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Evaluation of Banks Grass Mite and Two-Spotted Spider Mite Response to Spiromesifen Field Application and Potential Changes in Spiromesifen Tolerance

A report to the Texas Corn Producers Board

E. D. Bynum [1],G. J. Michels, Jr. [2] and J. B. Bible [2]

[1] Texas AgriLife Extension Service, [2] Texas AgriLife Research

SUMMARY

Field control of spider mites on tasseled corn, late in the season when populations are increasing is influenced by environmental conditions, susceptibility of mites to a chemical, the complex of mite species present, the chemical mode of action, and application spray coverage. The comprehensive field trials this past season showed that all miticides evaluated, including Oberon® (spiromesifen), were affected by some, if not all, of these factors. The inability of over the top applications to get the spray into the corn where mites are feeding probably had the greatest effect on mite control. For miticides like Oberon®, Zeal®, and Onager® coverage is critical because these products are not systemic within the plant and their activity is against mite eggs and the immature stages. The incidence of twospotted spider mites in the field populations could contribute to control failures, particularly if twospotted spider mites are less susceptible to the currently registered miticides. This can be important because field identification of mites are not easy and can be miss-identified.

Laboratory studies provided interesting insights into Oberon's mechanism for control spider mites infesting corn. The studies confirmed that Oberon® is not a good adulticide and control is associated with mortality of eggs. The studies provided baseline data that can be used to evaluate possible changes in twospotted spider mite susceptibility as Oberon® continues to be used by producers. The studies showed that the susceptibility of the tested mite population did not change after being treated with Oberon®. This would indicate the population was not a mixed with susceptible and resistant mites. Further studies are needed to determine if there are differences in susceptibility by Banks grass mites and twospotted spider mites.

INTRODUCTION

Four species of spider mites have been reported to infest corn in the Texas High Plains. The Banks grass mite and the twospotted spider mite are the predominate species, with Banks grass mite infestations generally occurring earlier during the growing season than twospotted spider mites. Populations of either mite species or a combination of both species can reach levels that will cause significant yield losses.

Field control of these two different spider mites is difficult because mites have developed tolerance to most of the registered products and other products which are efficacious require good spray coverage for optimum control. Oberon®, spiromesifen, is a product that has been on the market for two years. Currently, it is the only miticide which can be used effectively as a rescue treatment late in the season on tasseled corn. However, some producers and crop consultants have experienced less than satisfactory results in the short time that Oberon® has been labeled for spider mite control. Some are of the opinion that spider mites have become more tolerant to the miticide. Our studies were designed and conducted to address these concerns and to better understand those factors contributing to the efficacy of this product.

OBJECTIVES

1) Evaluate the field efficacy of Spiromesifen (Oberon®) for spider mite suppression.

2) Determine baseline toxicity data of spider mite field population to spiromesifen.

3) Evaluate possible susceptibility changes by spider mite field population following exposure to spiromesifen.

RESULTS & DISCUSSION

Objective 1. Evaluate the field efficacy of Spiromesifen (Oberon®) for spider mite suppression.

We conducted two field trials at the Texas AgriLife Research Station at Etter, TX in 2009 (Table 1). These trials were conducted in an area that had been infested with mites that were collected from a producer's field located north of Sunray, TX and from a laboratory mite colony at the Texas AgriLife Research Station at Bushland, TX. These trials were treated with a hand-carried CO_2 spray boom held over the top of tasseled corn to simulated control by aerial applications.

Dr. Pat Porter, Extension Entomologist–Lubbock, and Mr. Monti Vandiver, Extension agent –IPM for Parmer and Bailey counties, each conducted two trials with Oberon® in 2009. Dr. Porter and Mr. Vandiver have granted permission for us to include the results from their trials in this report. Mr. Vandiver conducted two trials, one near Farwell, TX and another near Muleshoe, TX (Table 1). Applications were made with a hand-carried CO_2 spray boom held over the top of tasseled corn. Dr Porter's trials were conducted near Clovis, NM and at the Texas AgriLife Research Station–Lubbock (Table 2). His treatments were applied with a hand-carried CO_2 spray boom, but the boom was held vertically within the canopy to provide optimum spray coverage.

Another trial was conducted at the Texas AgriLife Research Station at Halfway, TX (Table 3). This trial was also conducted in an area that had been infested with mites from the producer's field near Sunray, TX. Treatments were applied to corn approximately 4 ft tall and prior to tassel on June 26. Applications were made with a tractor mounted spray boom designed to simulate chemigation using Low Energy Precision Application (LEPA) drop nozzles. Three drops nozzles, one each in every other furrow of the six row plot, were positioned in the canopy at 1 ft above the soil surface. The nozzles were commercially available Quad Senniger nozzles. Nozzles were set up with a 15.5 nozzle opening, a 6 psi regulator with a manifold pressure > 10 psi., and a 360^0 splash plate that sprayed water in a 60^0 angle back up in to the canopy. Each nozzle delivered water at 4.0 gal/min for a total water volume of 2,700 gal/A.

Findings from this cooperative work help explain the field performance of Oberon® for control of spider mites in the Texas High Plains.

Table 1. Field trials using a hand-carried spray boom held over the top of tasseled corn across the Texas High Plains. 2009.

Trial and Treatments	Common Name	Rate /ac	Surfactant[a]	No. Applications
Etter Trial 1				
Oberon® 4SC	Spiromesifen	5.0 fl.oz	1% COC	1
Untreated				
Etter Trial 2				
Hero®	Zeta-cypermethrin +Bifenthrin	5.1 fl. oz	1% COC	2 at 7 day interval
Hero®	Zeta-cypermethrin +Bifenthrin	10.3 fl. oz	1% COC	1
Oberon® 4SC	Spiromesifen	4.25 fl. oz	1% COC	1
Untreated				
Muleshoe - Vandiver				
Hero®	Zeta-cypermethrin +Bifenthrin	5.1 fl. oz	1% COC	2 at 7day interval
Hero®	Zeta-cypermethrin +Bifenthrin	10.3 fl. oz	1% COC	1
Oberon® 4SC	Spiromesifen	4.0 fl. oz	1% COC	1
Oberon® 4SC	Spiromesifen	6.0 fl. oz	1% COC	1
Oberon® 4SC	Spiromesifen	8.0 fl. oz	1% COC	1
Untreated				
Farwell - Vandiver				
Zeal®	Etoxazole	1.0 fl. oz	1% COC	1
Zeal®	Etoxazole	1.5 fl. oz	1% COC	1
Zeal®	Etoxazole	2.0 fl. oz	1% COC	1
Zeal®	Etoxazole	2.5 fl. oz	1% COC	1
Zeal®	Etoxazole	3.0 fl. oz	1% COC	1
Comite II	Propargite	3.375 pt	1% COC	1
Hero® +	(Zeta-cypermethrim	10.2 fl oz +	1% COC	1

Dimate®	+Bifenthrin) + dimethoate	16 fl. oz.		
Oberon® 4SC	Spiromesifen	4.25 fl. oz	1% COC	1
Untreated				

[a] COC = Crop oil concentrate

Mite infestations on tassel stage corn at the Texas AgriLife Research Station - Etter were developing very well when both trials were initiated. In the first trial (Figure 1), Oberon® did not effectively control the mites. In the second trial (Figure 2) a light shower fell on the treated plots within an hour of the spray application and may have reduced the efficacy of Hero® and Oberon® treatments. Still the Oberon® application appeared to provide some control within the first 7 days after treatment (DAT), but the treatment did not prevent mites from substantially increasing by the 16 DAT sample. The applications of either rate of Hero® did not control mites, even when a second application of Hero® 5.1 fl oz./ac was applied after the 7 day sample date. The high densities of mites in both trials caused heavy feeding damage to corn in all of the treatments. It should be noted that twospotted spider mites were observed in both trials and may have contributed to the poor performance of the miticides.

In a similar study with Hero® and Oberon® near Muleshoe, TX (Figure 3), all Oberon® treatment rates provided effective control of mites for 18 days after treatment when compared to the untreated check and Hero® treatments. Again, a single application of Hero® at 10.2 fl. oz/ac or two applications of Hero® at 5.1 fl. oz/ac did not provide acceptable control of the mite population. Also, none of the Oberon® treatments had feeding damage above 15% which was 25% lower than the untreated check at 40% plant damage. There was no evidence of twospotted spider mite presence in this trial.

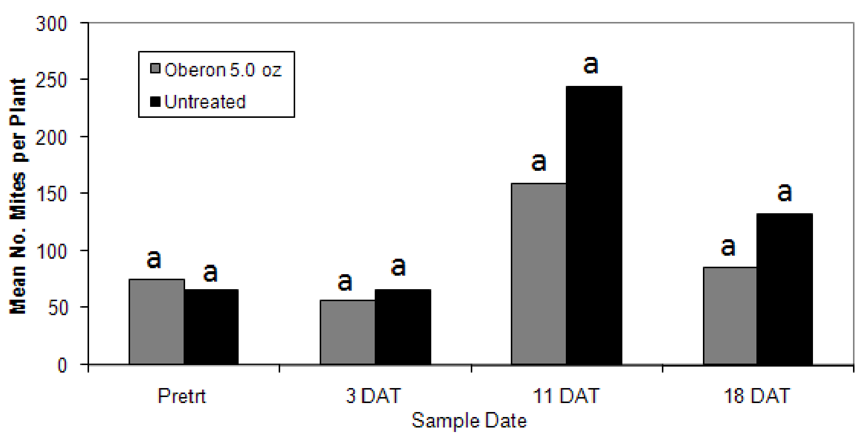

Figure 1. Field control of spider mites for Etter Trial 1. 2009.

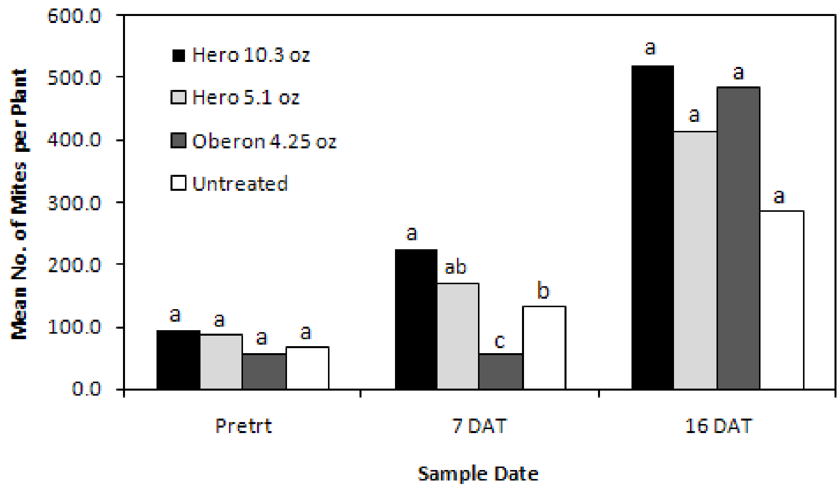

Figure 2. Field control of spider mites for Etter Trial 2. 2009.

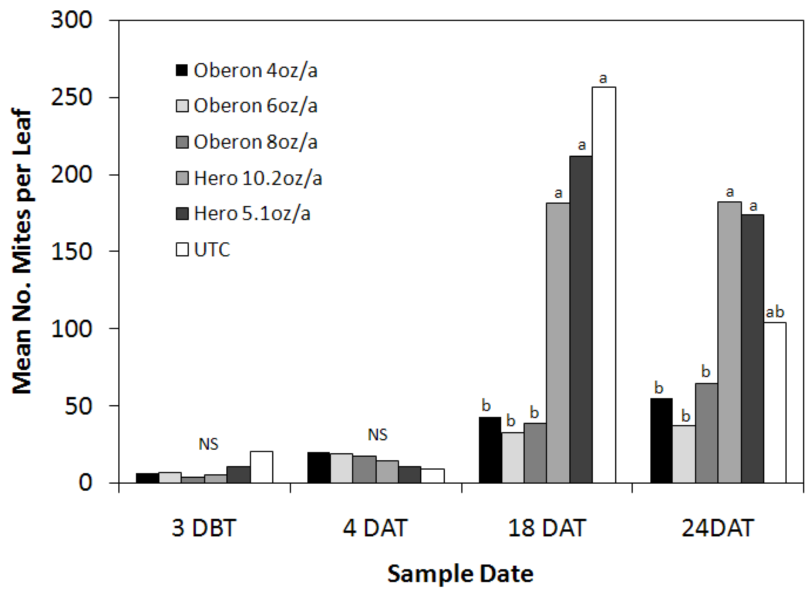

Figure 3. Field control of mites at Muleshoe, TX 2009

At the Farwell, TX, study (figure 4) mite densities were starting to develop at the beginning of the experiment, but populations remained low in all treatments and the untreated check for 14 DAT which resulted in no significance differences among treatments. By 22 DAT there was an increase in mite densities in the Oberon® and Hero® + Dimate® treatments. The only treatment that had statistically more mites than the untreated check at 22 DAT was Hero® + Dimate®. Then by 28 DAT, Hero® + Dimate® continued to have statistically more mites than the other treatments. A possible explanation is that the Hero® + Dimate® treatment was harsher on the natural predators than the other treatments which allowed mites to increase. Three other rates of Zeal® (1.0 oz/a, 1.5 oz/a, and 3.0 oz/a) were applied but none these treatments performed any differently than the 2.0 oz/a rate of Zeal®. The overall low densities of mites did not cause much damage to the corn by 28 DAT. The untreated check, Zeal®, Comite, and Oberon® treatments had from 5% to 10% plant damage from mite feeding and damage in the Hero® + Dimate® treatment was statistically higher at 26%.

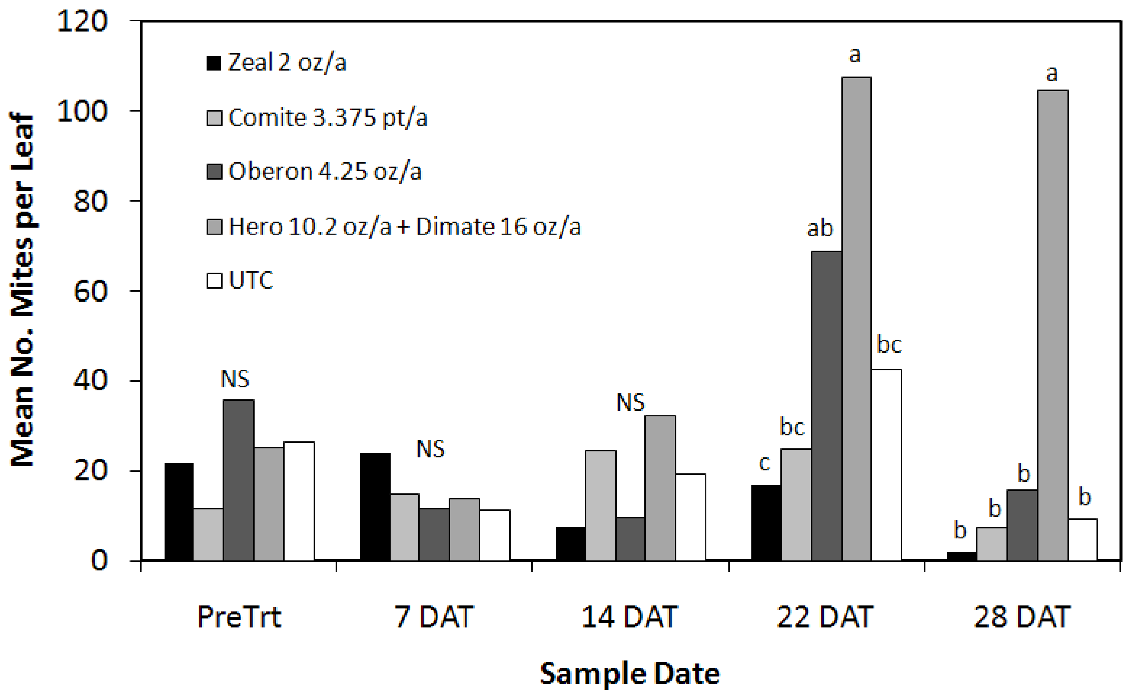

Figure 4. Field control of mites at Farwell, TX. 2009

The results from the trials at Clovis, NM and Lubbock, TX indicated improving coverage in the tasseled corn canopy also improved the performance of the miticide application. The control of mites at Clovis, NM was very good in 2007 and 2009 with all miticides (Oberon®, Hero®, and Hero® + Dimethoate) for 15 DAT (Figure 5). The level of control seemed to break down by 24 DAT but mite densities were still significantly lower than the untreated check.

Again, in field test at Lubbock, TX the number of mites at 16 DAT was significantly lower in all treatments other than the untreated check (Figure 6). In this trial, Oberon®, Onager®, Hero®, and the unidentified experimental miticides provided very good control of the mite population.

Table 2. Field trials using a hand-carried spray boom held vertical within the canopy of tasseled corn at Clovis, NM and Lubbock, TX. 2007 and 2009.

Trial and Treatments	Common Name	Rate /ac	Surfactant	No. Applications
Clovis - Porter				
Hero®- YR 2009	Zeta-cypermethrim +Bifenthrin	10.3 fl. oz		1
Hero®– YR 2007	Zeta-cypermethrim +Bifenthrin	10.3 fl. oz		1
Hero® + Dimate® – YR 2007	(Zeta-cypermethrim +Bifenthrin) + dimethoate	10.2 fl oz + 0.5 pt		1
Oberon® 4SC – YR 2009	Spiromesifen	4.25 fl. oz		1
Untreated				
Lubbock 2009 - Porter				
Onager®	Hexythiazox	10 fl.oz		1
Onager®	Hexythiazox	12 fl.oz		1
Hero®	Zeta-cypermethrim +Bifenthrin	10.4 fl. oz		1
Oberon® 4SC	Spiromesifen	4.25 fl. oz		1
Untreated				

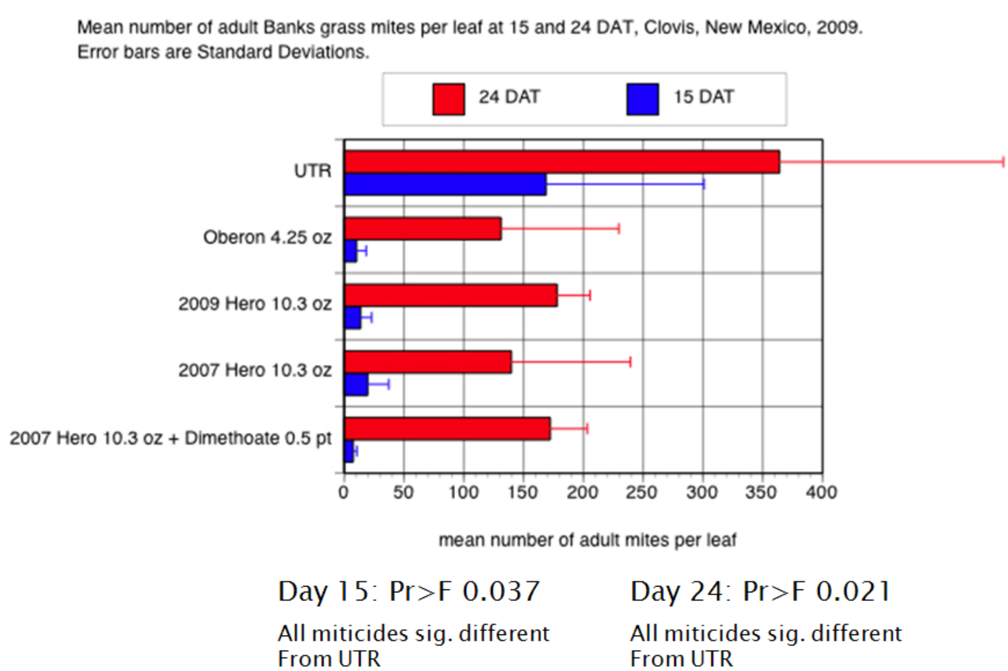

Figure 5. Field control of mites at 15 and 24 days after treatment at Clovis, NM. 2007 and 2009.

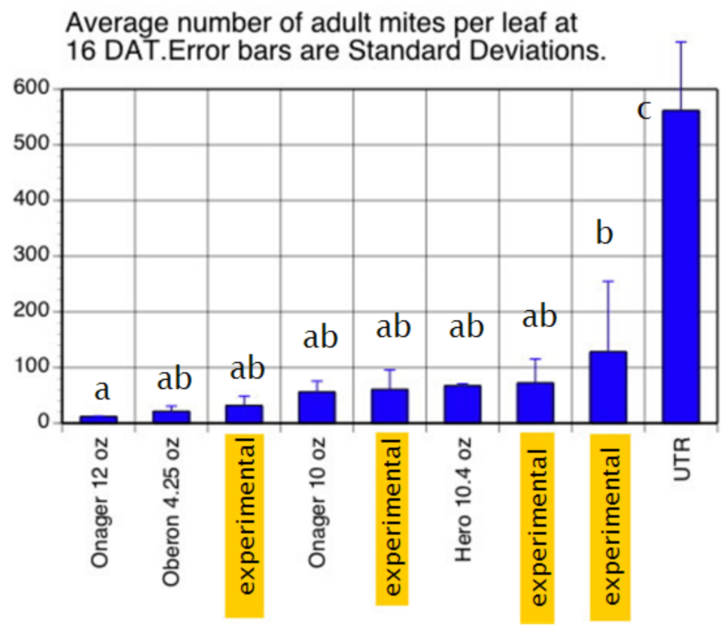

Figure 6. Field control of mites at 16 days after treatment at Lubbock. 2009.

Studies with pivot irrigation systems (chemigation) in the 1980's with other chemical chemistries were shown to be an effective method for applying miticides and in obtaining effective mite control. Chemigation, where nozzles are positioned ca. 1 ft off of the soil surface and the spray is projected back up into canopy, provided very good distribution and improved concentrations of chemicals within the corn. However, this application method has not been evaluated for mite control with products such as Oberon® and Onager®.

Mite infestations in this research were started from mites collected from a field near Sunray, Texas. Plants in the 3rd row of the plot were infested with mites June 12 by weaving 20 mite-infested leaves end to end on the lower 1/3 of the plant. Mite densities were allowed to increase naturally for 14 days before applying the treatments. Predator numbers also increased with the mite populations. Predatory thrips, spiders, orius nymphs, predatory mites, lady beetle larvae, Scymnus beetle larvae, lacewing larvae, and big-eyed bug adults comprised the predator complex throughout the testing dates. Predatory thrips and spiders were the most numerous. Predatory thrips comprised 67%, 78%, and 86% of the total number of predators at the pretreatment, 6 DAT, and 13 DAT sample dates, respectively. The percentage of spiders to the total predator numbers were 27%, 10%, and 3%, respectively, at the three sample dates. These predator numbers were not adversely affected by the miticide treatments.

Mite populations never became well established or increased very quickly (Figure 7 and Figure 8). This was probably associated with reduced mite development from cool conditions and from predators suppressing population growth of the establishing low mite numbers. The effect of these factors was evident by the 13 DAT sample when mite numbers in the untreated check plots had declined (Figure 7). There was some evidence at the 13 DAT sample (figure 8) that all of the Onager® treatments were reducing mite numbers. All three rates of Onager® had statistically fewer female, immature, and, subsequently, total number of mites than the non-treated. The lowest rate of Onager®, that was actually applied, was much lower than the recommended test rate, but control was still no different from the two higher rates. This is similar to previous chemigation studies with other miticides, in that chemical rates could be reduced if applications were made through drop nozzles positioned near the soil surface and the spray was directed up into the canopy. This improved activity has been related to improved distribution and concentration of chemical within the corn canopy.

Table 3. Field trials using a chemigation simulator. Halfway, TX. 2009.

Trial and Treatments	Common Name	Label Rate /ac	Rate / ac Injected	Surfactant[a] Rate / ac	No. Applications
Oberon® 4SC	Spiromesifen	5.0 fl.oz	3.9 fl. oz	1 qt COC	1
Onager®	Hexythiazox	8.0 fl.oz	6.6 fl. oz	1 qt COC	1
Onager®	Hexythiazox	10.0 fl.oz	9.5 fl. oz	1 qt COC	1
Onager®	Hexythiazox	12.0 fl.oz	13.5 fl. oz	1 qt COC	1
Untreated					

[a] COC = Crop oil concentrate

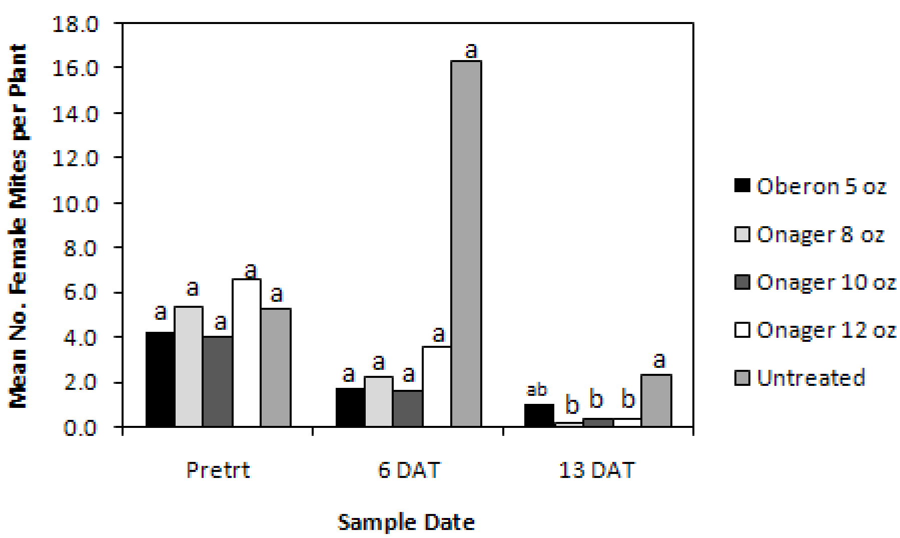

Figure 7. Field control of mites with a chemigation simulator at Halfway, TX. 2009.

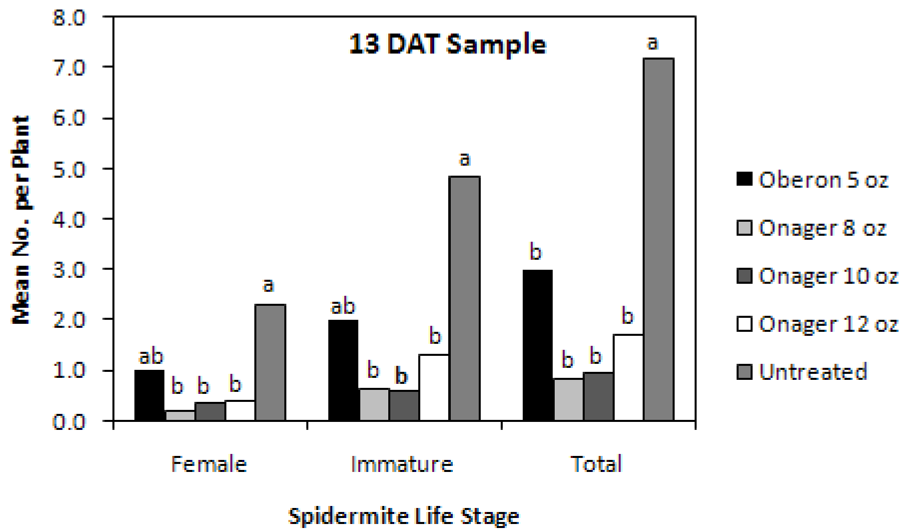

Figure 8. Field control of different mite stages at 13 day after treatment when chemigated at Halfway, TX. 2009.

The efficacy of any miticide, including Oberon®, when applied as a rescue treatment for mite infestations on tasseled corn is influenced by spray coverage within the corn canopy. This was shown by the contrasting performance of Oberon®, Hero®, and Onager® when these products were applied with a spray boom held vertically in the corn and when applied through a chemigation system. Another factor that may contribute to field efficacy is the mite species being treated. A field having twospotted spider mites or a combination of twospotted spider mites and Banks grass mites may be less susceptible than a population of Banks grass mites alone. These results illustrate the need for continued research to screen newer miticides when they become available and to evaluate methods to optimize the efficacy of currently registered miticides.

Objective 2. Determine baseline toxicity data of spider mite field populations to spiromesifen.

Objective 3. Evaluate possible susceptibility changes by spider mite field population following exposure to spiromesifen.

Laboratory studies were conducted to address objectives 2 and 3. Since Oberon® is a relatively new product, documenting the baseline toxicity and possible changes following an exposure of mites to Oberon® will provide a means for determining if there are shifts in population susceptibility.

The laboratory studies were conducted with mites collected for a field at the

Texas AgriLife Research Station at Etter, TX after plants had been infested with mites from a laboratory colony and from a field near Sunray, TX. These mites were the same as mites in the two Etter field tests. Mites were colonized in a greenhouse at the Texas AgriLife Research Station – Bushland and maintained until the laboratory studies were conducted. Prior to the tests, mites were identified as twospotted spider mites rather than Banks grass mites, using the empodium claw as a way to distinguish between species. Two laboratory mite colonies were maintained for testing with Oberon®. One mite colony was not exposed to Oberon® until being tested in the lab (Non-Sprayed Colony). The other mite colony was sprayed one week before the lab tests with Oberon® at a field rate of 2.5 fl. oz/A (Sprayed Colony). A leaf dip technique was utilized to determine the mortality response of female mites at 96 hrs after exposure to increasing concentrations of Oberon®. The mortality response of mites not previously exposed to Oberon® (Non-Sprayed colony) was compared to mites exposed to Oberon® (Sprayed colony) for 1 week before testing. Also, mite fecundity (egg lay per female) and number of collapsed eggs were recorded for each trial. Results presented are for summaries of three trials for each of the non-sprayed mites and sprayed mites.

Female mortality between sprayed or non-sprayed colonies did not increase with increases in Oberon® concentrations (Figure 9). However, the number of eggs collapsing did respond to increasing concentrations (Figure 10). The effect of Oberon® to cause eggs to collapse was not detectable at concentrations below 0.003 ml/mg. Female mites from the non-sprayed colony had a higher percentage of eggs collapsing than the sprayed colony female mite eggs at the 1 and 3 ml/mg concentrations. But, the slope of the linear relationship for both colonies was very similar, indicating there would be no major differences in the field for eggs laid from mites sprayed or non-sprayed. The number of eggs laid per female varied from concentration to concentration, but fewer eggs laid by females from the sprayed colony could not be associated with increasing Oberon® concentrations (Figure 11).

The laboratory studies provide insights into how Oberon® is controlling mites in the field. The mode of action by Oberon® is by inhibition of lipid synthesis which primarily affects the egg and immature stages of the mites. This was evident by Oberon's inability to kill female mites or affect oviposition, but causing eggs to collapse. Therefore, as mites are exposed to treated leaf surfaces, mite populations decline over time by mortality of the eggs and immatures. Since, Oberon® is not a systemic miticide the effectiveness of a treatment is dependent on spray coverage within the corn canopy and the concentration of the spray droplets to which mites are exposed.

Since the laboratory colony was started with twospotted spider mites, further laboratory trials are needed to determine if Banks grass mites respond similarly to Oberon®.

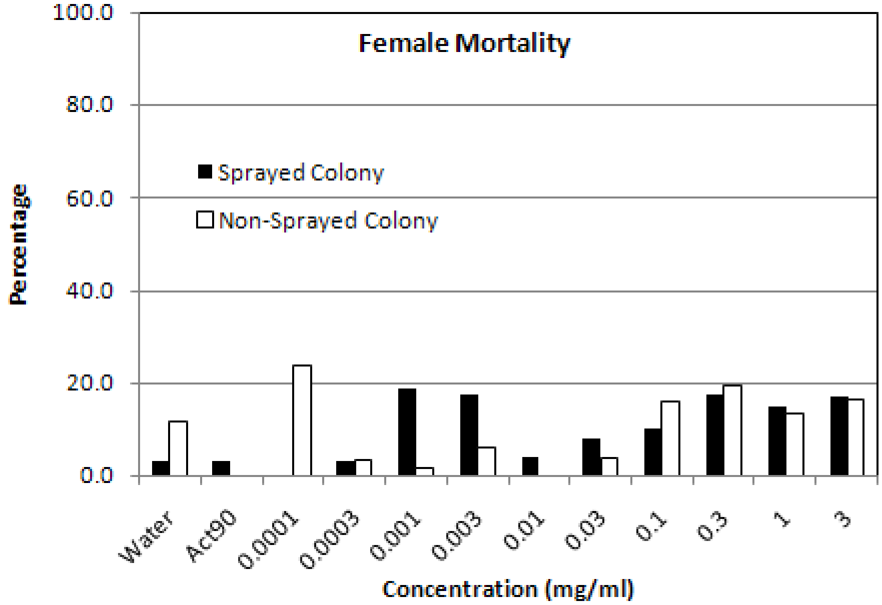

Figure 9. Dose response of female mortality to Oberon® for mites assayed from colonies sprayed and non-sprayed with a field rate (2.5 fl. oz/A) of Oberon®.

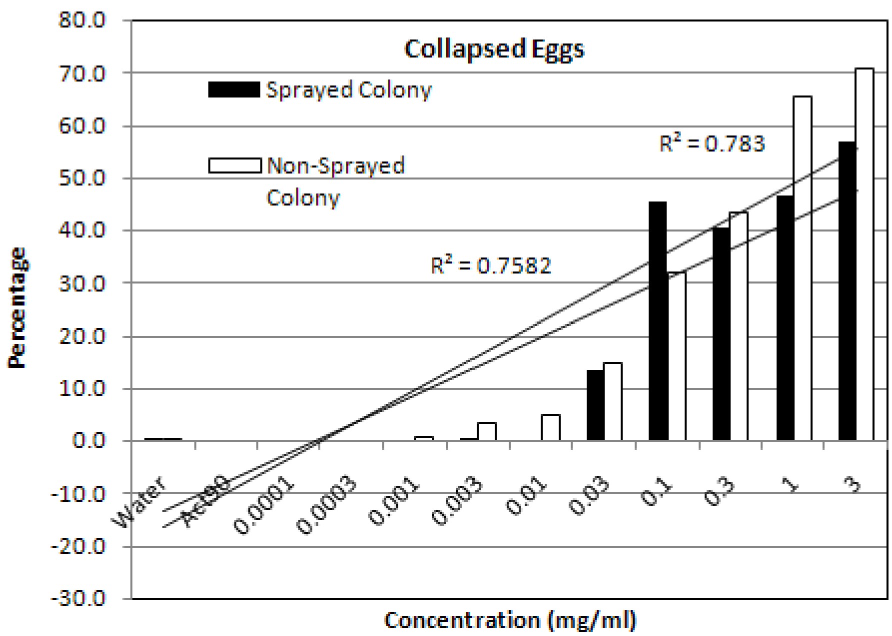

Figure 10. Dose response of mite eggs to Oberon® from colonies sprayed and non-sprayed with a field rate (2.5 fl. oz/A) of Oberon®

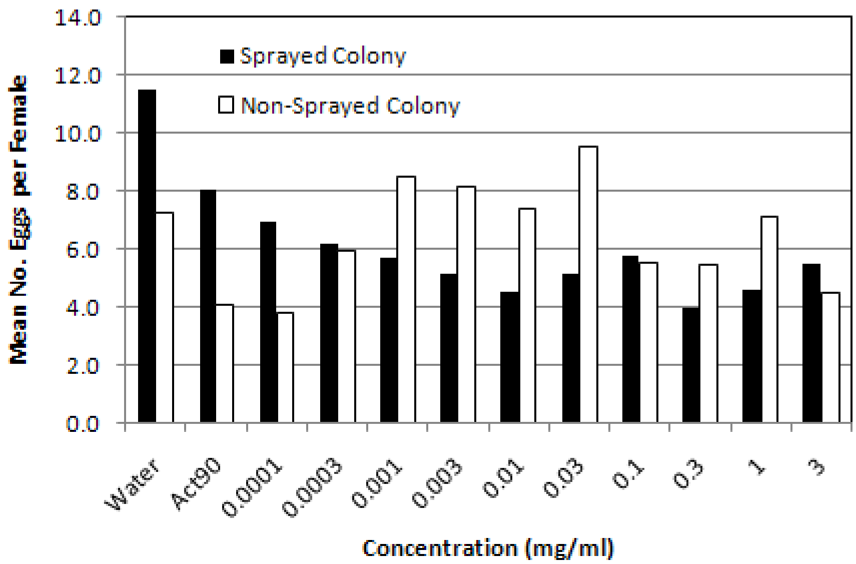

Figure 11. Dose response of female egg lay to Oberon® for mites from colonies sprayed and non-sprayed with a field rate (2.5 fl. oz/A) of Oberon®.

ACKNOWLEDGEMENTS

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Also, thanks are extended to Gowan, Inc.for providing financial support and insecticide products for the chemigation simulated trial conducted at the Texas AgriLife Research Station-Halfway.

Trade names of commercial products used in this report are included only for better understanding and clarity. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Texas A&M University System is implied. Readers should realize that results from one experiment do not represent conclusive evidence that the same response would occur where conditions vary.