Evaluation of Insect Repellents and Barriers as Methods to Control Cucumber Mosaic Virus of Bell Peppers

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UC Cooperative Extension-Kern
Kern County

Southern most county in the San Joaquin Valley

Major crops are Almonds, Table Grapes, Citrus, Pistachios, Carrots, Potatoes

2007 Bell Peppers accounted for 2,670 acres with a value of $41.8 million. Average yield was 18 tons/A in 2007
Cucumber Mosaic Virus

- CMV has been afflicting peppers in Kern County for 5 years
- Appears most heavily in the southern end of the county near Mettler
- Some years worse than others
- The earlier it appears in the season, the more damage occurs
- Aphid-transmitted.
Control of CMV

• Essentially none

• Plants are treated with imidacloprid as seedlings in greenhouses

• Imidacloprid treatments continue through season

• Organic fields treated with biologicals
  - Lady bug release
  - Lacewing, etc
Control of CMV

- Aphids can probe and transmit the virus before they are killed by insecticides

- Goal is to prevent aphids from landing on plants
How to Prevent Aphids from Landing on Plants?

• Insect repellents
  - Botanical oils that repel insects
  - Reflective mulches that repel insects

• Insect barriers
  - Floating row covers
Time for a Field Experiment!

1. Control-bare ground
2. Citronella oil
3. Citronella oil, Clove oil, & Geranium oil
4. Clove oil & Rosemary oil
5. Garlic oil
6. Garlic oil & Citronella oil
7. Floating Row Cover
8. Silver Reflective Mulch

California Organic Fertilizers, Inc.
7600 N. Ingram Ave., Suite 121,
Fresno, CA 93711
Tel: (800) 269-5690

Agribon AG15
Brite-N'up Silver Mulch 0.5 Mil
Peaceful Valley Farm Supply
P.O. Box 2209, 125 Clydesdale Court
Grass Valley, CA 95945
Field Trial

- Trial started at the time of transplanting
- Floating row cover and reflective mulch applied minutes after transplanting
- Botanical oils sprayed on a weekly basis beginning at the time of planting
- Yellow sticky cards placed just above canopy to monitor aphid flights and numbers on a weekly basis
- 2 trials conducted, 2\textsuperscript{nd} trial w/o botanical oils. Both in a commercial, organic field
Table 1. Aphid counts of botanical oils, reflective mulch and floating row cover in trial 1.

<table>
<thead>
<tr>
<th></th>
<th>3/13/08</th>
<th>3/20/08</th>
<th>3/26/08</th>
<th>4/02/08</th>
<th>4/10/08</th>
<th>4/17/08</th>
<th>4/24/08</th>
<th>5/01/08</th>
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</thead>
<tbody>
<tr>
<td>1. Control</td>
<td>19.25 B</td>
<td>53.8 AB</td>
<td>24.5 BC</td>
<td>28.8 B</td>
<td>42.0 AB</td>
<td>9.3 AB</td>
<td>26.3 AB</td>
<td>7.8</td>
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<tr>
<td>2. Citronella</td>
<td>33.0 A</td>
<td>70.0 A</td>
<td>42.0 A</td>
<td>43.5 A</td>
<td>51.3 A</td>
<td>15.0 A</td>
<td>30.5 A</td>
<td>X</td>
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<tr>
<td>3. Citro/Clove/Geranium</td>
<td>22.8 AB</td>
<td>53.0 AB</td>
<td>33.3 AB</td>
<td>34.8 AB</td>
<td>25.5 CD</td>
<td>8.5 AB</td>
<td>26.8 AB</td>
<td>X</td>
</tr>
<tr>
<td>4. Clove/Rosemary</td>
<td>20.8 B</td>
<td>50.3 AB</td>
<td>28.5 AB</td>
<td>32.8 AB</td>
<td>28.0 BCD</td>
<td>5.8 BC</td>
<td>20.0 BC</td>
<td>X</td>
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<tr>
<td>5. Garlic Oil</td>
<td>20.3 B</td>
<td>42.0 B</td>
<td>26.5 B</td>
<td>38.3 AB</td>
<td>36.7 AB</td>
<td>9.5 AB</td>
<td>31.5 A</td>
<td>X</td>
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<tr>
<td>6. Garlic/Citronella</td>
<td>25.0 AB</td>
<td>66.8 AB</td>
<td>35.5 AB</td>
<td>38.5 AB</td>
<td>38.8 ABC</td>
<td>14.8 A</td>
<td>27.5 AB</td>
<td>X</td>
</tr>
<tr>
<td>7. Floating Row Cover</td>
<td>1.0 C</td>
<td>0.8 C</td>
<td>0.0 D</td>
<td>0.5 D</td>
<td>0.3 E</td>
<td>0.0 C</td>
<td>0.3 D</td>
<td>0.0</td>
</tr>
<tr>
<td>8. Reflective Mulch</td>
<td>5.0 C</td>
<td>8.5 C</td>
<td>9.5 D</td>
<td>15.0 C</td>
<td>14.0 DE</td>
<td>3.5 BC</td>
<td>14.5 C</td>
<td>11.0</td>
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</table>

P=0.05  
0.00001 0.00001 0.0002 0.0000 0.0000 0.0030 0.0000

%CV=  
39.77 40.99 42.17 28.17 34.71 58.35 27.94

LSD, P=0.05  
1. Control
2. Citronella
3. Citronella/Clove Oil/Geranium
4. Clove oil/Rosemary oil
5. Garlic oil
6. Garlic oil/Citronella oil
7. Floating Row Cover
8. Reflective Mulch
Table 2. Aphid counts of reflective mulch, floating row cover in trial 2

<table>
<thead>
<tr>
<th></th>
<th>4/02/08</th>
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<th>4/24/08</th>
<th>05/01/08</th>
<th>05/07/08</th>
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<tbody>
<tr>
<td>1. Control</td>
<td>24.0 A</td>
<td>23.5 A</td>
<td>10.0 A</td>
<td>17.3 A</td>
<td>18.8 A</td>
<td>6.8 A</td>
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<tr>
<td>2. Floating Row Cover</td>
<td>0.5 B</td>
<td>0.0 C</td>
<td>0.3 B</td>
<td>0.3 B</td>
<td>0.3 C</td>
<td>1.0 B</td>
</tr>
<tr>
<td>3. Reflective Mulch</td>
<td>6.5 B</td>
<td>9.5 B</td>
<td>3.5 B</td>
<td>10.5 A</td>
<td>10.0 B</td>
<td>4.0 A</td>
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P=0.05

<table>
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<tr>
<th></th>
<th>0.004</th>
<th>0.002</th>
<th>0.0012</th>
<th>0.0049</th>
<th>0.0052</th>
<th>0.0072</th>
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<tbody>
<tr>
<td>%CV=</td>
<td>38.30</td>
<td>31.78</td>
<td>43.18</td>
<td>47.882</td>
<td>50.59</td>
<td>41.48</td>
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<td>LSD, P=0.05</td>
<td>6.848</td>
<td>6.049</td>
<td>3.424</td>
<td>7.732</td>
<td>8.462</td>
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</table>
Weekly Aphid Counts

- Control
- Floating Row Cover
- Reflective Mulch

Dates:
- 4/2/2008
- 4/9/2008
- 4/16/2008
- 4/23/2008
- 4/30/2008
- 5/7/2008
Harvest Data
- Total weight
- Weight for each grade category
- Total number peppers
- Number peppers for each grade category
<table>
<thead>
<tr>
<th></th>
<th>06/04/08</th>
<th>06/17/08</th>
<th>06/25/08</th>
<th>Total</th>
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<tbody>
<tr>
<td>1. Control</td>
<td>9.1 lb</td>
<td>28.3 lb</td>
<td>14.7 lb</td>
<td>52.2 ABC</td>
</tr>
<tr>
<td>2. Citronella</td>
<td>4.8</td>
<td>21.7</td>
<td>16.0</td>
<td>42.5 CD</td>
</tr>
<tr>
<td>3. Citronella/Clove/Geranium</td>
<td>6.0</td>
<td>27.5</td>
<td>16.4</td>
<td>49.9 ABCD</td>
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<tr>
<td>4. Clove/Rosemary</td>
<td>4.4</td>
<td>27.3</td>
<td>17.1</td>
<td>48.9 BCD</td>
</tr>
<tr>
<td>5. Garlic Oil</td>
<td>5.7</td>
<td>30.0</td>
<td>18.2</td>
<td>54.0 AB</td>
</tr>
<tr>
<td>6. Garlic/Citronella</td>
<td>7.7</td>
<td>23.1</td>
<td>20.1</td>
<td>50.9 ABC</td>
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<tr>
<td>7. Floating Row Cover</td>
<td>6.5</td>
<td>16.1</td>
<td>17.7</td>
<td>40.4 D</td>
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<td>8. Reflective Mulch</td>
<td>9.6</td>
<td>26.6</td>
<td>24.1</td>
<td>60.2 A</td>
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P=0.05  
%CV=  
LSD, P=0.05  
LSD, P=0.10
## Harvest Dates

<table>
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<tr>
<th></th>
<th>06/20/08</th>
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<th>07/17/08</th>
<th>Total</th>
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<tbody>
<tr>
<td><strong>1. Control</strong></td>
<td>11.1</td>
<td>15.1</td>
<td>13.2</td>
<td>39.4</td>
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<tr>
<td><strong>2. Floating Row Cover</strong></td>
<td>19.3</td>
<td>33.0</td>
<td>12.2</td>
<td>64.5</td>
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<tr>
<td><strong>3. Reflective Mulch</strong></td>
<td>25.6</td>
<td>53.4</td>
<td>20.0</td>
<td>99.0</td>
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P=0.05

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<tr>
<th></th>
<th>0.2781</th>
<th>0.0193</th>
<th>0.0557</th>
<th>0.0386</th>
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</table>

%CV=

|                | 61.67    | 39.56    | 25.55    | 36.50  |

LSD, P=0.05

|                | 19.9     | 23.2     | 6.7      | 42.7   |
Yield Totals after 3 Harvests of 40 feet of Row

Yield Totals:
- 1st harvest: 10 lbs
- 2nd harvest: 20 lbs
- 3rd harvest: 30 lbs
Total Yield after 3 Harvests per 40 ft plot

- Control
- Row Cover
- Reflective Mulch

Yield:
- 1st harvest
- 2nd harvest
- 3rd harvest

Control: 20 lbs
Row Cover: 60 lbs
Reflective Mulch: 100 lbs
2009 Pepper Trial

1. Non-treated Control
2. Floating Row Cover
3. Silver Reflective Mulch
4. Green Mulch
5. Red Mulch
6. Black Mulch
7. Silver Mulch
8. Surround Sprayed on beds as a Reflective Mulch
9. Surround sprayed onto plant canopy
10. White Mulch
Weekly Thrip Counts 2009

Number Thrips per Trap

0 200 400 600 800 1000 1200 1400 1600 1800


Legend:
- Control
- Floating Cover
- Reflective Mulch
- Green Mulch
- Red Mulch
- Black Mulch
- Silver Mulch
- Surround/Ground
- Surround/Canopy
- White Mulch
# Harvest Weights (lbs)

<table>
<thead>
<tr>
<th></th>
<th>BB’s Marketable Wt</th>
<th>Cull Wt</th>
<th>Total Marketable Wt</th>
<th>Total Processing Wt</th>
<th>Total Wt.</th>
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<tbody>
<tr>
<td>1. Control</td>
<td>1.14</td>
<td>0.12</td>
<td>16.61 BC</td>
<td>5.53 BC</td>
<td>22.14 BC</td>
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<tr>
<td>2. Row Cover</td>
<td>1.16</td>
<td>0.00</td>
<td>4.91 D</td>
<td>2.66 C</td>
<td>7.58 D</td>
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<tr>
<td>3. Silver Reflective Mulch</td>
<td>1.11</td>
<td>0.00</td>
<td>16.49 BC</td>
<td>4.56 C</td>
<td>21.04 C</td>
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<td>4. Green Mulch</td>
<td>0.76</td>
<td>0.41</td>
<td>18.26 ABC</td>
<td>9.63 AB</td>
<td>27.89 A</td>
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<td>5. Red Mulch</td>
<td>0.69</td>
<td>0.76</td>
<td>22.68 A</td>
<td>6.49 ABC</td>
<td>29.16 A</td>
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<tr>
<td>6. Black Mulch</td>
<td>1.15</td>
<td>0.59</td>
<td>20.33 AB</td>
<td>5.09 BC</td>
<td>25.11 ABC</td>
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<tr>
<td>7. Silver Mulch</td>
<td>0.64</td>
<td>0.10</td>
<td>18.60 ABC</td>
<td>5.51 BC</td>
<td>24.11 ABC</td>
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<td>8. Surround Mulch</td>
<td>0.55</td>
<td>0.33</td>
<td>15.20 BC</td>
<td>10.81 A</td>
<td>26.66 AB</td>
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<tr>
<td>9. Surround Whitewash</td>
<td>0.87</td>
<td>0.26</td>
<td>17.80 ABC</td>
<td>6.75 ABC</td>
<td>24.55 ABC</td>
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<td>10. White Mulch</td>
<td>0.95</td>
<td>0.26</td>
<td>14.73 C</td>
<td>7.08 ABC</td>
<td>21.80 BC</td>
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<tr>
<td>P=0.05</td>
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<td>0.2142</td>
<td>0.0001</td>
<td>0.0454</td>
<td>0.0000</td>
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<tr>
<td>% CV</td>
<td>56.11</td>
<td>146.59</td>
<td>21.93</td>
<td>48.81</td>
<td>16.47</td>
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<tr>
<td>LSD, P=0.05</td>
<td>NS</td>
<td>NS</td>
<td>5.299</td>
<td>4.547</td>
<td>5.516</td>
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</table>
Conclusions

• Botanical oils do not repel aphids
• Reflective mulches do an excellent job of repelling aphids
• Floating row covers essentially allow zero aphids to reach plants.
• Reduction of aphids from landing on plants results in less CMV.
• Less CMV results in increased yields of peppers.
• Silver Mulch, Silver Reflective Mulch, and Floating Row Cover reduce thrip counts. Other colors increase thrip counts.
Thanks to

• Valpredo Farms
  - Don Valpredo, Mike Valpredo, Rick Martinez, Omar Martinez

• California Organic Fertilizer

• California Pepper Commission