ab	1.95ab
Gowan 1528	8 oz	36.275 cd	0.825a	0.375ab	1.20 ab
Gowan 1549	16 oz	0.85a	0.25a	0.225ab	0.475a
Gowan 1528 + Gowan 1549	6 oz 12 oz	1.90a	0.35a	0.10 ab	0.45 a
Microthiol Disperss	15 lbs	12.85ab	6.30ab	2.85 bc	9.15 bc
V-1283 72WDG	0.041lbs	35.05 cd	0.675a	0.35ab	1.025a
V-1283 72 WDG	0.0625 lbs	26.05 cd	0.875a	0.475ab	1.35 ab
Zephyr 0.15 EC + Trilogy	2 oz 1 qt	4.235a	0.95a	0.875abc	1.825ab
Untreated Check	------	46.90 d	11.475 b	5.85 d	17.325 d

Means in columns followed by the same letter are not statistically different at the p<0.05 level (Fishers LSD test)

Table 4. Numbers of two spotted spider mites/alfalfa stem 14 days after treatment on July 15, 2002 (thrips absent).

		Numbers of spider mite life stage per stem			
Treatment	Rate/acre	Eggs	Immatures	Adults	Total Motile
Treatments registered for usage on alfalfa hay as of April 1, 2003					
Dimethoate 400	1 pt	6.125abc	1.45 bcd	0.90ab	2.35 bc
Dimethoate 400 + Lorsban 4E	1 pt 1 pt	6.90 bc	2.525 de	1.125ab	3.65 bc
Dimethoate 400 + Mustang 1.5 EW	1 pt 4.3 oz	14.125 e	1.025abc	2.80 cd	3.825 c
Treatments not registered for usage on alfalfa hay as of April 1, 2003					
Acramite 50WS	1 lb	5.85abc	0.525abc	1.325abc	1.85 ab
Capture 2EC + Dimethoate 400	6.4 oz 1 pt	0.45a	0.00a	0.075a	0.075a
Danitol 2.4 EC	14 oz	1.825ab	0.05a	0.325a	0.375a
Danitol 2.4EC	21 oz	2.025ab	0.175ab	0.05a	0.225a
Danitol 2.4 EC + Dimethoate 400	14 oz 1 pt	0.175a	0.00a	0.025a	0.025a
Gowan 1528	8 oz	1.15ab	0.15ab	0.075a	0.225a
Gowan 1549	16 oz	0.35a	0.00a	0.00a	0.00a
Gowan 1528 + Gowan 1549	6 oz 12 oz	0.175a	0.00a	0.00a	0.00a
Microthiol Disperss	15 lbs	10.95 cd	1.775 cd	1.875 bc	3.65 bc
V-1283 72 WDG	0.041lbs	1.875ab	0.35ab	0.00a	0.35a
V-1283 72 WDG	0.0625 lbs	3.025ab	0.075a	0.15a	0.225a
Zephyr 0.15EC + Trilogy	2 oz 1 qt	0.475a	0.00a	0.075a	0.075a
Untreated Check	------	14.393 de	3.702 e	4.144 d	7.847 d

Means in columns followed by the same letter are not statistically different at the $p<0.05$ level (Fishers LSD test)

Table 5. Numbers of two spotted spider mites/alfalfa stem 21 days after treatment on July 15, 2002 (thrips absent).

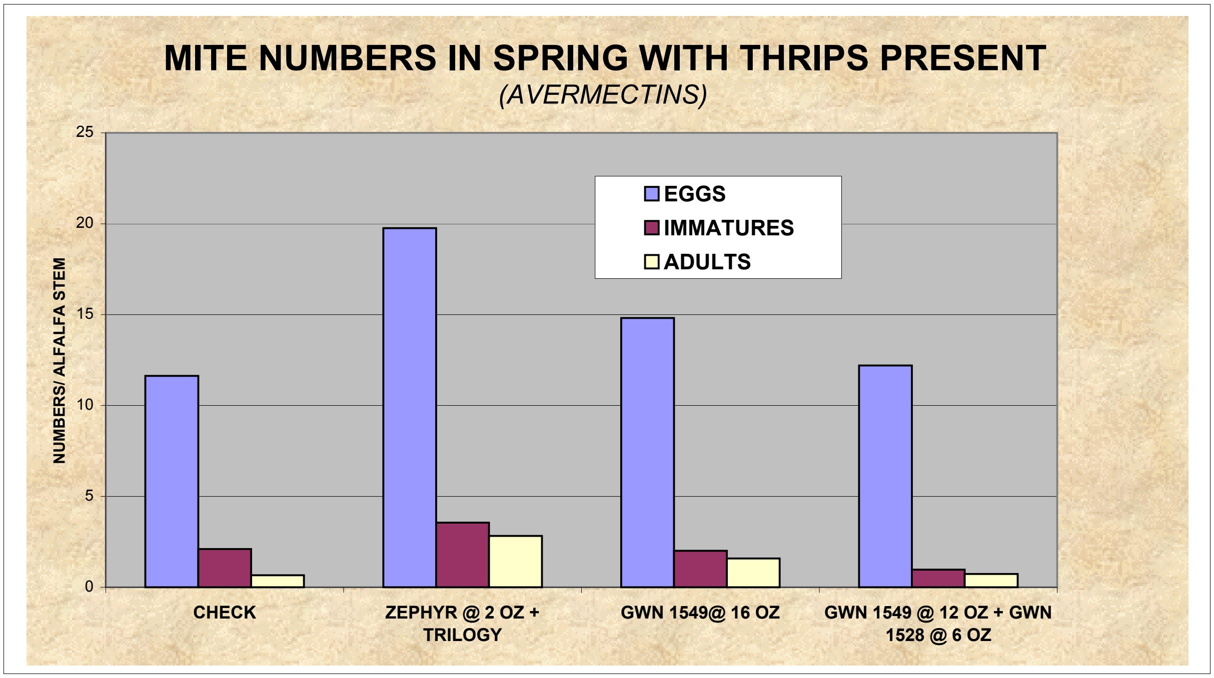
		Numbers of spider mite life stage per stem			
Treatment	Rate/acre	Eggs	Immatures	Adults	Total Motile
Treatments registered for usage on alfalfa hay as of April 1, 2003					
Dimethoate 400	1 pt	7.475 c	2.175 cde	2.100 cde	4.275 de
Dimethoate 400 + Lorsban 4E	1 pt 1 pt	2.20 ab	1.525 bc	1.450abcd	2.975 bcd
Mustang 1.5 EW + Dimethoate 400	4.3 oz 1 pt	7.875 c	2.00 cd	1.85 bcd	3.85 cd
Treatments not registered for usage on alfalfa hay as of April 1, 2003					
Acramite 50WS	1 lb	5.925 bc	3.80 f	2.525 de	6.325 ef
Capture 2 + Dimethoate	6.4 oz 1 pt	0.375a	0.025a	0.100a	0.125a
Danitol 2.4EC	14 oz	1.70 a	0.70ab	0.850abc	1.55abc
Danitol 2.4EC	21 oz	1.30 a	0.65ab	0.450ab	1.10ab
Danitol 2.4 EC + Dimethoate 400	14 oz 1 pt	0.40 a	0.475ab	0.325a	0.80ab
Gowan 1528	8 oz	0.50 a	0.30a	0.225a	0.525a
Gowan 1549	16 oz	1.825a	0.70ab	0.475ab	1.175ab
Gowan 1528 + Gowan 1549	6 oz 12 oz	0.175a	0.125a	0.075a	0.20a
Microthiol Disperss	15 lbs	3.275ab	2.775 def	3.50 ef	6.275 ef
V-1283 72WDG	0.041 lbs	1.275a	0.175a	0.075a	0.25a
V-1283 72WDG	0.0625 lbs	1.475a	0.025a	0.075a	0.10a
Zephyr 0.15EC + Trilogy	2 oz 1 qt	0.85a	0.475ab	0.300a	0.775ab
Untreated Check	------	6.00 bc	3.325 ef	4.05 f	7.375 f

Means in columns followed by the same letter are not statistically different at the p<0.05 level (Fishers LSD test).

Table 6. Mean numbers of alfalfa caterpillars, beet armyworms, and beneficial insects two days after treatment on July 15, 2002.

		Number in 10 three foot sweeps of alfalfa		
Treatment	Rate/acre	Alfalfa Caterpillar	Beet Armyworms	Total Beneficials
Treatments registered for usage on alfalfa hay as of April 1, 2003				
Dimethoate 400	1 pt	1.00a	2.00abc	3.25ab
Dimethoate 400 + Lorsban 4E	1 pt 1 pt	0.50a	0.25a	3.25ab
Mustang 1.5 EW + Dimethoate 400	4.3 oz 1 pt	2.00a	2.00abc	1.25ab
Treatments not registered for usage on alfalfa hay as of April 1, 2003				
Acramite 50WS	1 lb	10.50 cde	3.25abcd	3.50a
Capture 2 + Dimethoate 400	6.4 oz 1 pt	1.75a	0.50ab	1.00b
Danitol 2.4 EC	14 oz	0.75a	1.00ab	2.00ab
Danitol 2.4 EC	21 oz	0.50a	1.75abc	3.00ab
Danitol 2.4 EC + Dimethoate 400	14 oz 1 pt	0.75a	1.25ab	2.00ab
Gowan 1528	8 oz	12.50 de	5.00 cd	3.50 b
Gowan 1549	16 oz	8.75 cd	3.50abcd	3.50 b
Gowan 1528 + Gowan 1549	6 oz 12 oz	11.00 de	3.00abcd	2.25ab
Microthiol Disperss	15 lbs	3.25ab	3.75abcd	2.00ab
V-1283 72WDG	0.041 lbs	13.00 e	5.75 d	2.75ab
V-1283 72WDG	0.0625 lbs	9.25 cde	4.00 bcd	2.25ab
Zephyr 0.15EC + Trilogy	2 oz 1 qt	0.25a	5.00 cd	2.75ab
Untreated Check	------	6.50 bc	4.00 bcd	1.00a

Means in columns followed by the same letter are not statistically different at the p<0.05 level (Fishers LSD test)



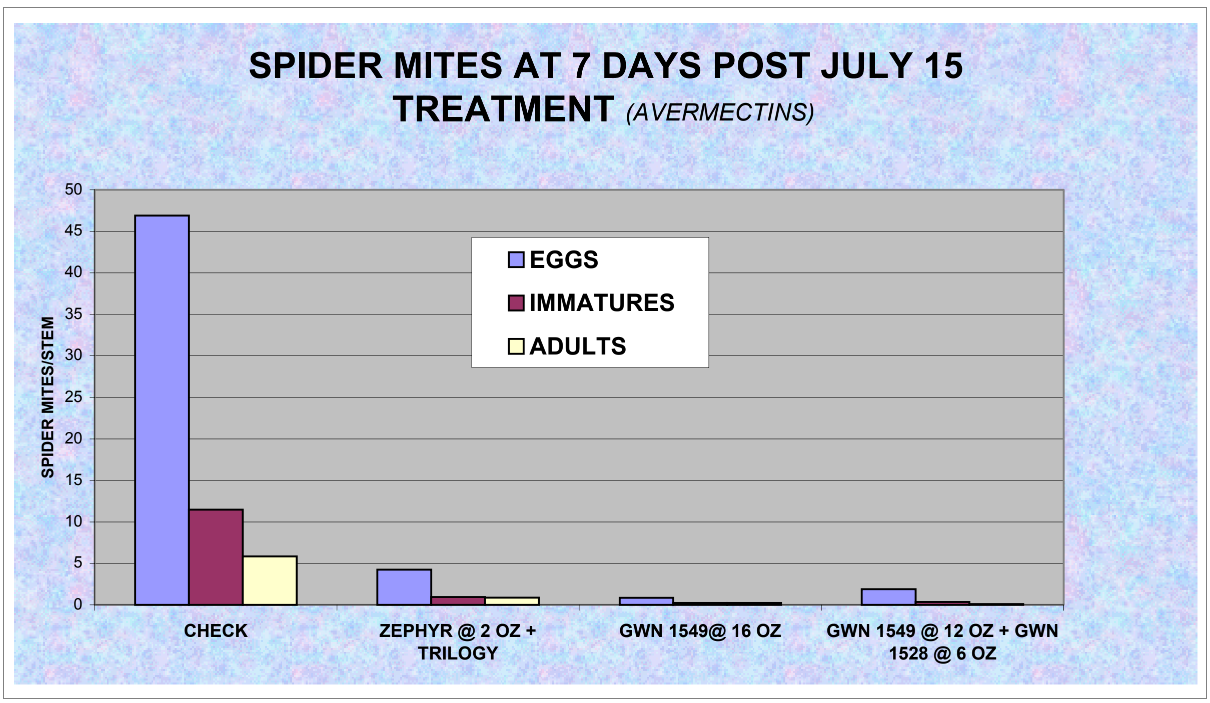
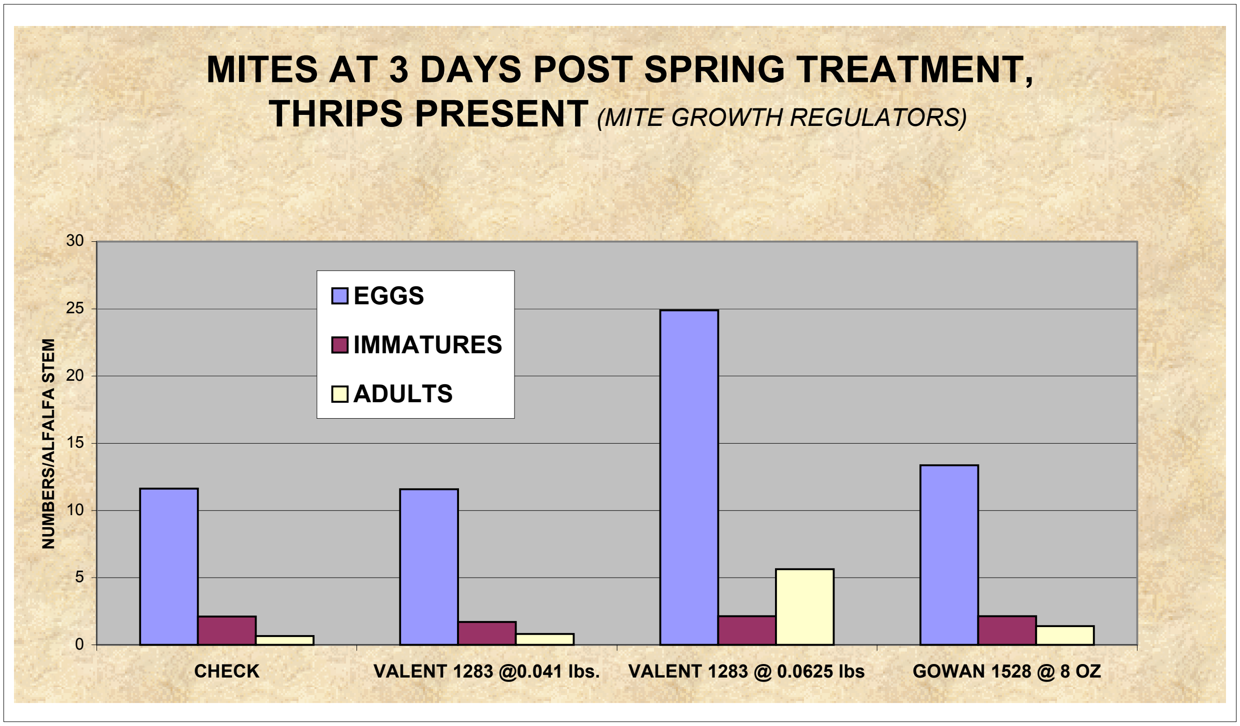


Figure 1. Spider mite life forms/alfalfa stem at first sample date after spring (top) and summer (bottom) applications of miticides containing avervmectin class active ingredient chemistries.



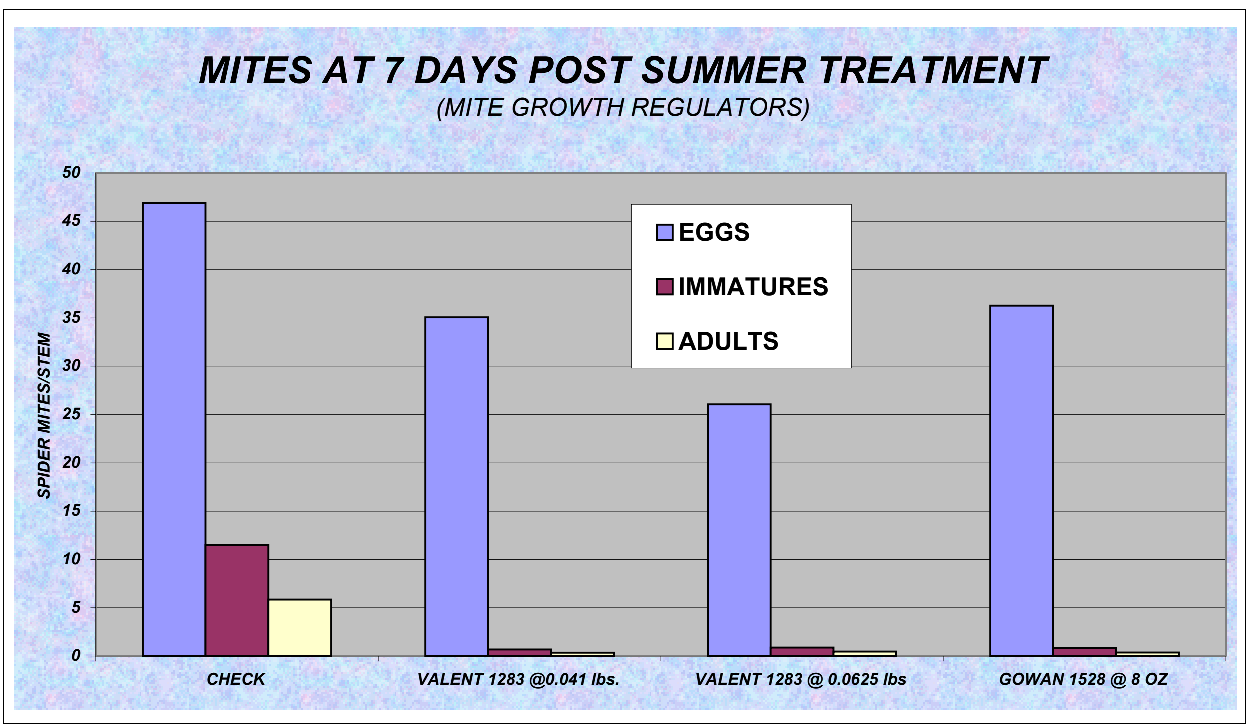
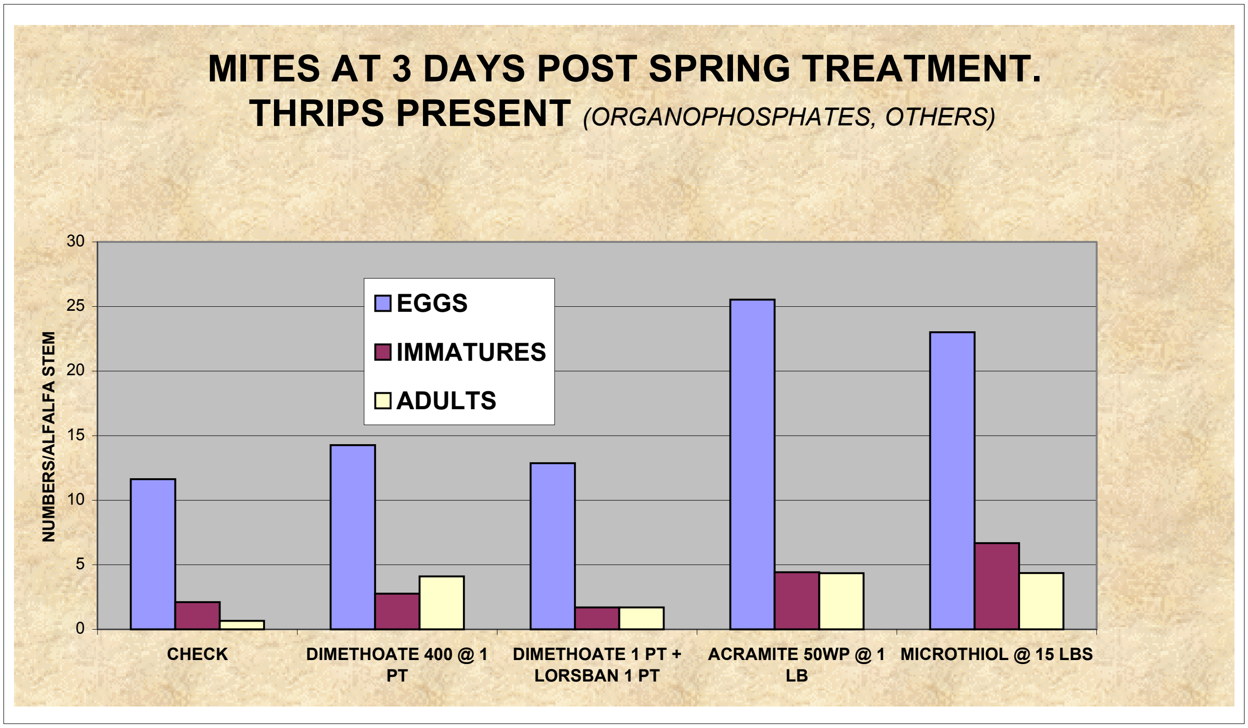


Figure 2. **Spider mite life forms/alfalfa stem at first sample date after spring (top) and summer (bottom) applications of miticides containing mite growth regulator class active ingredient chemistries.**



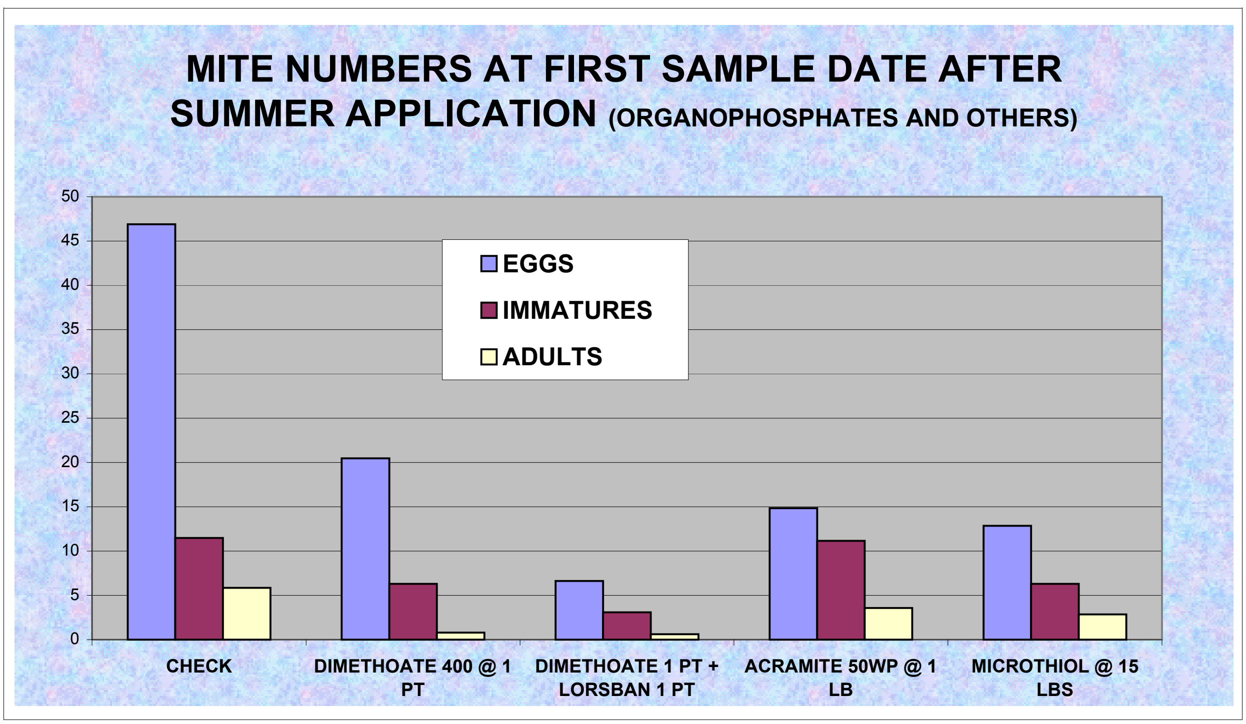
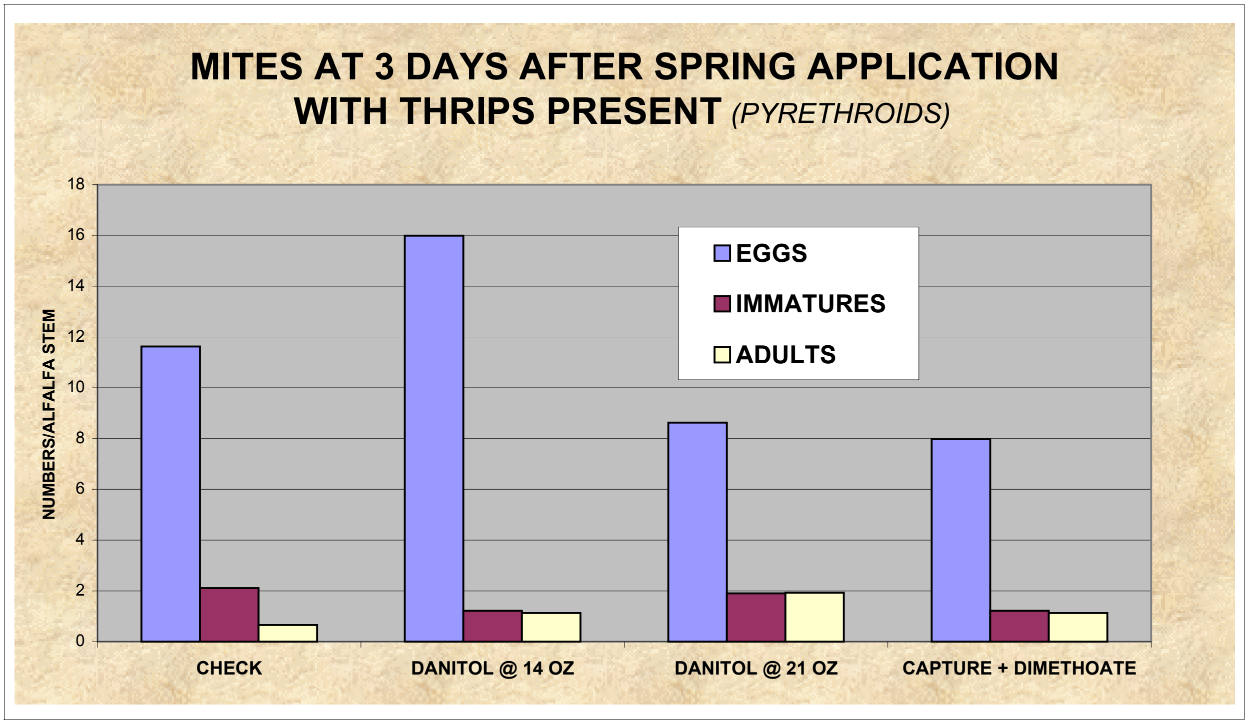


Figure 3. Spider mite life forms/alfalfa stem at first sample date after spring (top) and summer (bottom) applications of miticides containing mite growth regulator class active ingredient chemistries.



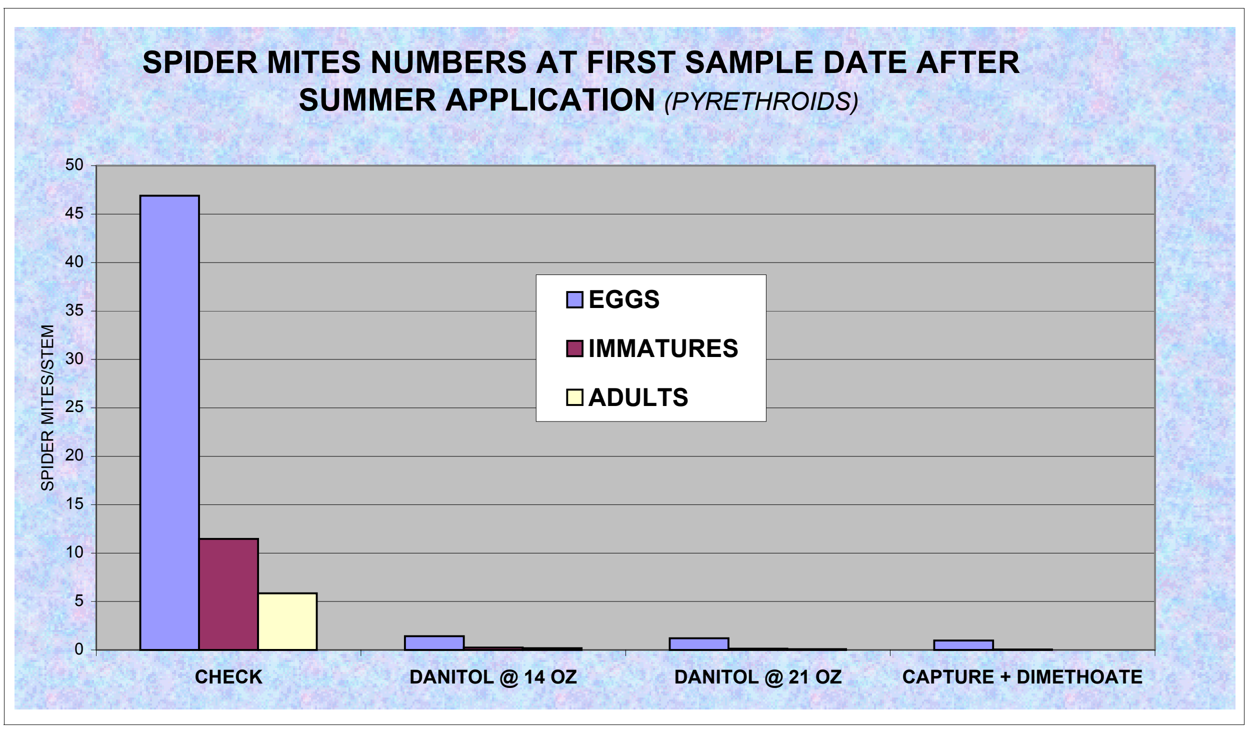


Figure 4. Spider mite life forms/alfalfa stem at first sample date after spring (top) and summer (bottom) applications of miticides containing pyrethoid class active ingredient chemistries.