Biopesticide Efficacy in Desert Produce Crops

John C. Palumbo

Arizona is a leading producer of fresh-market vegetables in the U.S., producing high quality produce on greater than 130,000 acres at an estimated value of almost $1 billion annually. Similarly, Arizona has recently become a major producer of certified-organic, fresh market vegetables (particularly leafy vegetables and cole crops).

Presently, Arizona growers have established a reputation for providing high quality produce for the fresh market. This is especially critical for the organic industry as expectations from the shippers/buyers and consumers is that organically grown leaf vegetables be of the same high-quality standards as conventionally produced crops. Consequently, production of organically-certified leafy vegetables is very challenging in Arizona due to the multitude of insect pests that growers must control to ensure a cosmetically acceptable product that meets the industry and consumer standards. Unfortunately, their options for controlling insects are limited.

Currently, organic growers rely heavily on a select few chemical biopesticides, and to a lesser extent, non-chemical tactics to control insect pests in organic leafy vegetables. Based on conversations with growers and PCAs, these control tactics are often marginally effective, and require intensive usage to meet quality standards. Furthermore, among the numerous pests they battle, aphids, bagrada bugs and flea beetles are almost impossible to control in organic crops, and reliable control options are essentially not available. Other major pests such as beet armyworm and western flower thrips can be effectively controlled with microbial insecticides (e.g., spinosad, Bt), but additional alternatives to be used in rotational programs for resistance management are lacking. Although numerous organically-allowed (USDA and OMRI approved) biopesticides are registered for insect control in Arizona, there is much uncertainty among growers and PCAs whether the products will actually work or control insects as advertised.

Many of the biopesticide manufacturer’s claim that their organic products will safely provide broad spectrum insect control that is “as good as or better” than conventional pesticides. Many local PCAs and organic growers are skeptical of these claims, largely because local scientific information to support the manufactures claims is not currently available. Given the demands for high-quality organic vegetables from Arizona, applied research providing this information would clearly benefit Arizona organic growers. This project was initiated because the research knowledge necessary for implementing effective insect management approaches in local organic vegetables must be developed specifically for Arizona’s unique desert growing conditions, leafy vegetable crops and pest spectrum. The overall goal of this project was to enhance pest management programs for the organic industry by developing new educational information on technologies for controlling insect in organically-certified leafy vegetable crops in Arizona (i.e., lettuce, romaine, cauliflower, cabbage, broccoli and spinach). Below are the results on numerous efficacy trials with biopesticides on leaf vegetables grown in the desert southwest.
**Biopesticide products evaluated for efficacy against insect pests in desert produce crops.**

<table>
<thead>
<tr>
<th>Biopesticide</th>
<th>Active Ingredient</th>
<th>Mode of action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust</td>
<td>Spinosad</td>
<td>Neurotoxic</td>
</tr>
<tr>
<td>Pyganic</td>
<td>pyrethrins</td>
<td>Neurotoxic</td>
</tr>
<tr>
<td>Veratran-D</td>
<td>Sabadilla</td>
<td>Neurotoxin</td>
</tr>
<tr>
<td>Aza-Direct</td>
<td>azadirachtin</td>
<td>IGR, repellent, anti-feedant</td>
</tr>
<tr>
<td>DeBug Turbo</td>
<td>Azadirachtin</td>
<td>IGR, repellent, anti-feedant</td>
</tr>
<tr>
<td>AzaGuard</td>
<td>Azadirachtin</td>
<td>IGR, repellent, anti-feedant</td>
</tr>
<tr>
<td>Ecozin</td>
<td>Azadirachtin</td>
<td>IGR, repellent, anti-feedant</td>
</tr>
<tr>
<td>Neemix</td>
<td>Azadirachtin</td>
<td>IGR, repellent, anti-feedant</td>
</tr>
<tr>
<td>Trilogy</td>
<td>Neem oil</td>
<td>IGR, repellent, anti-feedant</td>
</tr>
<tr>
<td>Azera</td>
<td>Azadirachtin + pyrethrin</td>
<td>IGR, repellent, anti-feedant and neurotoxic</td>
</tr>
<tr>
<td>Mantis</td>
<td>Rosemary, Peppermint and Soybean oils</td>
<td>Cell membrane, respiration disruptors</td>
</tr>
<tr>
<td>M-Pede</td>
<td>Potassium salts of fatty acids</td>
<td>Desiccation or Membrane disruptors</td>
</tr>
<tr>
<td>Xentari</td>
<td><em>Bacillus thuringiensis ‘aizawai’</em></td>
<td>Disruptors of Insect Midgut Membranes</td>
</tr>
<tr>
<td>Dipel</td>
<td><em>Bacillus thuringiensis ‘kurstaki’</em></td>
<td>Disruptors of Insect Midgut Membranes</td>
</tr>
<tr>
<td>Venerate</td>
<td><em>Burkholderia spp. strain A396</em></td>
<td>exoskeleton degradation/ molting interference</td>
</tr>
<tr>
<td>Botanigard</td>
<td><em>Beauveria bassiana</em></td>
<td>Fungal infection in host</td>
</tr>
<tr>
<td>PFR-97</td>
<td><em>Isaria fumosorosea</em></td>
<td>Fungal infection in host</td>
</tr>
<tr>
<td>Oroboost</td>
<td>Alcohol ethoxylate</td>
<td>Organic adjuvant</td>
</tr>
<tr>
<td>BugBomber</td>
<td>Garlic extract</td>
<td>Repellency</td>
</tr>
<tr>
<td>Captiva</td>
<td>Garlic/Capsicum extract</td>
<td>Repellency, anti-feeding, anti-oviposition</td>
</tr>
<tr>
<td>Grandivo</td>
<td><em>Chromobacterium subtsugae</em></td>
<td>Repellency, Reduced egg hatch, and fecundity</td>
</tr>
<tr>
<td>SuffOil-X</td>
<td>Mineral oil</td>
<td>Suffocation</td>
</tr>
</tbody>
</table>

**Acknowledgements**

I gratefully acknowledge the assistance of Leo Chavez, Javier Chavez, Luis Ledesma, Javier Ruiz, Gerado Villegas for their tireless efforts in the collection of the data presented in these trials. This research was funded in part by a grant from the Specialty Crops Block Grant, USDA-AMS, administered by the Arizona Department of Agriculture under the award number SCRBP 16-01.
Methods  Broccoli "Emerald crown" was direct seeded on 6 Sep, 2016 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each treatment compound are provided in the tables. Three foliar spray applications were made on 24 Sep, and 11 and 19 Oct with a CO2 operated, back-pack sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 GPA. An adjuvant, Oroboost, was applied at 0.25% v/v with all treatments. The pH of the spray water in the Pyganic, Azera and Aza-Direct treatments was lowered to a pH of 5.5-6 using Neutralizer at 0.1% v/v.

At various intervals after treatment (DAA), plants were randomly selected from each replicate and destructively sampled for the presence of each insect species. Bagrada bug control was evaluated by examining 20 plants per rep and counting the number of adults and damage on each plant at 1, 3 and 5 DAA. Beet armyworm (BAW), cabbage looper (CL) and diamondback moth (DBM) control was based on the examination of 10 whole plants for presence of small (newly hatched and 1st instar) and large (2nd instar or > ) larvae at 6 DAA. The number of plants in each plot with fresh feeding tracks on plants was also recorded. Adult WF were estimated using a modified vacuum method that employed a 2- gallon portable vacuum (DeWALT, Baltimore, MD) which was fitted with cloth-screened 40 Dram containers to capture and retain vacuumed adults. At 1, 3 and 7 DAA, 5 individual plants from each replicate were sampled by vacuuming the terminal area of the plants for 3 s. Containers with adults were taken into the laboratory, placed in a freezer for 24 h after which the number of adults/ plant was recorded. Because of heterogeneity of mean variances, data were transformed using a log10 (x-1) function before analysis. Data for percentage of plants with fresh feeding damage on leaves were subjected to an arcsine transformation before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Means from non-transformed data are presented in the tables.

Summary  All the treatments significantly reduced Bagrada bug feeding damage relative to the untreated control, but none of the biopesticides provided control comparable to the conventional products. When averaged across all sample dates, only the Entrust combinations, Aza-Direct+Pyganic, and Azera provided significant control of whitefly adults. None of these treatments provided control comparable to the conventional standard. Similarly, only the Entrust treatments and the conventional standard insecticides significantly controlled Lepidopterous larvae.
## Bagrada bug control with organically approved insecticides on broccoli

### Trial Average

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>Adults</th>
<th>Fresh Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust</td>
<td>8 oz</td>
<td>0.4bcd</td>
<td>1.4bc</td>
</tr>
<tr>
<td>Entrust+M-Pede</td>
<td>8 oz+2 %</td>
<td>0.4bcd</td>
<td>1.0e</td>
</tr>
<tr>
<td>Entrust+Mantis</td>
<td>8 oz+1 pt</td>
<td>0.3cde</td>
<td>1.2e</td>
</tr>
<tr>
<td>Veratran-D</td>
<td>10 lbs</td>
<td>0.6bc</td>
<td>1.4cde</td>
</tr>
<tr>
<td>Grandivo</td>
<td>2 lbs</td>
<td>0.8ab</td>
<td>1.8b</td>
</tr>
<tr>
<td>Aza-Direct + Pyganic</td>
<td>2 pts + 17 oz</td>
<td>0.4bcd</td>
<td>1.0e</td>
</tr>
<tr>
<td>Aza</td>
<td>3 pts</td>
<td>0.4bcd</td>
<td>1.3cd</td>
</tr>
<tr>
<td>Oroboost</td>
<td>0.60%</td>
<td>0.7ab</td>
<td>1.9b</td>
</tr>
<tr>
<td>Brigade</td>
<td>6.2 oz</td>
<td>0.1de</td>
<td>0.2f</td>
</tr>
<tr>
<td>Brigade+Venom</td>
<td>6.2 + 3 oz</td>
<td>0.0e</td>
<td>0.1f</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>1.2a</td>
<td>3.1a</td>
</tr>
</tbody>
</table>

\[ F \text{ value} = 107.2 \quad 68.79 \quad 10.31 \quad 82 \quad 33.35 \quad 81.17 \quad 176.7 \]

\[ P > F = .0001 \quad .0001 \quad .0001 \quad .0001 \quad .0001 \quad .0001 \quad .0001 \]

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## Efficacy of organically approved insecticides against whitefly adults in broccoli

### Whitefly Adults / Leaf

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>1-DAA-1</th>
<th>3-DAA-1</th>
<th>7-DAA-1</th>
<th>1-DAA-2</th>
<th>3-DAA-2</th>
<th>7-DAA-2</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust</td>
<td>8 oz</td>
<td>18.5abc</td>
<td>20.9ab</td>
<td>12.3a</td>
<td>12.6ab</td>
<td>11.8a</td>
<td>17.1a</td>
<td>15.5abc</td>
</tr>
<tr>
<td>Entrust+M-Pede</td>
<td>8 oz+2 %</td>
<td>14.7bc</td>
<td>17.5ab</td>
<td>11.6a</td>
<td>8.9b</td>
<td>9.5a</td>
<td>12.5ab</td>
<td>12.4c</td>
</tr>
<tr>
<td>Entrust+Mantis</td>
<td>8 oz+1 pt</td>
<td>13.2c</td>
<td>14.5b</td>
<td>12.5a</td>
<td>12.4ab</td>
<td>9.8a</td>
<td>12.0b</td>
<td>12.4c</td>
</tr>
<tr>
<td>Veratran-D</td>
<td>10 lbs</td>
<td>17.7abc</td>
<td>20.9ab</td>
<td>12.4a</td>
<td>12.6ab</td>
<td>10.8a</td>
<td>14.8ab</td>
<td>14.9abc</td>
</tr>
<tr>
<td>Grandivo</td>
<td>2 lbs</td>
<td>19.7abc</td>
<td>20.3ab</td>
<td>13.9a</td>
<td>12.7ab</td>
<td>13.7a</td>
<td>14.1ab</td>
<td>15.7abc</td>
</tr>
<tr>
<td>Aza-Direct + Pyganic</td>
<td>2 pts + 17 oz</td>
<td>17.6abc</td>
<td>18.8ab</td>
<td>11.3a</td>
<td>9.8ab</td>
<td>8.8a</td>
<td>14.5ab</td>
<td>13.4bc</td>
</tr>
<tr>
<td>Aza</td>
<td>3 pts</td>
<td>18.2abc</td>
<td>18.7ab</td>
<td>11.1a</td>
<td>8.7b</td>
<td>10.3a</td>
<td>12.0b</td>
<td>13.2bc</td>
</tr>
<tr>
<td>Oroboost</td>
<td>0.60%</td>
<td>21.9a</td>
<td>21.1ab</td>
<td>15.3a</td>
<td>13.9ab</td>
<td>13.9a</td>
<td>13.6ab</td>
<td>16.6ab</td>
</tr>
<tr>
<td>Brigade</td>
<td>6.2 oz</td>
<td>16.2abc</td>
<td>14.5b</td>
<td>11.5a</td>
<td>11.1ab</td>
<td>9.6a</td>
<td>14.5ab</td>
<td>12.9bc</td>
</tr>
<tr>
<td>Brigade+Venom</td>
<td>6.2 + 3 oz</td>
<td>1.0d</td>
<td>1.1c</td>
<td>3.5b</td>
<td>0.4c</td>
<td>3.0b</td>
<td>1.6c</td>
<td>1.4d</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>20.7ab</td>
<td>22.9a</td>
<td>14.4a</td>
<td>15.0a</td>
<td>13.8a</td>
<td>17.6a</td>
<td>17.4a</td>
</tr>
</tbody>
</table>

\[ F \text{ value} = 107.2 \quad 68.79 \quad 10.31 \quad 82 \quad 33.35 \quad 81.17 \quad 176.7 \]

\[ P > F = .0001 \quad .0001 \quad .0001 \quad .0001 \quad .0001 \quad .0001 \quad .0001 \]
## Lep larvae control with organically approved insecticides on broccoli - 6 DAA-3

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>BAW</th>
<th>CL</th>
<th>DBM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust</td>
<td>8 oz</td>
<td>0.0c</td>
<td>0.4a</td>
<td>0.0c</td>
<td>0.4d</td>
</tr>
<tr>
<td>Entrust+M-Pede</td>
<td>8 oz+2 %</td>
<td>0.4bc</td>
<td>0.4a</td>
<td>0.0c</td>
<td>0.8cd</td>
</tr>
<tr>
<td>Entrust+Mantis</td>
<td>8 oz+1 pt</td>
<td>0.0c</td>
<td>0.0a</td>
<td>0.4bc</td>
<td>0.4d</td>
</tr>
<tr>
<td>Veratran-D</td>
<td>10 lbs</td>
<td>5.0a</td>
<td>4.6a</td>
<td>2.9abc</td>
<td>12.5a</td>
</tr>
<tr>
<td>Grandivo</td>
<td>2 lbs</td>
<td>6.7a</td>
<td>2.9a</td>
<td>2.5abc</td>
<td>12.1a</td>
</tr>
<tr>
<td>Aza-Direct + Pyganic</td>
<td>2 pts + 17 oz</td>
<td>2.1abc</td>
<td>3.3a</td>
<td>3.8abc</td>
<td>9.2ab</td>
</tr>
<tr>
<td>Azaera</td>
<td>3 pts</td>
<td>4.2a</td>
<td>0.0a</td>
<td>5.4ab</td>
<td>9.6ab</td>
</tr>
<tr>
<td>Oroboost</td>
<td>0.60%</td>
<td>3.8a</td>
<td>0.9a</td>
<td>2.1abc</td>
<td>6.8ab</td>
</tr>
<tr>
<td>Brigade</td>
<td>6.2 oz</td>
<td>3.3ab</td>
<td>0.4a</td>
<td>0.8bc</td>
<td>4.6b</td>
</tr>
<tr>
<td>Brigade+Venom</td>
<td>6.2 + 3 oz</td>
<td>3.3ab</td>
<td>0.0a</td>
<td>0.4bc</td>
<td>3.7bc</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>7.1</td>
<td>2.9a</td>
<td>5.8a</td>
<td>7.1a</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Avg. Large Larvae / 10 Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>F value</td>
<td>8.11</td>
</tr>
<tr>
<td>P&gt;F</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>3.17</td>
</tr>
<tr>
<td></td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>0.0005</td>
</tr>
<tr>
<td></td>
<td>&lt;.0001</td>
</tr>
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</table>
Cross-spectrum Insect Control in Organic Broccoli, Fall 2016

Methods  Broccoli "Emerald crown' was direct seeded on 6 Sep, 2016 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each treatment compound are provided in the tables. Three foliar spray applications were made on 19 and 27 Sep, and 7 Oct with a CO2 operated, back-pack sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 GPA. An adjuvant, Silwet, was applied at 0.125% v/v with all treatments. The pH of the spray water in the Pyganic, and Azera treatments was lowered to a pH of 5.5-6 using Neutralizer at 0.1% v/v.

At various intervals after treatment, plants were randomly selected from each replicate and destructively sampled for the presence of each insect species. Bagrada bug and flea beetle damage were evaluated by examining 10 plants per rep and counting the number of adults and damage on each plant. Beet armyworm, cabbage looper and diamondback moth (DBM) control was based on the examination of whole plants for presence of small (newly hatched and 1st instar) and large (2nd instar or > ) larvae. The number of plants in each plot with fresh feeding tracks on plants was also recorded. Adult populations were assessed by counting all adults on the lower surface of a single leaf from 5 plants per replicate. Evaluations of SWF control was estimated by counting the number of eggs and immature lifestages on two, 2-cm² disk sections taken from 2 leaves collected from each of 5 plants per replicate at various days after application (DAA). WF immature densities on each leaf disk were estimated under magnification in the laboratory.

Because of heterogeneity of mean variances, data were transformed using a log₁₀ (x-1) function before analysis. Data for percentage of plants with fresh feeding damage on leaves were subjected to an arcsine transformation before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Means from non-transformed data are presented in the tables.

Summary  Among the biopesticides, only the Entrust treatments significantly controlled all lepidopterous species present. Similarly, when averaged across all sample dates, only the Entrust treatments and Azera significantly reduced whitefly adults. Among biopesticides, Grandivo, Venerate, Pyganic and Botanigard +Xentrari did not provided significant control of whitefly nymphs. Bagrada bug damage was reduced with the Entrust treatments and flea beetle damage was reduced by Azera. The conventional insecticide (Exirel+Sniper) provided consistent control of all pests following each spray.
### Efficacy of organically approved insecticides against Lep Larvae in broccoli

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>BAW</th>
<th>CL</th>
<th>DBM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exirel + Sniper</td>
<td>15 + 5 oz</td>
<td>0.1e</td>
<td>0.4c</td>
<td>0.0b</td>
<td>0.5c</td>
</tr>
<tr>
<td>Entrust + M-Pede</td>
<td>6 oz + 2 %</td>
<td>0.2de</td>
<td>0.9c</td>
<td>0.0b</td>
<td>1.1c</td>
</tr>
<tr>
<td>Entrust + Mantis</td>
<td>6 oz + 2 pts</td>
<td>0.4de</td>
<td>0.6c</td>
<td>0.0b</td>
<td>1.0c</td>
</tr>
<tr>
<td>Grandivo</td>
<td>2 lbs</td>
<td>1.9ab</td>
<td>5.9a</td>
<td>0.9a</td>
<td>8.7a</td>
</tr>
<tr>
<td>Venerate</td>
<td>2 qt</td>
<td>2.2a</td>
<td>6.4a</td>
<td>0.3ab</td>
<td>8.9a</td>
</tr>
<tr>
<td>Pyganic</td>
<td>17 oz</td>
<td>1.5abc</td>
<td>7.0a</td>
<td>0.5ab</td>
<td>9.0a</td>
</tr>
<tr>
<td>Azera</td>
<td>2 pts</td>
<td>1.4abc</td>
<td>3.1b</td>
<td>0.5ab</td>
<td>4.9b</td>
</tr>
<tr>
<td>Azera + Pyganic</td>
<td>2 pts + 17 oz</td>
<td>0.9bcd</td>
<td>2.2b</td>
<td>0.6ab</td>
<td>3.7b</td>
</tr>
<tr>
<td>Botanigard + Xentari</td>
<td>1 qt + 1 lb</td>
<td>0.7cde</td>
<td>2.9b</td>
<td>0.3ab</td>
<td>3.9b</td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td>3.1a</td>
<td>7.9a</td>
<td>0.4ab</td>
<td>11.3a</td>
</tr>
</tbody>
</table>

**F value**  
16.99  
63.21  
2.77  
64.19

**P < F**  
<.0001  
<.0001  
0.02  
<.0001

### Efficacy of organically approved insecticides against whitefly adults in broccoli

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>1-DAA-1</th>
<th>20-Sep</th>
<th>22-Sep</th>
<th>26-Sep</th>
<th>28-Sep</th>
<th>1-Oct</th>
<th>4-Oct</th>
<th>Trial Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exirel + Sniper</td>
<td>15 + 5 oz</td>
<td>0.6d</td>
<td>0.7c</td>
<td>7.6b</td>
<td>0.5d</td>
<td>1.3b</td>
<td>3.8b</td>
<td>2.4e</td>
<td></td>
</tr>
<tr>
<td>Entrust + M-Pede</td>
<td>6 oz + 2 %</td>
<td>4.0bc</td>
<td>4.3ab</td>
<td>16.3a</td>
<td>8.1bc</td>
<td>13.0a</td>
<td>13.8a</td>
<td>10.1cd</td>
<td></td>
</tr>
<tr>
<td>Entrust + Mantis</td>
<td>6 oz + 2 pts</td>
<td>3.2c</td>
<td>3.4b</td>
<td>15.3a</td>
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<td>10.3a</td>
<td>14.4a</td>
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<tr>
<td>Grandivo</td>
<td>2 lbs</td>
<td>7.0ab</td>
<td>6.5a</td>
<td>20.3a</td>
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<tr>
<td>Venerate</td>
<td>2 qt</td>
<td>7.4a</td>
<td>6.2a</td>
<td>20.8a</td>
<td>15.9ab</td>
<td>17.6a</td>
<td>19.6a</td>
<td>14.6a</td>
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<tr>
<td>Pyganic</td>
<td>17 oz</td>
<td>5.8ab</td>
<td>5.2ab</td>
<td>15.0a</td>
<td>15.6ab</td>
<td>14.2a</td>
<td>17.4a</td>
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<tr>
<td>Azera</td>
<td>2 pts</td>
<td>6.3ab</td>
<td>4.7ab</td>
<td>15.9a</td>
<td>13.3ab</td>
<td>13.3a</td>
<td>12.0a</td>
<td>10.9bc</td>
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<tr>
<td>Azera + Pyganic</td>
<td>2 pts + 17 oz</td>
<td>5.6ab</td>
<td>5.2ab</td>
<td>22.0a</td>
<td>13.0ab</td>
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<td>15.1a</td>
<td>12.4abc</td>
<td></td>
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<tr>
<td>Botanigard + Xentari</td>
<td>1 qt + 1 lb</td>
<td>5.5ab</td>
<td>5.2ab</td>
<td>19.6a</td>
<td>16.4ab</td>
<td>17.4a</td>
<td>20.3a</td>
<td>12.9ab</td>
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<td>20.9a</td>
<td>16.4a</td>
<td>17.1a</td>
<td>14.5a</td>
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**F value**  
38.33  
29.94  
7.67  
42.33  
33.22  
9.63  
135.71

**P > F**  
<.0001  
<.0001  
<.0001  
<.0001  
<.0001  
<.0001  
<.0001
### Efficacy of organically approved insecticides against whitefly immatures in broccoli

#### Trial Average

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>Eggs</th>
<th>Small nymphs</th>
<th>Large nymphs</th>
<th>Total nymphs</th>
</tr>
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<tbody>
<tr>
<td>Exirel + Sniper</td>
<td>15 + 5 oz</td>
<td>1.4c</td>
<td>1.2b</td>
<td>0.1e</td>
<td>1.2f</td>
</tr>
<tr>
<td>Entrust + M-Pede</td>
<td>6 oz + 2 %</td>
<td>7.0ab</td>
<td>5.6a</td>
<td>1.8abc</td>
<td>7.4bcde</td>
</tr>
<tr>
<td>Entrust + Mantis</td>
<td>6 oz + 2 pts</td>
<td>5.9ab</td>
<td>5.4a</td>
<td>1.4bcd</td>
<td>6.8cde</td>
</tr>
<tr>
<td>Grandivo</td>
<td>2 lbs</td>
<td>9.6a</td>
<td>6.6a</td>
<td>2.2ab</td>
<td>8.8abcd</td>
</tr>
<tr>
<td>Venerate</td>
<td>2 qt</td>
<td>8.9ab</td>
<td>6.4a</td>
<td>3.8a</td>
<td>10.3abc</td>
</tr>
<tr>
<td>Pyganic</td>
<td>17 oz</td>
<td>7.6ab</td>
<td>8.1a</td>
<td>3.6a</td>
<td>11.7a</td>
</tr>
<tr>
<td>Azera</td>
<td>2 pts</td>
<td>9.0ab</td>
<td>6.1a</td>
<td>0.7cd</td>
<td>6.8de</td>
</tr>
<tr>
<td>Azera + Pyganic</td>
<td>2 pts + 17 oz</td>
<td>7.5ab</td>
<td>5.2a</td>
<td>0.4d</td>
<td>5.6e</td>
</tr>
<tr>
<td>Botanigard + Xentari</td>
<td>1 qt + 1 lb</td>
<td>10.1a</td>
<td>7.5a</td>
<td>3.1ab</td>
<td>10.6ab</td>
</tr>
<tr>
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<td>11.1a</td>
<td>6.4a</td>
<td>3.8a</td>
<td>10.2abcd</td>
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</table>

F value: 16.43  P>F: <.0001

### Efficacy of organically approved insecticides against bagrada bug and flea beetles in broccoli

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>Bagrada bug</th>
<th>Flea Beetles</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Adults /10 plants</td>
<td>Damage (% plants)</td>
</tr>
<tr>
<td>Exirel + Sniper</td>
<td>15 + 5 oz</td>
<td>0.0b</td>
<td>0.0b</td>
</tr>
<tr>
<td>Entrust + M-Pede</td>
<td>6 oz + 2 %</td>
<td>0.3ab</td>
<td>0.0b</td>
</tr>
<tr>
<td>Entrust + Mantis</td>
<td>6 oz + 2 pts</td>
<td>0.0b</td>
<td>2.5b</td>
</tr>
<tr>
<td>Grandivo</td>
<td>2 lbs</td>
<td>0.0b</td>
<td>7.5ab</td>
</tr>
<tr>
<td>Venerate</td>
<td>2 qt</td>
<td>0.0b</td>
<td>12.5ab</td>
</tr>
<tr>
<td>Pyganic</td>
<td>17 oz</td>
<td>0.3ab</td>
<td>7.5ab</td>
</tr>
<tr>
<td>Azera</td>
<td>2 pts</td>
<td>1.0ab</td>
<td>10.0ab</td>
</tr>
<tr>
<td>Azera + Pyganic</td>
<td>2 pts + 17 oz</td>
<td>0.0b</td>
<td>7.5ab</td>
</tr>
<tr>
<td>Botanigard + Xentari</td>
<td>1 qt + 1 lb</td>
<td>0.0b</td>
<td>5.0ab</td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td>1.5a</td>
<td>17.5a</td>
</tr>
</tbody>
</table>

F value: 3.03  P>F: 0.01

F value: 3.37  P>F: 0.007

F value: 0.39  P>F: 0.93

F value: 2.96  P>F: 0.01
Whitefly Control in Organic Broccoli, Fall 2017

Methods  The objective of the study was to evaluate the efficacy of several biopesticides against whiteflies on broccoli under fall desert growing conditions. Broccoli ‘Emerald Crown’ was transplanted on Aug 25, 2017 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each treatment are provided in the table. Two foliar sprays were applied on 5 and 16 Oct with a CO2 operated boom sprayer at 40 psi and 20.5 GPA. A broadcast application was delivered through 2 TXVS-18 ConeJet nozzles per bed. An acidifier (Neutralizer) was applied at 0.1% vol/vol to the Ecoszin, Aza-Direct and Azera treatments to modify spray pH to ~5.5. An organic surfactant (Silwet) was applied to each treatment at 0.125% vol/vol.

Adult populations were assessed by counting all adults on the lower surface of a single leaf from 3-5 plants per replicate. Nymphs were assessed by making estimates of immature whiteflies at 7-d intervals following each spray application. Population densities were estimated by counting the number of small nymphs (1st and 2nd instars) and large nymphs (3rd and 4th instars) on two, 1-cm² disk discs taken from 2 leaves collected from each of 5 plants per replicate. Because of heterogeneity of mean variances, data were transformed using a log10 (x-1) function before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Means from non-transformed data are presented in the tables.

Summary  None of the biopesticide treatments significantly controlled whitefly adults compared with the untreated check. Only the conventional standard, Exirel, significantly reduced whitefly adults following each application.

Efficacy of organically approved insecticides against whitefly adults in broccoli

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
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<tbody>
<tr>
<td>Ecozin</td>
<td>30 oz</td>
<td>9.0a</td>
<td>10.5a</td>
<td>9.6a</td>
<td>8.3a</td>
<td>8.0ab</td>
<td>13.3a</td>
<td>15.2a</td>
</tr>
<tr>
<td>Aza-Direct</td>
<td>3 pts</td>
<td>9.2a</td>
<td>9.1a</td>
<td>10.2a</td>
<td>10.5a</td>
<td>5.5ab</td>
<td>11.8a</td>
<td>14.1a</td>
</tr>
<tr>
<td>Azera</td>
<td>48 oz</td>
<td>10.5a</td>
<td>9.7a</td>
<td>13.6a</td>
<td>11.4a</td>
<td>7.0ab</td>
<td>10.8a</td>
<td>13.3a</td>
</tr>
<tr>
<td>Venerate XC</td>
<td>2 qts</td>
<td>9.7a</td>
<td>10.8a</td>
<td>11.4a</td>
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<td>11.0a</td>
<td>12.7a</td>
<td>15.3a</td>
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<tr>
<td>Exirel</td>
<td>16 oz</td>
<td>1.7b</td>
<td>0.9b</td>
<td>3.0b</td>
<td>2.0b</td>
<td>1.1b</td>
<td>1.6b</td>
<td>2.2b</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>11.5a</td>
<td>11.5a</td>
<td>14.8a</td>
<td>12.2a</td>
<td>13.3a</td>
<td>13.8a</td>
<td>15.8a</td>
</tr>
</tbody>
</table>

F value  38.33  29.94  7.67  42.33  33.22  9.63  135.71
P > F  <.0001  <.0001  <.0001  <.0001  <.0001  <.0001  <.0001
**Flea Beetle Control in Organic Broccoli, Fall 2016**

**Methods** Broccoli ‘Emerald Crown’ was direct seeded into double row beds on 42 inch centers on 31 Aug. Plots were two beds wide by 25 ft long and bordered by two untreated beds. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each compound are provided in the tables. A single foliar spray were applied on 9 Sep as a broadcast application delivered through 2 TXVS-18 ConeJet nozzles at 22.5 gpa and 40 psi. An adjuvant, Silwet, was applied at 0.125% vol/vol to all treatments. The pH of the spray water in the Pyganic treatments was lowered to a pH of 5.5-6 using neutralizer at 0.1% v/v.

Insect control evaluations were made 1, 2, 3 and 5 days after application (DAA). Flea beetle efficacy was measured by assessing seedling damage by counting the number of plants with evidence of flea beetle feeding present on true leaves and cotyledons in 6 row ft per plot. FB damage was rated as **Light**, when 1-2 small feeding sites (1-2 mm) on cotyledon or leaf; **Moderate**, when multiple feeding sites (3-4 mm) on at least 1 cotyledon or leaf; and **Heavy**, when cotyledons or leaves with multiple feeding sites (>5 mm) with holes chewed through cotyledons/leaves. Because of heterogeneity of mean variances, insect data were transformed using a log10 (x-1) function before analysis. Data for percentage of plants with fresh feeding damage on leaves were subjected to an arcsine transformation before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Actual non-transformed means are presented in the tables.

**Summary** Averaged across each sampling dates, feeding damage from flea beetles did not differ among the biopesticide treatments and the untreated control. Only the conventional standard pyrethroid (Discipline) significantly reduced feeding damage.

---

**Flea Beetle control with organically approved insecticides in lettuce**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>Light</th>
<th>Moderate</th>
<th>Heavy</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust</td>
<td>8 oz</td>
<td>7.2ab</td>
<td>3.5a</td>
<td>2.9a</td>
<td>13.5a</td>
</tr>
<tr>
<td>Entrust + M-Pede</td>
<td>8 oz + 2%</td>
<td>6.3ab</td>
<td>3.2a</td>
<td>3.2a</td>
<td>12.7a</td>
</tr>
<tr>
<td>Pyganic</td>
<td>17 oz</td>
<td>9.7a</td>
<td>2.8a</td>
<td>2.3a</td>
<td>14.7a</td>
</tr>
<tr>
<td>Discipline</td>
<td>5 oz</td>
<td>3.5b</td>
<td>0.3b</td>
<td>0.0b</td>
<td>3.8b</td>
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<tr>
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<td>-</td>
<td>10.8a</td>
<td>4.1a</td>
<td>3.2a</td>
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</table>

**F value** 4.51 6.49 10.18 10.02  

**P > F** 0.02 0.005 0.0008 0.0008
Methods Broccoli ‘Emerald Crown’ was direct seeded into double row beds on 42 inch centers on 8 Sep. Plots were two beds wide by 15 ft long and bordered by two untreated beds. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each compound are provided in the tables. A single foliar spray were applied on 18 Sep as a broadcast application delivered through 2 TXVS-18 ConeJet nozzles at 22.5 gpa and 40 psi. An adjuvant, Silwet, was applied at 0.125% vol/vol to all treatments. The pH of the spray water in the Pyganic and Azera treatments was lowered to a pH of 5.5-6 using neutralizer at 0.1% v/v.

Insect control evaluations were made 1, 2, 3 and 5 days after application (DAA). Flea beetle efficacy was measured by assessing seedling damage by counting the number of plants with evidence of flea beetle feeding present on true leaves and cotyledons in 6 row ft. FB damage was rated as Light, when 1-2 small feeding sites (1-2 mm) on cotyledon or leaf; Moderate, when multiple feeding sites (3-4 mm) on at least 1 cotyledon or leaf; and Heavy, when cotyledons or leaves with multiple feeding sites (>5 mm) with holes chewed through cotyledons/leaves. Because of heterogeneity of mean variances, insect data were transformed using a log10 (x-1) function before analysis. Data for percentage of plants with fresh feeding damage on leaves were subjected to an arcsine transformation before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Actual non-transformed means are presented in the tables.

Summary Averaged across each sampling dates, total feeding damage from flea beetles did not differ among the biopesticide treatments and the untreated control. Only the conventional insecticide, Endigo, significantly reduced feeding damage.

Flea Beetle control with organically approved insecticides in lettuce

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>Light</th>
<th>Moderate</th>
<th>Heavy</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust</td>
<td>8 oz</td>
<td>2.5a</td>
<td>3.8a</td>
<td>3.8a</td>
<td>10.0ab</td>
</tr>
<tr>
<td>Entrust + Pyanic</td>
<td>8 + 17 oz</td>
<td>2.5a</td>
<td>6.3a</td>
<td>2.5a</td>
<td>11.3a</td>
</tr>
<tr>
<td>Pyanic</td>
<td>17 oz</td>
<td>2.5a</td>
<td>2.5a</td>
<td>0.0b</td>
<td>5.0ab</td>
</tr>
<tr>
<td>Azera+Pyanic</td>
<td>32 + 17 oz</td>
<td>3.8a</td>
<td>5.0a</td>
<td>2.5a</td>
<td>11.3a</td>
</tr>
<tr>
<td>Endigo</td>
<td>4.5 oz</td>
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<td>0.0a</td>
<td>0.0a</td>
<td>0.0b</td>
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<tr>
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<td>3.8a</td>
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Lepidopterous Control in Organic Head Lettuce, Fall 2015

Methods  Head lettuce 'El Guapo' was direct seeded on 18 Sep, 2015 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 45 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each treatment compound and adjuvant are provided in the tables. Four foliar applications were made on 6, 16 Oct and 2, 18 Nov with a CO2 operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 GPA.

Beet armyworm (BAW), cabbage looper (CL) and corn earworm (CEW) control was based on the examination of 10 whole plant at 3, 7, 10 and 14 days following the first three applications (DAA) for the presence of large (2nd or > instar) larvae. The number of plants in each plot with fresh feeding tracks on plants was also recorded. At harvest, (7 DAA-4), 10 plants from each plot were harvested and assessed for damage and larval contamination. Because of heterogeneity of mean variances, insect data were transformed using a log10 (x-1) function before analysis. Data for percentage of plants with fresh feeding damage on leaves were subjected to an arcsine transformation before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Means from non-transformed data are presented in the tables.

Summary  All of the biopesticides significantly reduced % damage, BAW and Total large larvae numbers compared to the untreated control. Only the Entrust combinations provided significant control of CL, and overall provided the most consistent control of BAW. Entrust activity was not enhanced by the use of any one adjuvant. Harvest evaluations showed that the Entrust treatments provided the best protection, whereas head contamination from feeding damage, frass and BAW in the Grandivo treatment was not significantly different from the untreated control.

Lep larvae control with organically approved insecticides in lettuce

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>Damage (%)</th>
<th>Trial Average</th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CL</td>
<td>BAW</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entrust+Oroboost</td>
<td>5 oz+0.25%</td>
<td>11.1c</td>
<td>0.2b</td>
<td>0.4c</td>
<td>0.6c</td>
<td></td>
</tr>
<tr>
<td>Entrust+M-Pede</td>
<td>5 + 2%</td>
<td>10.6c</td>
<td>0.2b</td>
<td>0.3c</td>
<td>0.5c</td>
<td></td>
</tr>
<tr>
<td>Entrust+Mantis</td>
<td>5 +1 pt</td>
<td>9.7c</td>
<td>0.2b</td>
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<td>0.4c</td>
<td></td>
</tr>
<tr>
<td>Entrust+Nufilm-P</td>
<td>5 oz+0.25%</td>
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<td>0.1b</td>
<td>0.2c</td>
<td>0.3c</td>
<td></td>
</tr>
<tr>
<td>Dipel+Nufilm P</td>
<td>2 lb+0.25%</td>
<td>24.5b</td>
<td>0.5ab</td>
<td>1.7b</td>
<td>2.2b</td>
<td></td>
</tr>
<tr>
<td>Xentari+NuFilm P</td>
<td>2 lb+0.25%</td>
<td>27.8b</td>
<td>0.4ab</td>
<td>1.5b</td>
<td>2.0b</td>
<td></td>
</tr>
<tr>
<td>Grandivo+NuFilm P</td>
<td>3 lbs+0.25%</td>
<td>33.7b</td>
<td>0.8ab</td>
<td>2.1b</td>
<td>2.9b</td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>58.0a</td>
<td>1.1a</td>
<td>3.7a</td>
<td>4.8a</td>
<td></td>
</tr>
</tbody>
</table>

F value  43.53  5.18  17.59  39.47
P>F  <.0001  0.002  <.0001  <.0001
## Lep larvae control with organically approved insecticides in lettuce at harvest (7 DAA-4)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>Damage</th>
<th>Frass</th>
<th>CL</th>
<th>BAW</th>
<th>CEW</th>
<th>Total larvae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust+Oroboost</td>
<td>5 oz+0.25%</td>
<td>5.0bc</td>
<td>10.0bc</td>
<td>0.0b</td>
<td>2.5b</td>
<td>0.0a</td>
<td>2.5cd</td>
</tr>
<tr>
<td>Entrust+M-Pede</td>
<td>5 + 2%</td>
<td>2.5c</td>
<td>0.0c</td>
<td>0.0b</td>
<td>0.0b</td>
<td>0.0a</td>
<td>0.0d</td>
</tr>
<tr>
<td>Entrust+Mantis</td>
<td>5 +1 pt</td>
<td>0.0c</td>
<td>2.5c</td>
<td>0.0 b</td>
<td>0.0b</td>
<td>0.0a</td>
<td>0.0d</td>
</tr>
<tr>
<td>Entrust+NuFilm-P</td>
<td>5 oz+0.25%</td>
<td>2.5c</td>
<td>2.5c</td>
<td>0.0 b</td>
<td>0.0b</td>
<td>0.0a</td>
<td>0.0d</td>
</tr>
<tr>
<td>Dipel+NuFilmP</td>
<td>2 lb+0.25%</td>
<td>15.0bc</td>
<td>10.0bc</td>
<td>5.0b</td>
<td>2.5b</td>
<td>2.5a</td>
<td>10.0b</td>
</tr>
<tr>
<td>Xentari+NuFilm P</td>
<td>2 lb+0.25%</td>
<td>8.0bc</td>
<td>10.0bc</td>
<td>2.5b</td>
<td>5.0ab</td>
<td>0.0a</td>
<td>7.5bc</td>
</tr>
<tr>
<td>Grandivo+NuFilm P</td>
<td>3 lbs+0.25%</td>
<td>30.0ab</td>
<td>22.5ab</td>
<td>0.0b</td>
<td>15.0a</td>
<td>0.0a</td>
<td>15.0b</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>65.0a</td>
<td>52.5a</td>
<td>22.5a</td>
<td>15.0a</td>
<td>2.5a</td>
<td>40.0a</td>
</tr>
</tbody>
</table>

\[ F = 14.08, \quad P>F = \text{<.0001} \]

\[ P>F = \text{<.0001} < .0001 < .0001 < .0001 < .0001 \]
**Methods**

Head lettuce 'El Guapo' was direct seeded on 7 Sep, 2016 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 45 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each treatment compound are provided in the tables. Three foliar applications were made on 1, 8, and 23 Oct with a CO₂ operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 GPA. An adjuvant, Nufilm P, was applied @ 0.125% vol/vol with each treatment on applications 1 and 3, Silwet was applied as an adjuvant @ 0.125% for application 2. The pH of the spray water in the AzaGuard treatments was lowered to a pH of 5.5 using Neutralizer at 0.1% v/v.

Beet armyworm (BAW) and cabbage looper (CL) control was based on the examination of 10 whole plant at 3, 7, and 10 days following each application (DAA) for the presence of large (2nd or > instar) larvae. The number of plants in each plot with fresh feeding tracks on plants was also recorded. Because of heterogeneity of mean variances, insect data were transformed using a log10 (x-1) function before analysis. Data for percentage of plants with fresh feeding damage on leaves were subjected to an arcsine transformation before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Means from non-transformed data are presented in the tables.

**Summary**

When averaged across all sample dates, Grandivo and Venerate did not significantly control BAW or CL, whereas AzaGuard and Dipel did not control BAW. The Entrust and Xentari treatments significantly reduced both CL and BAW larvae, and had significantly less feeding damage than the untreated check. No differences in control were observed between the 3 and 5 oz Entrust rates.

<table>
<thead>
<tr>
<th>Lep larvae control with organically approved insecticides in lettuce</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Entrust</td>
</tr>
<tr>
<td>Entrust</td>
</tr>
<tr>
<td>AzaGuard</td>
</tr>
<tr>
<td>Dipel</td>
</tr>
<tr>
<td>Xentari</td>
</tr>
<tr>
<td>Grandivo</td>
</tr>
<tr>
<td>Venerate</td>
</tr>
<tr>
<td>Untreated</td>
</tr>
</tbody>
</table>

F value 21.64 36.31 9.91 34.64

P>F <.0001 <.0001 <.0001 <.0001

2019
Methods

Head lettuce ‘EXP1221 SK’ was direct seeded on 5 Sep, 2017 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 45 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each treatment compound are provided in the tables. Two foliar applications were made on 29 Sep and 6 Oct with a CO2 operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 GPA. An adjuvant, Silwet was applied as an adjuvant @ 0.125%. The pH of the spray water in the Aza-Direct and Azera treatments was lowered to a pH of 5.5-6 using Neutralizer at 0.1% v/v.

Beet armyworm (BAW) and cabbage looper (CL) control was based on the examination of 10 whole plant at 3, and 7 days following each application (DAA) for the presence of large (2nd or > instar) larvae. The number of plants in each plot with fresh feeding tracks on plants was also recorded. Because of heterogeneity of mean variances, insect data were transformed using a log10 (x-1) function before analysis. Data for percentage of plants with fresh feeding damage on leaves were subjected to an arcsine transformation before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Means from non-transformed data are presented in the tables.

Summary

CL populations were light and no differences were observed among the spray treatments and the untreated control. In contrast, BAW numbers were moderate to heavy. Entrust provided the best BAW control, and Venerate and Xentari significantly reduced BAW numbers relative to the untreated check. Aza-Direct, Azera, Dipel, and Grandivo did not provide significant BAW control.

Lep larvae control with organically approved insecticides in lettuce

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>CL</th>
<th>BAW</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust</td>
<td>5 oz</td>
<td>0.0a</td>
<td>0.1c</td>
<td>0.1c</td>
</tr>
<tr>
<td>Aza-Direct</td>
<td>3 pts</td>
<td>1.0a</td>
<td>3.5ab</td>
<td>3.5ab</td>
</tr>
<tr>
<td>Azera</td>
<td>32 oz</td>
<td>0.5a</td>
<td>4.8ab</td>
<td>4.8ab</td>
</tr>
<tr>
<td>Dipel</td>
<td>1 lbs</td>
<td>0.8a</td>
<td>4.0ab</td>
<td>4.0ab</td>
</tr>
<tr>
<td>Xentari</td>
<td>1 lbs</td>
<td>0.6a</td>
<td>3.1b</td>
<td>3.1b</td>
</tr>
<tr>
<td>Grandivo</td>
<td>2 lbs</td>
<td>1.5a</td>
<td>5.5ab</td>
<td>5.5ab</td>
</tr>
<tr>
<td>Venerate</td>
<td>2 qts</td>
<td>0.8a</td>
<td>2.8b</td>
<td>2.8b</td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td>0.9a</td>
<td>7.2a</td>
<td>7.2a</td>
</tr>
</tbody>
</table>

\[
\begin{array}{ccc}
F & 1.86 & 11.67 & 13.24 \\
\text{P>F} & 0.13 & <.0001 & <.0001 \\
\end{array}
\]
Lepidopterous Control in Organic Broccoli, Fall 2017

Methods  Broccoli ‘Emerald Crown’ was direct seeded into double row beds on 42 inch centers 7 Sep, 2017. Plots were two beds wide by 45 ft long and bordered by two untreated beds. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Four replications of each treatment were arranged in a RCB design. Product formulations and rates for each compound are provided in the tables. Three foliar sprays were applied on 20 Sep, 1 and 12 Oct with a CO2 pressurized boom sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 23.5 gpa. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.125% vol/vol with these spray treatments.

For assessment of Lepidopterous larvae, 10 plants were randomly selected from each replicate at various intervals following each spray application during the trial. For diamondback moth, beet armyworm, and cabbage looper, whole plants were destructively sampled for the presence of large (2nd or > instar) larvae. Because of heterogeneity of mean variances, data were transformed using a log10 (x + 1) function before analysis and subjected to ANOVA (Proc GLM; SAS Institute 2009). Means were compared means using Turkey’s HSD test (P ≤ 0.05). Means from non-transformed data are presented in the tables.

Summary  CL and BAW population levels were light, and DBM were light-moderate. Against CL, BAW and DBM, Entrust provided control comparable to the local standards Radiant and Proclaim. Xentari only provided significant control against DBM. Overall Entrust was a much more effective biopesticide against Lep larvae than Xentari.

Lep larvae control with organically approved insecticides in broccoli.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>CL</th>
<th>BAW</th>
<th>DBM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiant</td>
<td>5 oz</td>
<td>0.9bc</td>
<td>0.02b</td>
<td>0.6c</td>
<td>1.5c</td>
</tr>
<tr>
<td>Proclaim</td>
<td>4.8 oz</td>
<td>1.7bc</td>
<td>0.2b</td>
<td>0.9c</td>
<td>2.9c</td>
</tr>
<tr>
<td>Entrust</td>
<td>5 oz</td>
<td>0.7c</td>
<td>0.1b</td>
<td>0.5c</td>
<td>1.3c</td>
</tr>
<tr>
<td>Xentari</td>
<td>1.5 lb</td>
<td>2.2ab</td>
<td>0.7ab</td>
<td>3.4b</td>
<td>6.2b</td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td>2.0ab</td>
<td>1.0a</td>
<td>8.3a</td>
<td>11.2a</td>
</tr>
</tbody>
</table>

F value 6.58 8.86 28.86 25.87
P>F <.0001 <.0001 <.0001 <.0001
**Methods**  
Broccoli ‘Emerald Crown’ was direct seeded into double row beds on 42 inch centers 7 Sep, 2017. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Four replications of each treatment were arranged in a RCB design. Product formulations and rates for each compound are provided in the tables. Two foliar sprays were applied on 1 and 11 Oct with a CO2 pressurized boom sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 23.5 gpa. An adjuvant, Silwet (Helena Chemical Co.), was applied at 0.125% vol/vol with these spray treatments. The pH of the spray water in the Pyganic, Aza-Direct and Azera treatments was lowered to a pH of 5.5-6 using Neutralizer at 0.1% v/v.

For assessment of Lepidopterous larvae, 10 plants were randomly selected from each replicate at various intervals following each spray application during the trial. For beet armyworm and cabbage looper, whole plants were destructively sampled for the presence of large (2nd or > instar) larvae. For diamondback moth, the presence of all large (1st - 4th instar) larvae were counted. Because of heterogeneity of mean variances, data were transformed using a log10 (x + 1) function before analysis and subjected to ANOVA (Proc GLM; SAS Institute 2009). Means were compared means using Turkey’s HSD test (P ≤ 0.05). Means from non-transformed data are presented in the tables.

**Summary**  
CL and BAW population levels were light, and DBM were moderate. Entrust was the only treatment that significantly reduced the numbers of all three Lep species relative to the untreated. Dipel significantly reduced BAW and DBM numbers, and Aza-Direct reduced DBM numbers. Larvae numbers in the Pyganic+Azera and Venerate treatments were not significantly different from the untreated control. Overall, Entrust provided the most consistent control of BAW, CL and DBM larvae in this broccoli trial.

---

**Lep larvae control with organically approved insecticides in broccoli.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>BAW</th>
<th>CL</th>
<th>DBM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust</td>
<td>5 oz</td>
<td>0.0b</td>
<td>0.5b</td>
<td>1.0d</td>
<td>1.5e</td>
</tr>
<tr>
<td>Pyganic+Azera</td>
<td>17+48 oz</td>
<td>0.8ab</td>
<td>2.1a</td>
<td>10.8ab</td>
<td>13.7bc</td>
</tr>
<tr>
<td>Venerate</td>
<td>2 qts</td>
<td>0.9ab</td>
<td>3.4a</td>
<td>12.6ab</td>
<td>16.9ab</td>
</tr>
<tr>
<td>Aza-Direct</td>
<td>3 pts</td>
<td>0.7ab</td>
<td>1.7ab</td>
<td>8.8bc</td>
<td>11.2cd</td>
</tr>
<tr>
<td>Dipel</td>
<td>1.5 lbs</td>
<td>0.2b</td>
<td>2.6a</td>
<td>6.4c</td>
<td>9.1d</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>1.6a</td>
<td>3.0a</td>
<td>15.4a</td>
<td>20.1a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th><strong>F value</strong></th>
<th><strong>P&gt;F</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.35</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>8.65</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>57.15</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>100.69</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
Methods   Broccoli ‘Emerald Crown’ was direct seeded into double row beds on 42 inch centers 27 Oct, 2017. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Four replications of each treatment were arranged in a RCB design. Product formulations and rates for each compound are provided in the tables. A single foliar spray was applied on 25 Nov with a CO2 pressurized boom sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 23.5 gpa. An adjuvant, Silwet (Helena Chemical Co.), was applied at 0.125% vol/vol with these spray treatments.

For assessment of diamondback moth larvae, 10 plants were randomly selected from each replicate at various intervals. Whole plants were destructively sampled for the presence of all (1st - 4th instar) larvae were counted. Because of heterogeneity of mean variances, data were transformed using a log10 (x + 1) function before analysis and subjected to ANOVA (Proc GLM; SAS Institute 2009). Means were compared means using Turkey’s HSD test (P ≤ 0.05). Means from non-transformed data are presented in the tables.

Summary   DBM populations level were light. Among the biopesticides only Entrust provided DBM control comparable to the conventional standards (Radiant, Proclaim). When averaged across all samples, all of the treatments significantly reduced DBM compared to the untreated control.

<table>
<thead>
<tr>
<th>Diamondback moth larvae control with organically approved insecticides in broccoli.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean DBM larvae / 10 plants at DAA</strong></td>
</tr>
<tr>
<td>Treatment</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Radiant</td>
</tr>
<tr>
<td>Proclaim</td>
</tr>
<tr>
<td>Entrust</td>
</tr>
<tr>
<td>Dipel</td>
</tr>
<tr>
<td>Xentari</td>
</tr>
<tr>
<td>Untreated</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>P&gt;F</td>
</tr>
</tbody>
</table>
Diamondback Moth Control in Broccoli, Spring 2017

**Methods**  Broccoli 'Emerald Crown' was direct seeded into double row beds on 42 inch centers 27 Oct, 2017. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Four replications of each treatment were arranged in a RCB design. Product formulations and rates for each compound are provided in the tables. Three foliar sprays were applied on 17 and 31 Jan and 8 Feb with a CO2 pressurized boom sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 23.5 gpa. An adjuvant, Silwet (Helena Chemical Co.), was applied at 0.125% vol/vol with these spray treatments.

For assessment of diamondback moth larvae, 10 plants were randomly selected from each replicate 6 days following each application. Whole plants were destructively sampled for the presence of all (1st - 4th instar) larvae were counted. Because of heterogeneity of mean variances, data were transformed using a $\log_{10}(x + 1)$ function before analysis and subjected to ANOVA (Proc GLM; SAS Institute 2009). Means were compared means using Turkey’s HSD test ($P \leq 0.05$). Means from non-transformed data are presented in the tables.

**Summary**  DBM populations were moderate to heavy in this trial. All of the treatments provided significant control of DBM larvae at 6 DAA for each application. Both biopesticides Entrust and Xentari provided DBM control comparable to the conventional standards.

### Diamondback moth larvae control with organically approved insecticides in broccoli.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>6 DAA-1</th>
<th>6 DAA-2</th>
<th>6 DAA-3</th>
<th>Trial Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiant</td>
<td>6 oz</td>
<td>2.0b</td>
<td>12.5b</td>
<td>11.3b</td>
<td>8.0b</td>
</tr>
<tr>
<td>Proclaim</td>
<td>4.8 oz</td>
<td>4.0b</td>
<td>12.9b</td>
<td>6.3b</td>
<td>7.5b</td>
</tr>
<tr>
<td>Entrust</td>
<td>6 oz</td>
<td>4.0b</td>
<td>13.3b</td>
<td>7.1b</td>
<td>7.8b</td>
</tr>
<tr>
<td>Xentari</td>
<td>1.5 lb</td>
<td>0.6b</td>
<td>10.8b</td>
<td>10.4b</td>
<td>8.5b</td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td>16.0a</td>
<td>36.7a</td>
<td>43.3a</td>
<td>25.4a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>F value</th>
<th>6 DAA-1</th>
<th>6 DAA-2</th>
<th>6 DAA-3</th>
<th>Trial Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.91</td>
<td>2.41</td>
<td>6.03</td>
<td>12.44</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0002</td>
<td>0.03</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td></td>
</tr>
</tbody>
</table>
**Methods**  Cabbage ‘Gazzelle’ was direct seeded into double row beds on 42 inch centers 17 Jan, 2018. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Four replications of each treatment were arranged in a RCB design. Product formulations and rates for each compound are provided in the tables. Three foliar sprays were applied on 3, 14, and 24 April with a CO₂ pressurized boom sprayer that delivered a broadcast application through 2 TXVS-18 Conejet nozzles per bed at 40 psi and 23.5 gpa. An adjuvant, Dyne-Amic (Helena Chemical Co.), was applied at 0.25% vol/vol with these spray treatments.

For assessment of diamondback moth (DBM) larvae, 10 plants were randomly selected from each replicate at 6 days following each spray application (DAA) during the trial. Whole plants were destructively sampled for the presence of all larval instars. Because of heterogeneity of mean variances, data were transformed using a log_{10} (x + 1) function before analysis and subjected to ANOVA (Proc GLM; SAS Institute 2009). Means were compared using Turkey’s HSD test (\( P \leq 0.05 \)). Means from non-transformed data are presented in the tables.

**Summary**  DBM populations were heavy in this trial. Similar to the 2017 broccoli trial, all of the treatments provided significant control of DBM larvae at 6 DAA for each application. Both biopesticides, Entrust and Xentari, provided DBM control comparable to the conventional standards Radiant and Proclaim.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>6-DAA1</th>
<th>6-DAA2</th>
<th>6-DAA3</th>
<th>Trial Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiant</td>
<td>5 oz</td>
<td>1.0b</td>
<td>0.0b</td>
<td>0.0b</td>
<td>0.3b</td>
</tr>
<tr>
<td>Proclaim</td>
<td>4.8 oz</td>
<td>0.0b</td>
<td>0.0b</td>
<td>0.8b</td>
<td>0.3b</td>
</tr>
<tr>
<td>Xentari</td>
<td>2 lb</td>
<td>1.0b</td>
<td>0.8b</td>
<td>2.5b</td>
<td>1.4b</td>
</tr>
<tr>
<td>Entrust</td>
<td>5.0 oz</td>
<td>1.5b</td>
<td>0.0b</td>
<td>0.8b</td>
<td>0.8b</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>20.5a</td>
<td>15.8a</td>
<td>153.3a</td>
<td>63.2a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F value</th>
<th>9.49</th>
<th>11.12</th>
<th>11.73</th>
<th>19.76</th>
</tr>
</thead>
<tbody>
<tr>
<td>P&gt;F</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
Methods  Romaine ‘Del Sol’ was direct seeded on 29 Sep, 2016 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each treatment compound are provided in the tables. Two foliar application were made 1 and 11 Nov with a CO2 operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 GPA. No adjuvants were applied with any of the sprays. An acidifier (Neutralizer) was applied at 0.1% vol/vol to the Pyganic, AzaGaurd, Aza-Direct and Azera treatments to modify spray pH to ~5.5.

Numbers of Western flower thrips (WFT) and Bean thrips (BT) from 5 plants per replicate were recorded at 3, 7, and 10 days following each application. Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6 inch sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted. Because of heterogeneity of mean variances, data for all insect were transformed using a log10 (x+1) function before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Means from non-transformed data are presented in the tables.

Summary  Thrips populations were moderate. The Entrust treatments provided the most effective BT and WFT control compared to the other biopesticides. Addition of M-Pede with Entrust, 5 oz enhanced overall WFT control better than Entrust, 7 oz alone. Among the other biopesticides, only Veratran-D significantly reduced WFT adults and larvae compared with the untreated control.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>BT adults</th>
<th>WFT Adults</th>
<th>WFT Larvae</th>
<th>WFT Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust</td>
<td>7 oz</td>
<td>4.5b</td>
<td>5.5bc</td>
<td>4.9cd</td>
<td>10.4c</td>
</tr>
<tr>
<td>Entrust+M-Pede</td>
<td>5 oz + 2%</td>
<td>2.9b</td>
<td>2.9c</td>
<td>3.0d</td>
<td>5.9d</td>
</tr>
<tr>
<td>Entrust+Mantis</td>
<td>5 oz + 1 pt</td>
<td>6.3b</td>
<td>6.3bc</td>
<td>5.9c</td>
<td>12.2c</td>
</tr>
<tr>
<td>Aza-Direct</td>
<td>3.5 pts</td>
<td>21.1a</td>
<td>9.6ab</td>
<td>30.8ab</td>
<td>40.4ab</td>
</tr>
<tr>
<td>AzaGuard</td>
<td>16 oz</td>
<td>20.6a</td>
<td>10.1ab</td>
<td>28.4ab</td>
<td>38.4ab</td>
</tr>
<tr>
<td>Azera</td>
<td>3 pts</td>
<td>19.6a</td>
<td>8.8ab</td>
<td>33.3ab</td>
<td>42.0ab</td>
</tr>
<tr>
<td>Azera+Pyganic</td>
<td>3 pts + 17 oz</td>
<td>20.1a</td>
<td>11.2a</td>
<td>26.5ab</td>
<td>37.6ab</td>
</tr>
<tr>
<td>Pyganic</td>
<td>17 oz</td>
<td>17.7a</td>
<td>10.5ab</td>
<td>37.8a</td>
<td>48.3a</td>
</tr>
<tr>
<td>Veratrans-D</td>
<td>10 lbs</td>
<td>18.5a</td>
<td>6.0bc</td>
<td>19.7b</td>
<td>25.6b</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>23.3a</td>
<td>11.0ab</td>
<td>48.6a</td>
<td>59.7a</td>
</tr>
</tbody>
</table>

| F value  | 58.84           | 9.81     | 62.23   | 58.45   |
| P>F      | <.0001           | <.0001   | <.0001  | <.0001  |
Thrips Control in Organic Head Lettuce, Spring 2016

Methods

Head Lettuce ‘Domingos 67’ was direct seeded on 3 Dec, 2015 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42-inch centers. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each compound are provided in the tables. Four foliar sprays were applied 31 Jan, 10, 16, and 26 Feb. The Entrust +M-Pede treatment only received M-Pede (2%) on the 3rd spray date. The applications were made with a CO₂ pressurized boom sprayer that delivered a broadcast application at 50 psi and 25 gpa through 2 TXVS-18 ConeJet nozzles per bed. An adjuvant, Silwet, was applied at 0.125% to all treatments.

Aphid populations were assessed by estimating the number of aphids/plant in whole plant, destructive samples. On each sampling date, 5-8 plants were randomly selected from each plot and placed individually into large 5-gal tubs. Each plant was sampled by visually examining all plant foliage and counting the number of apterus (non-winged) aphids present. Numbers of western flower thrips (WFT) from 5 plants per replicate were recorded at 3 and 6 days following each application (DAA). Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6-inch sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted. Because of heterogeneity of mean variances, data were transformed using a log₁₀ (x + 1) function before analysis and subjected to ANOVA; means were compared using Turkey’s HSD test (P ≤ 0.05). Means from non-transformed data are presented in the tables.

Summary:

Averaged across all sample evaluations, only the Entrust+M-Pede and the Aza-Direct treatments had significantly fewer total thrips than the untreated control. None of the insecticide treatments provided aphid control (data not shown), although aphid numbers were low.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>Adults</th>
<th>Larvae</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust+M-Pede</td>
<td>5 oz+2%</td>
<td>4.3b</td>
<td>0.8d</td>
<td>5.1c</td>
</tr>
<tr>
<td>Aza-Direct</td>
<td>3.5 pts</td>
<td>8.1a</td>
<td>3.6c</td>
<td>11.7b</td>
</tr>
<tr>
<td>Pyganic</td>
<td>17 oz</td>
<td>7.1a</td>
<td>10.1abc</td>
<td>17.2ab</td>
</tr>
<tr>
<td>Azera</td>
<td>3 pts</td>
<td>8.3a</td>
<td>4.9bc</td>
<td>13.2ab</td>
</tr>
<tr>
<td>PFR-97</td>
<td>2 lbs</td>
<td>8.0a</td>
<td>9.2ab</td>
<td>17.2ab</td>
</tr>
<tr>
<td>Grandivo</td>
<td>3 lbs</td>
<td>7.8a</td>
<td>9.5ab</td>
<td>17.3ab</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>7.8a</td>
<td>13.3a</td>
<td>21.1a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>F value</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16.51</td>
<td>43.63</td>
<td>53.94</td>
<td></td>
</tr>
<tr>
<td>P&gt;F</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td></td>
</tr>
</tbody>
</table>
Thrips Control with Entrust and Adjuvants in Organic Head Lettuce, Spring 2016

**Methods**  Head lettuce 'S7735LD’ was direct seeded on 5 Nov, 2015 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each compound are provided in the tables. Two foliar sprays were applied on 18 and 26 Jan. The applications were made with a CO2 pressurized boom sprayer that delivered a broadcast application at 50 psi and 22.5 gpa through 2 TXVS-18 ConeJet nozzles per bed. Several adjuvants were applied to Entrust at different rates (% vol/vol).

Numbers of WFT from 5 plants per replicate were recorded at 3 and 7 days following each application (DAA). Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6 inch sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted. Because of heterogeneity of mean variances, data were transformed using a $\log_{10}(x + 1)$ function before analysis and subjected to ANOVA; means were compared using Turkey’s HSD test ($P \leq 0.05$). Means from non-transformed data are presented in the tables.

**Summary**  WFT populations levels were light. All the Entrust treatments, regardless of adjuvant used, significantly provided WFT control when averaged across all sample dates. Among adjuvants, M-Pede, Silwet, and Mantis provided the most consistent WFT control compared to Entrust allied without an adjuvant.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>Adults</th>
<th>Larvae</th>
<th>Total</th>
<th>Trial Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust, 7 oz + NuFilm P</td>
<td>0.25%</td>
<td>1.5b</td>
<td>6.4b</td>
<td>7.8b</td>
<td></td>
</tr>
<tr>
<td>Entrust, 7 oz + NanoBS</td>
<td>5%</td>
<td>1.3b</td>
<td>4.7bc</td>
<td>6.0bc</td>
<td></td>
</tr>
<tr>
<td>Entrust, 7 oz + M-Pede</td>
<td>2%</td>
<td>1.2b</td>
<td>3.7c</td>
<td>4.9c</td>
<td></td>
</tr>
<tr>
<td>Entrust, 7 oz + Oroboost</td>
<td>0.25%</td>
<td>0.9b</td>
<td>6.0bc</td>
<td>6.9bc</td>
<td></td>
</tr>
<tr>
<td>Entrust, 7 oz + Silwet</td>
<td>0.25%</td>
<td>1.0b</td>
<td>3.2c</td>
<td>4.2c</td>
<td></td>
</tr>
<tr>
<td>Entrust, 7 oz + Mantis</td>
<td>1 pt</td>
<td>1.2b</td>
<td>3.1c</td>
<td>4.3c</td>
<td></td>
</tr>
<tr>
<td>Entrust, 7 oz</td>
<td>-</td>
<td>1.2b</td>
<td>6.9b</td>
<td>8.1b</td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>3.9a</td>
<td>15.1a</td>
<td>19.0a</td>
<td></td>
</tr>
</tbody>
</table>
Romaine' Solid King’ was direct seeded on 3 Dec, 2015 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each compound are provided in the tables. Two foliar sprays were applied 12 and 27 Feb. The applications were made with a CO2 pressurized boom sprayer that delivered a broadcast application at 50 psi and 22.5 gpa through 2 TXVS-18 ConeJet nozzles per bed. Various adjuvant was applied to the treatments at various rates.

Numbers of WFT from 5 plants per replicate were recorded at 3, 7 and 11 days following each application (DAA). Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6 inch sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted.

Because of heterogeneity of mean variances, data were transformed using a log$_{10} (x + 1)$ function before analysis and subjected to ANOVA; means were compared using Turkey’s HSD test ($P \leq 0.05$). Means from non-transformed data are presented in the tables.

As opposed to the previous head lettuce trial, WFT populations in this romaine trial were much heavier. All the Entrust treatments significantly reduced WFT numbers compared to the untreated check, and the M-Pede+Entrust, 5 oz treatment provided the better control compared to Entrust, 7 oz applied alone.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Adjuvant Rate</th>
<th>Western Flower Thrips / Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adults</td>
<td>Larvae</td>
</tr>
<tr>
<td>Entrust, 5 oz + NuFilm P</td>
<td>0.25%</td>
<td>8.5b</td>
</tr>
<tr>
<td>Entrust, 5 oz + M-Pede</td>
<td>2%</td>
<td>5.7c</td>
</tr>
<tr>
<td>Entrust, 5 oz + Oroboost</td>
<td>0.25%</td>
<td>8.4b</td>
</tr>
<tr>
<td>Entrust, 5 oz + Silwet</td>
<td>0.25%</td>
<td>7.6bc</td>
</tr>
<tr>
<td>Entrust, 5 oz + Mantis</td>
<td>1 pt</td>
<td>7.6bc</td>
</tr>
<tr>
<td>Entrust, 7 oz</td>
<td>-</td>
<td>8.3b</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>16.8a</td>
</tr>
</tbody>
</table>
**Methods**  
Romaine' Solid King’ was direct seeded on 3 Dec, 2015 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each compound are provided in the tables. Two foliar sprays were applied on 2 and 16 Feb. The applications were made with a CO₂ pressurized boom sprayer that delivered a broadcast application at 50 psi and 22.5 gpa through 2 TXVS-18 ConeJet nozzles per bed. No adjuvant was applied to the treatments.

Numbers of WFT from 5 plants per replicate were recorded at various sample dates following each application (DAT). Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6 inch sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted. Because of heterogeneity of mean variances, data were transformed using a log₁₀ (x + 1) function before analysis and subjected to ANOVA; means were compared using Turkey’s HSD test (P ≤ 0.05). Means from non-transformed data are presented in the tables.

**Summary**  
WFT populations in this romaine trial were light-moderate. All the Entrust treatments significantly reduced adult and larval WFT numbers compared to the untreated check, and M-Pede enhanced insecticidal activity when combined rate for rate with Entrust, over Entrust applied alone.

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**Thrips Control with Entrust in Romaine.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>Adult</th>
<th>Larvae</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust</td>
<td>3</td>
<td>4.0ab</td>
<td>4.2b</td>
<td>8.2b</td>
</tr>
<tr>
<td>Entrust</td>
<td>5</td>
<td>3.7bc</td>
<td>2.5bc</td>
<td>6.3bc</td>
</tr>
<tr>
<td>Entrust</td>
<td>7</td>
<td>3.4bc</td>
<td>2.4bc</td>
<td>5.8bc</td>
</tr>
<tr>
<td>Entrust +M-Pede</td>
<td>3+2%</td>
<td>3.1bc</td>
<td>1.4cde</td>
<td>4.5cd</td>
</tr>
<tr>
<td>Entrust +M-Pede</td>
<td>5+2%</td>
<td>3.0bc</td>
<td>1.2de</td>
<td>4.2cd</td>
</tr>
<tr>
<td>Entrust +M-Pede</td>
<td>7+2%</td>
<td>2.7c</td>
<td>1.0e</td>
<td>3.6d</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>7.5a</td>
<td>18.8a</td>
<td>26.3a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F value</th>
<th>P&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.91</td>
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</tr>
<tr>
<td>28.31</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>27.29</td>
<td>&lt;.0001</td>
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</tbody>
</table>
**Thrips Control in Organic Romaine, Fall 2017**

**Methods**  Romaine 'Del Sol' was direct seeded on 21 Sep, 2017 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each treatment compound are provided in the tables. Two foliar application were made 22 Oct and 3 Nov with a CO₂ operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 GPA. An adjuvant, Silwet, was applied at 0.125% vol/vol to all treatments. An acidifier (Neutralizer) was applied at 0.1% vol/vol to the DeBug Turbo, Neemix, Aza-Direct and Azera treatments to modify spray pH to ~5.5.

Numbers of Western flower thrips (WFT) and Bean thrips (BT) from 5 plants per replicate were recorded at 3, 7, and 10 days following each application. Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6 inch sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted. Because of heterogeneity of mean variances, data for all insect were transformed using a log10 (x+1) function before analysis. All data were subjected to ANOVA; means were compared using Turkey's HSD test (P=0.05). Means from non-transformed data are presented in the tables.

**Summary**  WFT population levels were light. Only Entrust provided significant reduction of BT compared to the untreated control. Against WFT larvae, only Entrust and Aza-Direct provided significant control. Overall Entrust was the most effective biopesticide against thrips in romaine.

### Thrips control with organically approved insecticides in romaine.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>Mean Bean WFT / Plant</th>
<th>Mean WFT / Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Adult</td>
</tr>
<tr>
<td>Entrust</td>
<td>7 oz</td>
<td>3.9b</td>
<td>6.5a</td>
</tr>
<tr>
<td>Veratran-D</td>
<td>15 lbs</td>
<td>5.7ab</td>
<td>8.1a</td>
</tr>
<tr>
<td>Aza-Direct</td>
<td>3 pts</td>
<td>5.0ab</td>
<td>7.2a</td>
</tr>
<tr>
<td>Azera</td>
<td>48 oz</td>
<td>6.0a</td>
<td>7.8a</td>
</tr>
<tr>
<td>DeBug Turbo</td>
<td>32 oz</td>
<td>5.8ab</td>
<td>7.6a</td>
</tr>
<tr>
<td>Neemix 4.5</td>
<td>10 oz</td>
<td>5.9ab</td>
<td>7.7a</td>
</tr>
<tr>
<td>Trilogy</td>
<td>2%</td>
<td>5.6ab</td>
<td>7.5a</td>
</tr>
<tr>
<td>M-Pede</td>
<td>2%</td>
<td>6.3a</td>
<td>7.4a</td>
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<tr>
<td>SuffOil-X</td>
<td>2%</td>
<td>6.3a</td>
<td>8.6a</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>6.0a</td>
<td>8.0a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>F value</th>
<th>P&gt;F</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td>14.51</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
**Methods**  
Head lettuce 'Gazelle' was direct seeded on 25 Jan, 2017 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each treatment compound are provided in the tables. Three foliar application was made on 6, 14 and 24 Mar with a CO₂ operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 18 GPA. An acidifier (Neutralizer) was applied at 0.1% vol/vol to the DeBug Turbo, AzaGuard, and Aza-Direct treatments to modify spray pH to ~5.5.

No adjuvants were applied with any of the sprays.

Numbers of WFT from 5 plants per replicate were recorded at 3 and 7 days following each application (DAT). Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6 inch sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted. Because of heterogeneity of mean variances, data for all insect were transformed using a log10 (x+1) function before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Means from non-transformed data are presented in the tables.

**Summary**  
Thrips population levels were light-moderate. Among the biopesticides, only Entrust+M-Pede provided significant control of adults and larvae in this trial.

---

**Thrips control with organically approved insecticides in head lettuce.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>Adult</th>
<th>Larvae</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeBug Turbo</td>
<td>32 oz</td>
<td>13.7a</td>
<td>27.0a</td>
<td>40.7a</td>
</tr>
<tr>
<td>AZA-Direct</td>
<td>3 pts</td>
<td>15.0a</td>
<td>21.3 a</td>
<td>36.3a</td>
</tr>
<tr>
<td>AZAGuard</td>
<td>16 oz</td>
<td>14.3a</td>
<td>23.1a</td>
<td>37.4a</td>
</tr>
<tr>
<td>Entrust+M-Pede</td>
<td>7 oz + 2 %</td>
<td>7.9b</td>
<td>3.4b</td>
<td>11.3b</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>12.1a</td>
<td>34.4a</td>
<td>46.5a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Trial Average</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean WFT/Plant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F value</td>
<td>10.73</td>
<td>41.12</td>
<td>32.51</td>
</tr>
<tr>
<td>P&gt;F</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
Methods  Romaine ‘Del Sol’ was direct seeded on 17 Jan, 2018 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each treatment compound are provided in the tables. Two foliar application was made on 8 and 20 Mar with a CO₂ operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 18 GPA. An acidifier (Neutralizer) was applied at 0.1% vol/vol to the Aza-Direct treatment to modify spray pH to ~5.5. No adjuvants were applied with any of the sprays.

Numbers of WFT from 5 plants per replicate were recorded at 3, 7 and 11 days following each application (DAT). Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6 inch sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted. Because of heterogeneity of mean variances, data for all insect were transformed using a log₁₀(x+1) function before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Means from non-transformed data are presented in the tables.

Summary  Thrips populations were moderate-heavy in the trial. Among the biopesticide treatments only Entrust and Entrust+M-Pede consistently provided significant WFT control compared to the untreated control. Aza-Direct+M-Pede had significantly lower larvae and total WFT numbers compared to the untreated check, but did not provide control comparable to the Entrust treatments. This corroborates previous studies showing that M-Pede combined with a 5 oz rate of Entrust provided control comparable to Entrust at a 7 oz rate.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>Adult</th>
<th>Larvae</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrust</td>
<td>7 oz</td>
<td>12.6bc</td>
<td>6.6c</td>
<td>19.2c</td>
</tr>
<tr>
<td>M-Pede</td>
<td>2%</td>
<td>13.6ab</td>
<td>34.1ab</td>
<td>47.6ab</td>
</tr>
<tr>
<td>Aza-Direct</td>
<td>3 pts</td>
<td>14.1ab</td>
<td>33.5ab</td>
<td>47.6ab</td>
</tr>
<tr>
<td>Entrust + M-Pede</td>
<td>5 oz + 2%</td>
<td>10.0c</td>
<td>4.9c</td>
<td>14.9c</td>
</tr>
<tr>
<td>Aza-Direct + M-Pede</td>
<td>2.5 pts + 2%</td>
<td>11.6abc</td>
<td>30.7b</td>
<td>42.4b</td>
</tr>
<tr>
<td>Grandivo</td>
<td>2 lbs</td>
<td>15.5a</td>
<td>48.5ab</td>
<td>64.1a</td>
</tr>
<tr>
<td>Venerate</td>
<td>2 qts</td>
<td>16.3a</td>
<td>48.0ab</td>
<td>64.3a</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>16.1a</td>
<td>55.9a</td>
<td>72.0a</td>
</tr>
</tbody>
</table>

F value  8.06  72.48  47.81
P>F <.0001 <.0001 <.0001
Aphid Control in Organic Head Lettuce, Spring 2015

Methods  The objective of this study was to evaluate the efficacy of several organically-approved insecticides against green peach and foxglove aphids in lettuce under desert growing conditions. ‘Lettuce’ Navajo’ was direct seeded into double row beds on 42 inch centers on 2 Dec 2014. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each compound are provided in the tables. Three foliar sprays were applied on 28 Jan, 4 and 12 Feb as broadcast applications delivered through 2 TXVS-18 ConeJet nozzles at 29.5 gpa and 60 psi. No adjuvants were applied to any of the treatments. Where instructed by the label, the pH of the spray water was lowered to 5.5 using Buffer X as the acidifier.

Evaluations of green peach and foxglove aphid populations were assessed by estimating the number of aphids/plant in whole plant, destructive samples. On each sample date, six or eight plants were randomly selected from each plot and placed individually into large 5-gal tubs. Each plant was sampled by visually examining all plant foliage and counting the number of live aphids present. Because of heterogeneity of mean variances, data were log transformed (mean+1) and subjected to ANOVA; means were separated using Tukeys ($P = 0.05$). Actual non-transformed means are presented in the tables.

Summary

Aphid populations were light in the trial. None of the spray treatments significantly reduced aphid populations relative the untreated control on any sample date with the exception of AZA-Direct at 6 DAA1. No phytotoxicity was observed in any of the treatments.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate (oz/ac)</th>
<th>6 DAA1</th>
<th>6 DAA2</th>
<th>6 DAA3</th>
<th>12 DAA3</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AzaGuard</td>
<td>16 oz</td>
<td>6.3ab</td>
<td>3.7a</td>
<td>2.7a</td>
<td>4.9a</td>
<td>4.4a</td>
</tr>
<tr>
<td>AzaDirect</td>
<td>3 pts</td>
<td>3.6b</td>
<td>2.8a</td>
<td>2.3a</td>
<td>5.3a</td>
<td>3.7a</td>
</tr>
<tr>
<td>Pyganic</td>
<td>17 oz</td>
<td>5.9ab</td>
<td>5.0a</td>
<td>5.8a</td>
<td>9.8a</td>
<td>6.6a</td>
</tr>
<tr>
<td>M-Pede</td>
<td>2%</td>
<td>7.2ab</td>
<td>3.9a</td>
<td>5.2a</td>
<td>5.5a</td>
<td>5.5a</td>
</tr>
<tr>
<td>AzaDirect+M-Pede</td>
<td>3 pts + 2%</td>
<td>5.3ab</td>
<td>2.7a</td>
<td>11.7a</td>
<td>14.5a</td>
<td>8.6a</td>
</tr>
<tr>
<td>AzaDirect+Pyganic</td>
<td>3 pts + 17 oz</td>
<td>5.5ab</td>
<td>1.5a</td>
<td>2.8a</td>
<td>6.3a</td>
<td>4.0a</td>
</tr>
<tr>
<td>Pyganic+M-Pede</td>
<td>17 oz + 2%</td>
<td>6.0ab</td>
<td>4.2a</td>
<td>1.4a</td>
<td>3.1a</td>
<td>3.7a</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>10.3a</td>
<td>5.5a</td>
<td>5.9a</td>
<td>6.3a</td>
<td>7.0a</td>
</tr>
</tbody>
</table>

| F value          | 2.36  | 2.33  | 0.75  | 0.38  | 0.87  |
| P > F            | 0.06  | 0.06  | 0.63  | 0.91  | 0.54  |
Aphid Control in Organic Cabbage, Spring 2016

Methods Cabbage 'Primo vantage' was direct seeded on 28 Jan, 2016 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Plots were two beds wide by 45 ft long and bordered by two untreated beds. Plots were arranged in a randomized complete block design with 3 replications. Formulations and rates for each compound are provided in the tables. Four applications were made on 3, 10, 17, 25 March. Foliar sprays were applied with a CO2 operated boom sprayer at 50 psi and 25 gpa. A broadcast application was delivered through 4 TX-18 ConeJet nozzles per bed. Oroboost was applied to all treatments at 0.25% vol/vol.

Green peach aphid (GPA) populations were assessed by estimating the number of aphids / plants in whole plant, destructive samples. On each sampling date, 6-8 plants were randomly selected from each plot and placed individually into large 5-gal tubs. Each plant was sampled by visually examining all plant foliage and counting the number of apterous (non-winged) aphids present. Because of heterogeneity of mean variances, data were transformed using a log10 (x + 1) function before analysis and subjected to ANOVA; means were compared using Turkey’s HSD test (P ≤ 0.05). Means from non-transformed data are presented in the table.

Summary: Aphid population was light-moderate. No significant differences in aphid numbers were detected among the biopesticide treatments and the untreated control on each sample date. Averaged across all four sample evaluations (6 DAA), only the Aza-Direct and Azera treatments had significantly fewer aphids than the untreated control.

Aphid control with organically approved insecticides in cabbage.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>6 DAA-1 9-Mar</th>
<th>6 DAA-2 16-Mar</th>
<th>6 DAA-3 22-Mar</th>
<th>6 DAA-4 31-Mar</th>
<th>Trial Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aza-Direct</td>
<td>3.5 pts</td>
<td>5.1a</td>
<td>21.3a</td>
<td>14.1b</td>
<td>18.3a</td>
<td>17.9b</td>
</tr>
<tr>
<td>Pyganic 5.0</td>
<td>17 oz</td>
<td>1.0a</td>
<td>32.6a</td>
<td>29.0a</td>
<td>16.6a</td>
<td>19.8ab</td>
</tr>
<tr>
<td>Azera</td>
<td>3.5 pts</td>
<td>8.3a</td>
<td>35.2a</td>
<td>13.6b</td>
<td>13.6a</td>
<td>17.7b</td>
</tr>
<tr>
<td>Mantis</td>
<td>2 pts</td>
<td>12.5a</td>
<td>34.2a</td>
<td>27.2a</td>
<td>14.9a</td>
<td>22.2ab</td>
</tr>
<tr>
<td>M-Pede</td>
<td>2%</td>
<td>12.8a</td>
<td>33.0a</td>
<td>26.9a</td>
<td>29.9a</td>
<td>25.6ab</td>
</tr>
<tr>
<td>PFR-97</td>
<td>2 lbs</td>
<td>16.1a</td>
<td>30.8a</td>
<td>24.2a</td>
<td>30.3a</td>
<td>25.3ab</td>
</tr>
<tr>
<td>Gandivo</td>
<td>3 lbs</td>
<td>21.1a</td>
<td>33.3a</td>
<td>30.8a</td>
<td>20.6a</td>
<td>26.5ab</td>
</tr>
<tr>
<td>BugBomb</td>
<td>2.3%</td>
<td>14.3a</td>
<td>34.8a</td>
<td>28.9a</td>
<td>30.4a</td>
<td>27.1ab</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>18.4a</td>
<td>54.1a</td>
<td>37.9a</td>
<td>38.8a</td>
<td>37.3a</td>
</tr>
</tbody>
</table>

\[
F = 2.12 \quad 0.88 \quad 4.62 \quad 3.57 \quad 3.42 \\
P>F = 0.1 \quad 0.55 \quad 0.01 \quad 0.01 \quad 0.02
\]
Methods  Cabbage 'Primo vantage' was direct seeded was direct seeded on 17 Nov, 2017 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Plots were two beds wide by 45 ft long and bordered by two untreated beds. Plots were arranged in a randomized complete block design with 3 replications. Formulations and rates for each compound are provided in the tables. Three applications were made on 13 and 21 Feb and 3 March. Foliar sprays were applied with a CO₂ operated boom sprayer at 50 psi and 25 gpa. A broadcast application was delivered through 4 TX-18 ConeJet nozzles per bed. Oroboost was applied to all treatments at 0.25% vol/vol. An acidifier (Neutralizer) was applied at 0.1% vol/vol to the Ecozin, PFR-97, DeBug Turbo, Aza-Direct and Azera treatments to modify spray pH to ~5.5. No adjuvants were applied with any of the sprays.

Green peach aphid (GPA) populations were assessed at 6 days following each application (DAA) by estimating the number of aphids / plants in whole plant, destructive samples. On each sampling date, 6-8 plants were randomly selected from each plot and placed individually into large 5-gal tubs. Each plant was sampled by visually examining all plant foliage and counting the number of apterous (non-winged) aphids present. Because of heterogeneity of mean variances, data were transformed using a $\log_{10}(x + 1)$ function before analysis and subjected to ANOVA; means were compared using Turkey’s HSD test ($P \leq 0.05$). Means from non-transformed data are presented in the table.

Summary: Aphid population levels were heavy. At 6 DAA1, only the PFR 97 treatment had significantly fewer aphids than the untreated control, and at 6 DAA3, only Aza-Direct had fewer aphids than the untreated control. Averaged across all four sample evaluations (6 DAA), Aza-Direct had significantly fewer aphids than the untreated control.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>6 DAA1</th>
<th>6 DAA2</th>
<th>6 DAA3</th>
<th>Trial Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aza-Direct</td>
<td>30 oz</td>
<td>125.3a</td>
<td>119.2a</td>
<td>35.9b</td>
<td>93.5b</td>
</tr>
<tr>
<td>Ecozin</td>
<td>2 lbs</td>
<td>118.8a</td>
<td>150.1a</td>
<td>57.1ab</td>
<td>108.7ab</td>
</tr>
<tr>
<td>Azera</td>
<td>2 pts</td>
<td>135.9a</td>
<td>156.8a</td>
<td>42.1ab</td>
<td>111.6ab</td>
</tr>
<tr>
<td>DeBug Turbo</td>
<td>32 oz</td>
<td>137.3a</td>
<td>155.3a</td>
<td>56.9ab</td>
<td>116.5ab</td>
</tr>
<tr>
<td>M-Pede</td>
<td>2%</td>
<td>145.9a</td>
<td>216.2a</td>
<td>49.9ab</td>
<td>137.4ab</td>
</tr>
<tr>
<td>PFR 97</td>
<td>2%</td>
<td>90.2b</td>
<td>288.3a</td>
<td>63.6ab</td>
<td>147.4ab</td>
</tr>
<tr>
<td>Trilogy</td>
<td>2 oz</td>
<td>133.9a</td>
<td>301.9a</td>
<td>45.1ab</td>
<td>160.3ab</td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td>161.8a</td>
<td>277.8a</td>
<td>81.2a</td>
<td>173.5a</td>
</tr>
</tbody>
</table>

$F$ 3.21 5.31 19.58 32.74  
$P>F$ 0.01 0.0007 <.0001 <.0001
Methods Spinach 'Cello' was planted on 84 inch beds in a plant density of 18 seedlines per bed on 27 Jan, 2016. Stands were established with sprinkler irrigation and irrigated with sprinklers thereafter. Plots for each trial consisted of a single 84" bed, 35' long with a 5 ft buffer within rows and a 1 bed untreated buffer between plots. Plots were arranged in a randomized complete block design with 4 replications. Formulations and rates for each compound are provided in the tables. Three applications were made on 3, 14 and 20 March. Beleaf was only applied on 3 and 20 Mar. The foliar sprays were applied with a CO2 operated boom sprayer at 50 psi and 25 gpa. A broadcast application was delivered through 4 TX-18 ConeJet nozzles per bed. No adjuvants were applied to any of the treatments. An acidifier (Neutralizer) was applied at 0.1% vol/vol to the Pyganic, PFR-97, Aza-Direct and Azera treatments to modify spray pH to ~5.5. No adjuvants were applied with any of the sprays.

Green peach aphid (GPA) populations were assessed by estimating the number of aphids / plants in whole plant, destructive samples. On each sampling date, 10 plants were randomly selected from each plot and placed individually into large 5-gal tubs. Each plant was sampled by visually examining all plant foliage and counting the number of apterous (non-winged) aphids present. Because of heterogeneity of mean variances, data were transformed using a log10 (x + 1) function before analysis and subjected to ANOVA; means were compared using Turkey’s HSD test (P ≤ 0.05). Means from non-transformed data are presented in the table.

Summary Following three applications and averaged across all sample evaluations, all of the insecticide treatments had significantly fewer aphids then the untreated control. Aphid numbers were lowest in the conventional standard (Beleaf), and aphid numbers did not differ significantly among the biopesticide treatments.

Aphid control with organically approved insecticides in spinach.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>GPA / 10 Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>5 DAA-1</td>
</tr>
<tr>
<td>Aza-Direct</td>
<td>3.5 pt</td>
<td>11.5a</td>
</tr>
<tr>
<td>Pyganic 5.0</td>
<td>17 oz</td>
<td>9.3a</td>
</tr>
<tr>
<td>M-Pede</td>
<td>2%</td>
<td>12.0a</td>
</tr>
<tr>
<td>PFR-97</td>
<td>2 lbs</td>
<td>8.5a</td>
</tr>
<tr>
<td>Grandivo</td>
<td>3 lbs</td>
<td>5.3ab</td>
</tr>
<tr>
<td>Azera</td>
<td>3.5 pt</td>
<td>7.0a</td>
</tr>
<tr>
<td>BugBomber</td>
<td>2.30%</td>
<td>4.5ab</td>
</tr>
<tr>
<td>Beleaf</td>
<td>3.8 oz</td>
<td>0.3b</td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td>14.3a</td>
</tr>
</tbody>
</table>

F  4.36  26.5  8.17  3.85  1.99  26.67
P>F .002 <.0001 <.0001 .005  .09 <.0001
**Methods**  
Head lettuce 'Gazelle' was direct seeded on 25 Jan, 2017 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each treatment compound are provided in the tables. Four foliar application was made on 5, 11, 17 and 24 Mar with a CO2 operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 GPA. An acidifier (Neutralizer) was applied at 0.1% vol/vol to the DeBug Turbo, Neemix, AzaGuard, Aza-Direct and Azera treatments to modify spray pH to ~5.5. No adjuvants were applied with any of the sprays.

Evaluations of aphid populations were assessed by estimating the number of aphids / plant in whole plant, destructive samples at 5 days following each application (DAA). On each sample date, 5 plants were randomly selected from each plot and placed individually into large 5-gal tubs. Each plant was sampled by visually examining all plant foliage and counting the number of live aphids present. Numbers of WFT from 5 plants per replicate were recorded at 5 days following each application (DAA). Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6 inch sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted. Because of heterogeneity of mean variances, data for all insect were transformed using a log10 (x+1) function before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Means from non-transformed data are presented in the tables.

**Summary**  
Aphid and thrips population levels were light-moderate. Averaged across all sample dates, all of the biopesticide treatments except Neemix had significantly fewer aphids than the untreated control. Following 4 spray applications, only ~50% control of the aphids was achieved. Furthermore, none of the biopesticide treatments significantly reduced numbers of WFT adults and larvae relative to the untreated control.

**Aphid control with organically approved insecticides in head lettuce.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>5 DAA1</th>
<th>5 DAA2</th>
<th>5 DAA3</th>
<th>5 DAA4</th>
<th>Trial Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aza-Direct</td>
<td>3 pts</td>
<td>33.8a</td>
<td>9.7a</td>
<td>2.6b</td>
<td>0.3a</td>
<td>11.6b</td>
</tr>
<tr>
<td>AzaGuard</td>
<td>16 oz</td>
<td>26.0a</td>
<td>9.4a</td>
<td>2.5b</td>
<td>0.2a</td>
<td>9.5b</td>
</tr>
<tr>
<td>PFR 97</td>
<td>2 lbs</td>
<td>24.5a</td>
<td>12.4a</td>
<td>3.0ab</td>
<td>0.2a</td>
<td>10.0b</td>
</tr>
<tr>
<td>Azera</td>
<td>2 pts</td>
<td>21.6a</td>
<td>12.6a</td>
<td>2.5b</td>
<td>0.3a</td>
<td>9.2b</td>
</tr>
<tr>
<td>DeBug Turbo</td>
<td>32 oz</td>
<td>27.7a</td>
<td>10.1a</td>
<td>1.7b</td>
<td>0.1a</td>
<td>9.9b</td>
</tr>
<tr>
<td>Neemix 4.5</td>
<td>10 oz</td>
<td>46.0a</td>
<td>13.7a</td>
<td>2.4b</td>
<td>0.3a</td>
<td>15.6ab</td>
</tr>
<tr>
<td>Trilogy</td>
<td>2%</td>
<td>25.3a</td>
<td>10.0a</td>
<td>1.7b</td>
<td>0.2a</td>
<td>9.3b</td>
</tr>
<tr>
<td>M-Pede</td>
<td>2%</td>
<td>25.5a</td>
<td>11.2a</td>
<td>2.3b</td>
<td>0.2a</td>
<td>9.8b</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>50.1a</td>
<td>21.7a</td>
<td>6.1a</td>
<td>0.5a</td>
<td>19.6a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>F value</th>
<th>P&gt;F</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.44</td>
<td>0.23</td>
<td>0.21</td>
<td>0.0009</td>
<td>0.77</td>
<td>0.004</td>
</tr>
<tr>
<td>B</td>
<td>1.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>5.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>0.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>4.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---
## Thrips control with organically approved insecticides in head lettuce.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>Adults</th>
<th>Larvae</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aza-Direct</td>
<td>3 pts</td>
<td>13.2a</td>
<td>14.4a</td>
<td>27.6a</td>
</tr>
<tr>
<td>AzaGuard</td>
<td>16 oz</td>
<td>10.8a</td>
<td>16.2a</td>
<td>27.0a</td>
</tr>
<tr>
<td>PFR 97</td>
<td>2 lbs</td>
<td>11.6a</td>
<td>23.9a</td>
<td>35.5a</td>
</tr>
<tr>
<td>Azeria</td>
<td>2 pts</td>
<td>9.8a</td>
<td>21.4a</td>
<td>31.2a</td>
</tr>
<tr>
<td>DeBug Turbo</td>
<td>32 oz</td>
<td>9.8a</td>
<td>14.5a</td>
<td>24.3a</td>
</tr>
<tr>
<td>Neemix 4.5</td>
<td>10 oz</td>
<td>9.6a</td>
<td>20.7a</td>
<td>30.3a</td>
</tr>
<tr>
<td>Trilogy</td>
<td>2%</td>
<td>10.5a</td>
<td>27.2a</td>
<td>37.7a</td>
</tr>
<tr>
<td>M-Pede</td>
<td>2%</td>
<td>9.1a</td>
<td>17.8a</td>
<td>26.9a</td>
</tr>
<tr>
<td>Untreated</td>
<td>-</td>
<td>10.8a</td>
<td>26.7a</td>
<td>37.5a</td>
</tr>
</tbody>
</table>

| F value          | 1.15    | 2.41   | 2.24   |
| P>F              | 0.36    | 0.05   | 0.06   |
Methods

Head lettuce 'Magosa' was direct seeded on 17 Dec, 2017 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42 inch centers. Stand establishment was achieved using overhead sprinkler irrigation, with furrow irrigation used thereafter. Plots were two beds wide by 35 ft long and bordered by two untreated beds. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each treatment compound are provided in the tables. Three foliar application was made on 3, 9 and 17 Feb with a CO₂ operated sprayer that delivered a broadcast application through 2 TXVS-18 ConeJet nozzles per bed at 40 psi and 22.5 GPA. An acidifier (Neutralizer) was applied at 0.1% vol/vol to the Ecozin, DeBug Turbo, Aza-Direct and Azera treatments to modify spray pH to ~5.5. No adjuvants were applied with any of the sprays.

Evaluations of aphid populations were assessed by estimating the number of aphids/plant in whole plant, destructive samples at 6 days following each application (DAA). On each sample date, 5 plants were randomly selected from each plot and placed individually into large 5-gal tubs. Each plant was sampled by visually examining all plant foliage and counting the number of live aphids present. Numbers of WFT from 5 plants per replicate were recorded at 6 days following each application (DAA). Relative WFT numbers were measured by removing plants and beating them vigorously against a screened pan (12 inch x 7 inch x 2 inch) for a predetermined time (10 s). A 6 inch by 6 inch sticky card was placed inside of the pan to catch the dislodged WFT. Sticky cards were then taken to the laboratory where adult and larvae were counted. Because of heterogeneity of mean variances, data for all insect were transformed using a log10 (x+1) function before analysis. All data were subjected to ANOVA; means were compared using Turkey’s HSD test (P=0.05). Means from non-transformed data are presented in the tables.

Summary

Aphid and thrips population levels were light. Averaged across all sample dates, none of the biopesticide treatments had significantly fewer aphids than the untreated control. Only the conventional standard, Sequoia, significantly reduced aphid numbers. None of the biopesticide treatments significantly reduced numbers of WFT adults, whereas only Aza-Direct, Ecozin, Azera, and Debug Turbo had significantly few larvae than the untreated control.

### Aphid control with organically approved insecticides in head lettuce.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>6 DAA1</th>
<th>6 DAA2</th>
<th>6 DAA3</th>
<th>Trial Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aza-Direct</td>
<td>3 pts</td>
<td>5.1 a</td>
<td>0.9 ab</td>
<td>0.8 ab</td>
<td>3.1 a</td>
</tr>
<tr>
<td>Ecozin</td>
<td>30 oz</td>
<td>3.2 ab</td>
<td>0.9 ab</td>
<td>1.9 a</td>
<td>3.2 a</td>
</tr>
<tr>
<td>PFR 97</td>
<td>2 lbs</td>
<td>4.2 a</td>
<td>1.4 a</td>
<td>1.3 a</td>
<td>3.6 a</td>
</tr>
<tr>
<td>Azera</td>
<td>2 pts</td>
<td>4.0 ab</td>
<td>1.7 a</td>
<td>1.5 a</td>
<td>3.6 a</td>
</tr>
<tr>
<td>DeBug Turbo</td>
<td>32 oz</td>
<td>4.2 a</td>
<td>1.3 ab</td>
<td>1.6 a</td>
<td>3.2 a</td>
</tr>
<tr>
<td>Trilogy</td>
<td>2%</td>
<td>5.3 a</td>
<td>2.7 a</td>
<td>2.9 a</td>
<td>4.2 a</td>
</tr>
<tr>
<td>M-Pede</td>
<td>2%</td>
<td>4.2 a</td>
<td>1.4 a</td>
<td>2.0 a</td>
<td>4.0 a</td>
</tr>
<tr>
<td>Sequoia</td>
<td>2 oz</td>
<td>1.0 b</td>
<td>0.1 b</td>
<td>0.2 b</td>
<td>1.5 b</td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td>6.2 a</td>
<td>1.5 a</td>
<td>1.7 a</td>
<td>4.3 a</td>
</tr>
</tbody>
</table>

F value 4.05 3.59 5.15 9.58

P>F 0.004 0.007 0.0008 <.0001
Thrips control with organically approved insecticides in head lettuce.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate/ac</th>
<th>Adult</th>
<th>Larvae</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aza-Direct</td>
<td>3 pts</td>
<td>8.4a</td>
<td>6.8cd</td>
<td>15.2abc</td>
</tr>
<tr>
<td>Ecozin</td>
<td>30 oz</td>
<td>7.8a</td>
<td>7.0cd</td>
<td>14.8bc</td>
</tr>
<tr>
<td>PFR 97</td>
<td>2 lbs</td>
<td>8.3a</td>
<td>9.0abc</td>
<td>17.3ab</td>
</tr>
<tr>
<td>Azera</td>
<td>2 pts</td>
<td>7.8a</td>
<td>7.8bcd</td>
<td>15.6abc</td>
</tr>
<tr>
<td>DeBug Turbo</td>
<td>32 oz</td>
<td>8.6a</td>
<td>7.7bcd</td>
<td>16.3ab</td>
</tr>
<tr>
<td>Trilogy</td>
<td>2%</td>
<td>8.7a</td>
<td>9.3abc</td>
<td>18.0ab</td>
</tr>
<tr>
<td>M-Pede</td>
<td>2%</td>
<td>8.9a</td>
<td>10.6ab</td>
<td>19.4a</td>
</tr>
<tr>
<td>Sequoia</td>
<td>2 oz</td>
<td>6.5a</td>
<td>6.3d</td>
<td>12.8c</td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td>9.2a</td>
<td>11.3a</td>
<td>20.4a</td>
</tr>
</tbody>
</table>

| F value | 4.05 | 3.59 | 5.15 |
| P>F     | 0.004| 0.007| 0.0008 |