Miticide Efficacy Research Summary
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Introduction
Spider mites can be a serious problem in alfalfa seed fields. They feed on the underside of leaves and spin a fine webbing over the stems, leaves, and flowers. Webbing interferes with pollination, reducing yields, or if heavily infested, may kill the plant. In the spring, spider mites start colonizing at the bottom of the plant. As the season progresses, mite populations increase and the mites work their way up the plant. Damage caused by spider mites worsens in hot weather. Populations can explode in mid-summer, resulting in webbing and early dry down of the field. The most common spider mites in Central San Joaquin Valley seed alfalfa fields are Pacific, Two-Spotted, and Strawberry spider mites.

Objectives
The objectives of the trials conducted in 1996 - 1998 were to determine the efficacy of several miticides for controlling spider mite populations, while generating sufficient data to support efforts to register new miticides for use on alfalfa seed in California. Pesticide resistance to any chemical is caused by multiple applications to a single field within a season, and/or use of the same material in neighboring fields throughout the season. A well-constructed spider mite control strategy, utilizing miticide rotations, is an essential element in a pesticide resistance management program. It is evident that new miticide registrations will help prevent proliferation of spider mites in the alfalfa seed crop.

Materials and Methods
All treatments in the trials were compared with the standard, Comite®, and an untreated control. Materials evaluated were Zephyr®, Alert®, Savey®, and Ovasyn®. Zephyr and Alert, like Comite, are adulticides. Zephyr was registered on seed alfalfa following trials conducted in 1996, and has been a very effective control agent. Alert belongs to a new class of compounds known as pyrroles. It acts by blocking the cell’s energy production causing the larvae to become sluggish, turn brown, and eventually die. In addition to spider mites, Alert controls armyworms. Savey is active on eggs and larval mites of major tetranychid mite species. In addition, with Savey, females that come in contact with the miticide lay non-viable eggs. We tested a tank mix of Savey and Comite in hopes of extending the length of control by knocking down the adults with Comite and reducing the next generation by killing the eggs and larvae with Savey. Ovasyn was tested in one location in 1997 and 1998. It is an insecticide/miticide/ovicide currently registered for use on cotton.

Trials were conducted under Research Authorizations that limited the total area treated with unregistered materials to less than 10 acres. Each year, one trial was conducted in Kings County and treatments were applied by air. The second trial was conducted in Fresno County using ground application equipment. Treatments were arranged in a randomized complete block design with two replications of each treatment.

Sampling protocol: Fifty trifoliolates were randomly collected from each plot. Leaves were collected from the top, middle, and bottom of the canopy. Using magnification, we counted the number of motiles per trifoliate and calculated the average number of motile spider mites per leaf. Samples were also collected for identification. All spider mites in 1997 were Pacific spider mite (Tetranychus pacificus). In 1996 and 1998, both Pacific and Two-spotted spider mites (Tetranychus urticae) were present.
### TRIAL SPECIFICATIONS

#### 1996

<table>
<thead>
<tr>
<th>Locations</th>
<th>Plot Size</th>
<th>Application Date/Method</th>
<th>Treatments and Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boswell Ranch</td>
<td>180' x 300' (1.2 A/plot)</td>
<td>6/17/96 air</td>
<td>Untreated Control&lt;br&gt;Comite - 2 pints&lt;br&gt;Zephyr 0.15 EC - 16 oz.&lt;br&gt;Alert 2 SC - 13 oz.&lt;br&gt;Savey 50 WP - 4 oz.&lt;br&gt;Savey 50 WP + Comite - 3 oz. + 2 pints</td>
</tr>
<tr>
<td>Yribarren Ranch</td>
<td>60' x 1200' (1.7 A/plot)</td>
<td>7/16/96 ground</td>
<td>Untreated Control&lt;br&gt;Comite - 3 pints&lt;br&gt;Zephyr 0.15 EC - 16 oz.&lt;br&gt;Alert 2 SC - 13 oz.&lt;br&gt;Savey 50 WP - 4 oz.&lt;br&gt;Savey 50 WP + Comite - 3 oz. + 2 pints</td>
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Notes: *Boswell*: Materials were applied by air (10 gallon ride with 1 qt./100 RNA spreader/binder). *Yribarren*: Materials were applied in 30 gallon water with R-56 spreader at 2 pints/100, 5 mph, 40 psi, T-jet 80 series flat fan nozzles.

#### 1997

<table>
<thead>
<tr>
<th>Locations</th>
<th>Plot Size</th>
<th>Application Date/Method</th>
<th>Treatments and Rates</th>
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</thead>
<tbody>
<tr>
<td>Boswell Ranch</td>
<td>200' x 325' (1.5 A/plot)</td>
<td>6/30/97 air</td>
<td>Untreated Control&lt;br&gt;Comite - 3 pints&lt;br&gt;Zephyr 0.15 EC - 16 oz.&lt;br&gt;Zephyr 0.15 EC - 8 oz.&lt;br&gt;Alert 2 SC - 10 oz.&lt;br&gt;Savey 50 WP + Comite - 3 oz. + 2 pints</td>
</tr>
<tr>
<td>Motte Ranch</td>
<td>30' X 1225.3' (0.84 A/plot)</td>
<td>6/12/97 ground</td>
<td>Untreated Control&lt;br&gt;Comite - 3 pints&lt;br&gt;Zephyr 0.15 EC - 16 oz.&lt;br&gt;Zephyr 0.15 EC - 12 oz.&lt;br&gt;Zephyr 0.15 EC - 8 oz.&lt;br&gt;Savey 50 WP - 4 oz.&lt;br&gt;Alert 2 SC - 10 oz.&lt;br&gt;Savey 50 WP + Comite - 3 oz. + 2 pints&lt;br&gt;Ovasyn - 5.3 pints</td>
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Notes: *Boswell*: The entire field was sprayed with Lannate and the checks around the plot area were treated with Comite on 7/9/97. Monitor (2 pints/A) and Lorsban (2 pints/A) were applied to the field on 7/18/97.<br>*Motte*: Capture, Thiodan, and Zephyr were applied on 6/12/97. Zephyr was applied only outside of the trial area. Miticide treatments were applied in 25 gpa water using a non-ionic wetting agent.
<table>
<thead>
<tr>
<th>1998 Locations</th>
<th>Plot Size</th>
<th>Application Date/Method</th>
<th>Treatments and Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boswell Ranch</td>
<td>160' x 325'</td>
<td>7/18/98 air</td>
<td>Untreated Control&lt;br&gt;Comite - 3 pints&lt;br&gt;Zephyr 0.15 EC - 8 oz.&lt;br&gt;Zephyr 0.15 EC - 6 oz.&lt;br&gt;Alert 2 SC - 10 oz.&lt;br&gt;Savey 50 WP + Comite - 3 oz. + 2 pints</td>
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<td></td>
<td>(1.2 A/plot)</td>
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<tr>
<td>Matte Ranch</td>
<td>30' X 1225.3'</td>
<td>6/26/98 ground</td>
<td>Untreated Control&lt;br&gt;Comite - 3 pints&lt;br&gt;Zephyr 0.15 EC - 6 oz.&lt;br&gt;Zephyr 0.15 EC - 8 oz.&lt;br&gt;Savey 50 WP - 4 oz.&lt;br&gt;Alert 2 SC - 10 oz.&lt;br&gt;Savey 50 WP + Comite - 3 oz. + 2 pints&lt;br&gt;Ovasyn - 5.3 pints</td>
</tr>
<tr>
<td></td>
<td>(0.84 A/plot)</td>
<td></td>
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</table>

Notes:
Boswell: Cleanup Spray 7/6/98 – Capture (6.4 oz) + Thiodan (1 qt).
Motte: Cleanup Spray 6/25/98. Miticide treatments were applied in 25 gpa water using a non-ionic wetting agent (R-11 2 pts/100). On 7/20/98, entire field was treated with Capture + Thiodan. On 8/1/98, entire field was treated with Carzol and Thiodan.
Results - 1996

Initial spider mite populations were low at the time of treatment in the Kings County trial - 43% trifoliates infested with an average of 0.8 mites per leaf. They were higher in the Fresno location when treatments were applied - 61% infestation with an average of 1.8 mites per leaf.

The best material in both trials was Zephyr at a 16 oz. rate. It was effective through the entire five-week sampling period in the Kings County trial, and was one of the best materials in the Fresno County trial as well, although length of control could not be evaluated there. The Savey + Comite combination also looked promising when spider mite populations were low. It provided an excellent level of control for a period of four weeks after treatment. When spider mite populations were higher, Savey + Comite did not perform particularly well. Savey alone worked fairly well for about three weeks when spider mite pressure was low at the time of treatment, but it provided little control when spider mite pressure was high. Alert also looked quite good in these trials. Under both high and low spider mite pressure, it quickly reduced and held populations to acceptable levels for three to four weeks. Although growers had previously reported that Comite was not working well, in both of these trials it did a fair job of controlling spider mites.

Efficacy was compromised in the Kings County trial because the material was applied by air at a low rate. When applied by ground, at a 3 oz. rate, efficacy was excellent. Results from the trials conducted in 1996 are presented in Figure 1.

Results - 1997

An effort was made in 1997 to initiate the trials earlier in the season in hopes of better evaluating the ovicides and collecting data for a longer period to determine the residual activity of the various materials. When the Kings County trial was initiated, spider mite populations were fairly low - 22% infestation with an average of 0.39 mites per leaf. Pre-treatment spider mite populations were higher in the Fresno County location and similar to those recorded the previous year - 67% infestation with an average of 2.25 mites per leaf. Unfortunately, in both locations, the field began to dry down as significant treatment differences began to appear so the length of residual control could not be evaluated.

As in 1996, Zephyr was very effective in controlling spider mites in 1997 trials. When applied by air, the 16 oz. rate was more effective than the 8 oz rate. By ground, the 8 oz. rate was as effective as the 12 and 16 oz. rates in controlling spider mites throughout the sampling period. Once again, in both of these trials, Comite was effective for spider mite control, although indications are that it does not provide the same residual control as Zephyr. Results in 1996 indicated that Savey was most effective when applied at lower spider mite infestation levels. In 1997, there was a light infestation in the Kings County location, but Savey was not included in that trial because the materials would only be applied by air. It was included in the Fresno County trial, but pressure was fairly high when that trial was initiated. Results were consistent with data from 1996 - although it provided some level of control, Savey alone was not the best choice when dealing with heavy spider mite infestations. The Savey + Comite combination was effective when applied by ground, but data from the aerial application was inconsistent with results from 1996. When tank mixing with Savey, it appears to be important to keep the rate of Comite at 3 pints per acre for effective control. When applied by air, Alert did not appear to adequately control spider mites in the trials conducted in 1997, but the ground application was quite effective. Ovasyn was only evaluated in the Fresno County trial where it was applied by ground. Results were inconclusive. Results from the trials conducted in 1997 are presented in Figure 2.
Results - 1998
The Kings County trial got a late start due to late spider mite infestation in 1998, and only a few sample collections were available for evaluation. By the time the materials were applied, the field was already beginning to dry down. Due to an error in staking the plot, samples collected between 7/18 and 7/29 could not be used. By 7/29/98, spider mite populations in the untreated control plots averaged 2 mites per leaf while all of the treatments held mite populations to less than 0.5 mites per leaf. The field was so dry by 8/5/98, sampling was discontinued.

At the Motte location in Fresno County, following treatment in late June, all materials appeared to be effective in controlling spider mites by early July. Spider mite populations were building in the untreated control plots, while all treated plots showed equally good control. Once again, Comite performed well, but it may not provide the length of residual control that other materials offer. By mid-July, treatment differences were beginning to appear. On 7/20/98, the grower applied Capture + Thiodan to the entire field for lygus control. When sampled on 7/23/98, spider mite populations had crashed and there were no significant differences between treatments. The field was again treated for lygus (Carzol + Thiodan) on the first of August, and final samples were collected on 8/4/98. The untreated control and Comite-treated plots had populations of 1.26 and 1.77 mites per leaf, the Savey treated plots averaged 0.57 mites per leaf, and the Savey + Comite-treated plots were 0.28 mites per leaf. The plots treated with Zephyr at either 6 or 8 oz/A and the Ovasyn and Alert-treated plots all had populations less than 0.1 mites per leaf. The advantage provided by two insecticide applications to the field where this trial was located in strengthening the residual activity of some materials must not be forgotten, but it appears that Zephyr, and possibly Alert and Ovasyn when the initial application is properly timed, may provide season-long control of spider mites. Results from the trials conducted in 1998 are presented in Figure 3.

Summary
Although it has been reported that spider mites have developed resistance to Comite, it performed well in all of the trials conducted between 1996 and 1998. Perhaps as growers have begun to use alternate materials, mite populations have returned to a susceptible condition. However, it was noted that Comite may not provide the residual control offered by other materials, such as Zephyr. Zephyr was by far the most effective material each year of evaluation. When applied by air, Zephyr maintained its efficacy, supporting the label change in 1997 to allow this type of application. Based upon limited data, it might be prudent to use a higher rate of Zephyr when aerial applications are used due to difficulty in achieving good coverage by air. However, when applied by ground, control was excellent, even when lower rates were used. Although this material was registered in late 1996, and has been proven effective in commercial seed fields, other materials need to be examined to support continued efforts in developing resistance management strategies. Savey, when applied alone, must be timed to coincide with the initial spider mite buildup and applied to insure adequate coverage. It is not the type of material that can be applied to save a field from a heavy infestation; however, it may have a role in preventing or delaying buildup of spider mite populations. The combination of Savey + Comite was better than either of the materials applied alone. Alert looked promising under both high and low mite pressure especially when applied by ground. A nice fit for Alert may be late season where its ability to control worms may give it an advantage over other more specific mite materials. Ovasyn was only evaluated in two of the six trials. It performed well in one trial, but results were confounded by the applications of lygus control materials over the trial area. In the second trial, results were inconclusive. Additional research must be conducted to evaluate its potential.
Acknowledgments
I would like to acknowledge the participation of the growers in this trial - Jim Razor and Lori Uyemura, JG Boswell Ranch, Kings County and Bob Motte and Rick Yribarren, San Joaquin and Tranquility, Fresno County. Without their cooperation, this data could not have been generated to support registrations of new materials and label amendments. Doug Hudson, Wilbur Ellis Company, San Joaquin was also instrumental in identifying grower cooperators, assisting in the application of materials, and providing information regarding mite populations and commercial grower practice. Beth Grafton-Cardwell, Kearney Agricultural Center, Parlier graciously conducted the spider mite identifications throughout the season. Leaf samples and spider mite population data were collected by Catherine Nyberg, David Clay, Lorine Nickerson, Emily Urrutia, Steve Peterson, and Sonya Padron - Summer Interns with the University of CA Cooperative Extension. They spent many hours in the field and peering through a microscope in support of this research effort.
Figure 1. Relative Efficacy of Miticide Treatments as Determined by Calculation of Average Number of Mites per Leaf. 1996, Kings and Fresno Counties.

1996 - Kings County

1996 - Fresno County
Figure 2. Relative Efficacy of Miticide Treatments as Determined by Calculation of Average Number of Mites per Leaf. 1997, Kings and Fresno Counties.
Figure 3. Relative Efficacy of Miticide Treatments as Determined by Calculation of Average Number of Mites per Leaf. 1998, Kings and Fresno Counties.