Chemical Control/New Products

Reduced Risk Insecticide Evaluations for Apples in California

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Keywords: apple, chemical control, insecticide, codling moth, Cydia pomonella, San Jose scale, Quadraspisidius perniciosus, rosy apple aphid, Dysaphis plantaginea, woolly apple aphid, Eriosoma lanigerum, Assail, acetamiprid, Calypso, thiacloprid, Carpovirusine, granulosis virus, Clutch, clothianidin, GF-1640, Guthion, azinphosmethyl, Imidan, phosmet, Proclaim, emamectin benzoate, PureSpray Green oil, Rimon, novaluron, Success, spinosad, Warrior, Lambda-cyhalothrin

Abstract: Nine reduced risk materials were compared to a grower standard (GS) program and an untreated control (UTC) in 20 randomized, replicated treatments in ‘Gala’ and ‘Fuji’ apples in the northern San Joaquin Valley of California. Under extreme CM pressure (UTC = 69-87% damage) GF-1640 was the only material that performed as well as the GS (Imidan and Guthion). Treatments with Rimon, Assail, and Warrior performed better than the UTC but not as well as the GS. Success, Calypso, Proclaim and Carpovirusine provided some control early in the season but were similar to the UTC by season’s end. Treatments with Assail and Warrior also provided some control for San Jose scale. Treatments with Clutch, Calypso, and Assail suppressed rosy apple aphid.

Materials and Methods

Location: The trial was located in the northern San Joaquin Valley at the Chavez Home Farms in Brentwood, CA.

Crop: A 2.5 acre block of apples was planted as 3 rows of Gala to every 1 row of Fuji on M.111 rootstock with 151 trees per acre and tree height of about 8-10 ft.

Species: Codling moth (CM), Cydia pomonella (L.)
San Jose scale (SJS), Quadraspisidius perniciosus (Comstock)
Rosy apple aphid (RAA), Dysaphis plantaginea (Passerini)
Woolly apple aphid (WAA), Eriosoma lanigerum (Hausmann)

Plot Design: Twenty treatments were replicated four times in a randomized, complete block design in the Gala cultivar and three times in the Fuji cultivar. Each replicate consisted of three consecutive trees in a row of each cultivar with a one-tree buffer between each replicate.

Application Equipment: Foliar sprays were applied with a handheld orchard sprayer operating at 200 psi with a finished spray volume of 150 gal/acre (1.0 gal/replicate). Three applications (Carpovirusine on 10 June and Rimon on 20 April and 5 July) were applied with a backpack mistblower also delivering 150 gal/acre of finished spray volume.
<table>
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<th>No. appl.</th>
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<td>6.0 oz</td>
<td>4 Gala</td>
<td>26 April (239 from 1&lt;sup&gt;st&lt;/sup&gt; biofix), 25 May (635 from 1&lt;sup&gt;st&lt;/sup&gt; biofix), 27 June (270 from 2&lt;sup&gt;nd&lt;/sup&gt; biofix), 13 July (650 from 2&lt;sup&gt;nd&lt;/sup&gt; biofix) and 15 August (269 from 3&lt;sup&gt;rd&lt;/sup&gt; biofix)</td>
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<td>2. GF-1640 25WDG</td>
<td>7.2 oz</td>
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<tr>
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<tr>
<td>4. GF-1640 25WDG</td>
<td>7.2 oz</td>
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<td>5. Success 2SC</td>
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<td>6. Rimon 0.83EC&lt;sup&gt;a&lt;/sup&gt;</td>
<td>32.0 oz</td>
<td>4 Gala</td>
<td>6 April (63 from 1&lt;sup&gt;st&lt;/sup&gt; biofix), 20 April (182 from 1&lt;sup&gt;st&lt;/sup&gt; biofix), 20 June (156 from 2&lt;sup&gt;nd&lt;/sup&gt; biofix), 5 July (460 from 2&lt;sup&gt;nd&lt;/sup&gt; biofix), 29 July (1075 from 2&lt;sup&gt;nd&lt;/sup&gt; biofix) and 15 August (269 from 3&lt;sup&gt;rd&lt;/sup&gt; biofix)</td>
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<td>8. Assail 30SG</td>
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<td>9. Assail 30SG + Rimon 0.83EC</td>
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<td>4 Gala</td>
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<td>10. Calypso 4F</td>
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<td>11. Calypso 4F + Rimon 0.83EC</td>
<td>4.0 oz</td>
<td>4 Gala</td>
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Reports of the 80th Annual Western Orchard Pest & Disease Management Conference


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<th>Variety</th>
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<tr>
<td>13.</td>
<td>Proclaim 5WDG&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.8 oz</td>
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<td>14.</td>
<td>Proclaim 5WDG&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.8 oz</td>
<td>2 Gala, 3 Fuji, 2 Gala, 2 Fuji</td>
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<td>15.</td>
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<td>16.</td>
<td>Clutch 50WDG&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>17.</td>
<td>Carpovirusine&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>18.</td>
<td>Carpovirusine&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>6 Gala, 8 Fuji</td>
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<td>19.</td>
<td>Imidan 70WP&lt;sup&gt;c&lt;/sup&gt;</td>
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<td>1</td>
<td>26 April (239 from 1&lt;sup&gt;st&lt;/sup&gt; biofix)</td>
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<tr>
<td></td>
<td>Guthion 50WP&lt;sup&gt;c&lt;/sup&gt;</td>
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<td>3</td>
<td>27 May (677 from 1&lt;sup&gt;st&lt;/sup&gt; biofix), 28 June (288 from 2&lt;sup&gt;nd&lt;/sup&gt; biofix) and 14 July (679 from 2&lt;sup&gt;nd&lt;/sup&gt; biofix)</td>
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<tr>
<td>20.</td>
<td>Untreated&lt;sup&gt;a&lt;/sup&gt;</td>
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<td></td>
<td>16 August (295 from 3&lt;sup&gt;rd&lt;/sup&gt; biofix) Fuji only</td>
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</table>

<sup>a</sup>Treatments contained 0.25% PureSpray Green horticultural oil by volume.
<sup>b</sup>Treatments contained 0.25% Latron B-1956 by volume.
<sup>c</sup>Treatment pH was adjusted to <5.0.

**Application Dates:** Applications were scheduled based on day-degrees (DD). All dates and DD are listed above. DD were calculated with a biofix of 30 March for the first generation, a 12 June biofix for the second generation and 5 August for the third generation using a single sine horizontal cutoff model with a lower threshold of 50°F and an upper threshold of 88°F. Maximum and minimum air temperatures were obtained from the IMPACT weather station at Brentwood, CA. All treatments except treatment number 6 (Rimon) were targeted to be applied at the beginning of egg hatch at 250 DD for the first peak (A peak) and 650 DD for the second peak (B peak) of each flight. In addition, three treatments (GF-1640 at 6.0 oz/acre and 7.2 oz/acre and Carpovirusine) had a 14-day follow-up application after the first peak and, if needed, after the second peak to cover the entire hatch period. The Rimon (Tr. No. 6) was...
targeted to be applied at the beginning of egg deposition (50 DD) and reapplied 14 days later. However, the Rimon (Tr. No. 6) was not applied until 150 DD after the beginning of the 2A flight due to early adult emergence and unsettled weather. The exact dates and DD are show in the table above. Also, Latron B-1956 was inadvertently not included in the first application (26 April) of Proclaim (Tr. No. 13).

Evaluation Procedures: Flight activity of male CM was monitored with two pheromone traps placed 150 ft in from the east and west edges of the orchard in untreated trees. The traps were placed on 12 March and inspected once or twice a week through 20 September. Control of RAA was evaluated on 11 May and 20 June. Ten terminal shoots per replicate were inspected for the presence of RAA and WAA. Control of CM and SJS was evaluated at the end of the first generation on 20 June by inspecting 100 fruit per replicate. CM, SJS infestation and russetting damage were evaluated on 28 July at the Gala commercial harvest timing by inspecting 250 fruit per replicate. CM, SJS infestation and russetting damage were evaluated on 13 September at the Fuji commercial harvest timing by inspecting 333 fruit per replicate.

Results and Discussion

CM Flight Activity: The overwintering CM flight began on 26 March and biofix was set on 30 March (Fig. 1). CM biofix is set when sunset air temperatures meet or exceed 62°F and there is a sustained moth flight. This temperature is the minimum required for CM oviposition. The overwintering flight was highly bimodal. The first peak of the overwintering flight occurred around 16 April at 141 DD (Appendix). The air temperatures turned cool and unsettled with considerable periods of rain and moth flight decreased. The first peak often occurs at 300 DD after biofix. The second peak of the overwintering flight occurred around 21 May to 28 May at 543 to 689 DD, respectively. The second peak often occurs at 650 DD after biofix. The first flight was abbreviated and ended 9 June at 893 DD. The first flight is usually not completed until 1,060 DD. The second biofix was set on 12 June. The first peak of the second CM flight occurred between 13 June and 26 June at 47 to 256 DD, respectively. The second peak of the second CM flight occurred between 17 July and 25 July at 766 to 974 DD, respectively. The second flight was completed by 1 August at 1,153 DD. The third biofix was set on 5 August. The first peak of the third CM flight occurred on 7 August at 79 DD and a second peak of the third generation occurred on 26 August at 504 DD.

First Generation Fruit Evaluations

Codling Moth: The CM infestation in the untreated check was over 15% in the Gala cultivar and over 26% in the Fuji cultivar at the first generation evaluation on 20 June (Tables 1 and 2). CM damage far exceeded the acceptable grower levels of about 0.25% infested fruit by the first generation evaluation. Thus this trial provided a very stringent test of the experimental treatments. The CM infestation in all of the experimental treatments in both cultivars was significantly lower than in the untreated check. In the Gala cultivar, the experimental products GF-1640, Rimon (CM egg deposition timing), Assail, Assail with Rimon and Proclaim alternating with Warrior had numerically lower, but not significantly lower, CM infestations than the grower standard of Imidan and Guthion. Calypso alone and Clutch had significantly higher CM infestations than the grower standard. In the Fuji cultivar, GF-1640, Rimon (CM egg deposition timing), Rimon combined with Calypso, Warrior, Proclaim and Proclaim alternating with Warrior had numerically lower CM infestation than the grower standard of Imidan and Guthion. Elevated CM infestations were observed in the Success, Calypso and Clutch treatments.
in the Fuji cultivar. Since at this point in time both cultivars had received the same experimental treatments, the difference in infestation can be attributed to the inherent susceptibility of the individual cultivars. From this early evaluation, it appears that GF-1640 and Rimon (CM egg deposition timing) show promise as OP replacement compounds. Also, the CM egg deposition application timing of Rimon is superior to the CM larvae hatch application timing.

San Jose Scale: The SJS infestation in the untreated check and grower standard treatments numerically exceeded all the other treatments, except for Proclaim, in both cultivars (Tables 1 and 2). Assail, Assail with Rimon, Rimon (CM egg deposition timing), Warrior and Proclaim with Warrior had significantly lower SJS infestations than the untreated check in both cultivars. The early CM egg deposition timing of Rimon was superior to the CM larvae hatch application timing in the suppression of SJS. The SJS population was very clumped in its distribution, which caused higher variability in the infestation level among the treatments.

Harvest Fruit Evaluations

Codling Moth: The CM infestation in the untreated check was 69% in the Gala cultivar and 87% in the Fuji cultivar at the commercial harvest timing evaluations (Tables 1 and 2). In the Gala cultivar, the CM infestation was significantly lower in all of the treatments compared to the untreated check. All of the experimental treatments had significantly greater CM infestation compared to the grower standard except for two of the GF-1640 treatments. The experimental treatments that suppressed the CM population and show some promise as potential new CM insecticides are GF-1640, Rimon (CM egg deposition timing), Assail with Rimon, Calypso with Rimon, Warrior and Proclaim with Warrior. Calypso with Rimon had significantly less CM infestation compared to Calypso alone. Assail with Rimon had numerically less CM infestation compared to Assail alone. Rimon (CM egg deposition timing) had significantly less CM infestation compared to Rimon (CM larvae hatch timing). The combination of Rimon with Assail or Calypso performed better combined than by themselves. However, Rimon applied at the CM egg deposition timing performs almost as well as the combination of Assail or Calypso with Rimon applied at the CM larvae hatch timing. Both Warrior alone and combined with Proclaim had significantly less CM infestation compared to Proclaim alone. There was a strong rate response with Clutch where the higher rate had significantly less CM infestation compared to the lower rate. However, none of the rates of Clutch, Carpovirusine or Success suppressed CM infestation to the same degree as the other experimental treatments.

In the Fuji cultivar, there was no significant difference between the untreated check and the Carpovirusine, Proclaim, Success and Clutch treatments. The Fuji cultivar was harvested about six weeks after the Gala harvest and the Fuji cultivar was exposed to greater CM pressure than the Gala cultivar. Also, as the season progressed, the CM population became less brooded and more diffuse. Thus less toxic and shorter residual insecticides would be more prone to CM infestation. Only the 7.2 oz/acre of GF-1640 applied 7 times (Tr. No. 4) had a lower CM infestation percentage compared to the grower standard. All of the experimental treatments, except for the 7.2 and 6.0 oz/acre of GF-1640 applied 7 times and 7.2 oz/acre of GF-1640 applied 5 times (Tr. Nos. 2, 3 and 4) had significantly higher CM infestation compared to the grower standard. Rimon applied at the CM egg deposition timing had lower CM infestation compared to Rimon applied at the CM larval hatch timing. Calypso with Rimon had significantly less CM infestation compared to Calypso alone. Assail combined with Rimon had significantly less CM infestation compared to Assail alone. Warrior alone and Warrior combined with Proclaim had significantly less CM infestation compared to Proclaim alone.
**San Jose Scale:** In the Gala cultivar, Assail provided superior SJS control. GF-1640 at 6.0 oz/acre applied 4 times, Calypso with Rimon, Warrior and Proclaim with Warrior had numerically less SJS populations compared to the grower standard. However, GF-1640 at 7.2 oz/acre applied 5 times (Tr. No. 4) had a significantly greater percent infestation compared to the untreated check.

In the Fuji cultivar, all treatments containing Assail and Warrior provided superior SJS control with significantly less SJS populations compared to the grower standard. The 7.2 oz/acre of GF-1640 applied 5 and 7 times (Tr. Nos. 2 and 4), Success and Proclaim had numerically greater SJS infestation compared to the untreated check.

**Russetting:** In the Gala cultivar, the Rimon (CM egg deposition timing) and Calypso combined with Rimon treatments had a significantly greater percent of fruit with russetting compared to the untreated check. The 7.2 oz/acre of GF-1640 applied 7 times (Tr. No. 4), Assail and Proclaim treatments suppressed russetting. Russetting can be the result of a number of causal factors. However it appears that Rimon caused a slight but significant increase in russetting as compared to the untreated check.

In the Fuji cultivar, all of the experimental treatments had a higher percent of apples with russetting compared to the untreated check. The 6.0 oz/acre of GF-1640 applied 7 times (Tr. No. 3) and Calypso had a significantly greater percentage of apples with russetting compared to the untreated check. Fuji apple skin is delicate and prone to russetting with excess moisture. Also, there was no evidence of increased russetting due to Rimon in the Fuji cultivar as compared to the Gala cultivar.

**Foliar Evaluations**

**Rosy Apple Aphid:** In the spring evaluation of the Gala cultivar, all of the treatments had lower RAA populations compared to the untreated check. The high rate of Clutch had a significantly lower RAA population compared to the untreated check (Table 3). In the summer evaluation of the Gala cultivar, Assail, Calypso and Calypso with Rimon all had suppressed RAA populations with Assail combined with Rimon having significantly smaller RAA populations compared to both the grower standard and the untreated check.

In the spring evaluation of the Fuji cultivar, the Calypso treatment had significantly less RAA compared to the untreated check (Table 4). In the summer evaluation in the Fuji cultivar, Calypso as well as Assail, Assail with Rimon and Clutch had significantly less RAA compared to both the grower standard and the untreated check. The Warrior and Proclaim with Warrior treatments had significantly less RAA compared to the untreated check. The 7.2 oz/acre of GF-1640 applied 7 times and the Rimon (CM larval hatch timing) had much higher numerical damage from RAA than the untreated check.

**Woolly Apple Aphid:** In the Gala cultivar, the Rimon (CM larval hatch timing) and Proclaim treatments had numerically greater WAA populations compared to the grower standard and the untreated check. In the Fuji cultivar, while all the treatments had less WAA compared to the untreated check, Rimon (CM larvae hatch timing), Rimon (CM larvae hatch timing) and the Proclaim treatments all had greater WAA populations compared to the other experimental treatments.
Conclusions

This experiment was conducted in an orchard with 69% and 87% CM infestation in a Gala and Fuji cultivar, respectively. Thus these trials provided a very stringent test of the experimental treatments. GF-1640 applied at 7.2 oz/acre with 5 or 7 applications looks very promising as an OP replacement compound. This treatment had the lowest CM infestation of all the experimental treatments in the Gala cultivar and had the lowest overall CM infestation in the Fuji cultivar. Unfortunately, the high rates or high number of applications of GF-1640 did flare up the SJS populations. Rimon applied alone at the CM egg deposition timing outperformed Rimon applied alone at the larvae hatch timing and the earlier application also looks very promising as an OP replacement product. Rimon combined with Assail or Calypso and applied at the larval hatch timing also performed well. Warrior applied alone could also prove to be an effective OP replacement compound. Warrior also suppressed SJS populations, especially in the Fuji cultivar. Success, both Clutch treatments and both Carpovirusine treatments provided marginal CM control in the Gala cultivar and had CM infestation levels similar to the untreated check in the Fuji cultivar. Assail, Assail with Rimon and Calypso all suppressed RAA populations in both cultivars while Rimon and Proclaim tended to flare up WAA populations in both cultivars.
Table 1. Mean percent infestation or damage by codling moth and San Jose scale at first generation and by codling moth, San Jose scale and russetting at harvest on Gala cultivar in Brentwood, CA – 2005

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<td>1.5 abc</td>
<td>7.8 abc</td>
<td>10.4 abc</td>
<td>5.5 ab</td>
</tr>
<tr>
<td></td>
<td>7.2 oz</td>
<td>4</td>
<td>0.8 a</td>
<td>10.8 abc</td>
<td>12.3 bc</td>
<td>13.2 bcde</td>
</tr>
<tr>
<td></td>
<td>6.0 oz</td>
<td>5</td>
<td>0.5 a</td>
<td>12.5 abc</td>
<td>14.5 bcd</td>
<td>20.6 ef</td>
</tr>
<tr>
<td></td>
<td>7.2 oz</td>
<td>5</td>
<td>1.0 ab</td>
<td>12.0 abc</td>
<td>9.4 ab</td>
<td>24.2 f</td>
</tr>
<tr>
<td>Success 2SC</td>
<td>6.0 oz</td>
<td>4</td>
<td>2.3 abc</td>
<td>8.0 abc</td>
<td>35.2 ghi</td>
<td>17.5 cdef</td>
</tr>
<tr>
<td>Rimon 0.83EC</td>
<td>32.0 oz</td>
<td>4</td>
<td>0.8 a</td>
<td>3.0 ab</td>
<td>13.0 bcd</td>
<td>10.2 abcd</td>
</tr>
<tr>
<td>Rimon 0.83EC</td>
<td>32.0 oz</td>
<td>4</td>
<td>3.0 abcde</td>
<td>11.5 abc</td>
<td>27.1 efg</td>
<td>14.5 cdef</td>
</tr>
<tr>
<td>Assail 30SG</td>
<td>8.0 oz</td>
<td>4</td>
<td>1.3 abc</td>
<td>3.0 ab</td>
<td>18.3 cde</td>
<td>2.2 a</td>
</tr>
<tr>
<td>Assail 30SG + Rimon 0.83EC</td>
<td>8.0 oz</td>
<td>4</td>
<td>1.8 abc</td>
<td>3.0 ab</td>
<td>11.3 bc</td>
<td>2.2 a</td>
</tr>
<tr>
<td>Calypso 4F</td>
<td>4.0 oz</td>
<td>4</td>
<td>6.3 def</td>
<td>7.8 abc</td>
<td>22.4 def</td>
<td>9.3 abc</td>
</tr>
<tr>
<td>Calypso 4F + Rimon 0.83EC</td>
<td>32.0 oz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warrior 1CS</td>
<td>5.0 oz</td>
<td>4</td>
<td>2.5 abcd</td>
<td>3.0 ab</td>
<td>13.6 bcd</td>
<td>5.2 ab</td>
</tr>
<tr>
<td>Proclaim 5WDG</td>
<td>4.8 oz</td>
<td>4</td>
<td>4.0 abcdef</td>
<td>17.3 c</td>
<td>31.8 fgh</td>
<td>20.1 def</td>
</tr>
<tr>
<td>Proclaim 5WDG + Warrior 1CS</td>
<td>4.8 oz</td>
<td>2</td>
<td>0.8 a</td>
<td>1.0 a</td>
<td>12.0 be</td>
<td>5.7 ab</td>
</tr>
<tr>
<td>Clutch 50WDG</td>
<td>3.0 oz</td>
<td>4</td>
<td>7.0 f</td>
<td>5.0 abc</td>
<td>52.7 j</td>
<td>10.5 abcd</td>
</tr>
<tr>
<td>Clutch 50WDG</td>
<td>6.0 oz</td>
<td>4</td>
<td>6.5 ef</td>
<td>4.8 ab</td>
<td>32.1 fgh</td>
<td>11.7 abcde</td>
</tr>
<tr>
<td>Carpovirusine</td>
<td>13.5 oz</td>
<td>4</td>
<td>4.8 bcdef</td>
<td>8.3 abc</td>
<td>45.7 ij</td>
<td>11.0 abcde</td>
</tr>
<tr>
<td>Carpovirusine</td>
<td>13.5 oz</td>
<td>6</td>
<td>5.0 cdef</td>
<td>6.5 abc</td>
<td>41.4 hij</td>
<td>11.1 abcde</td>
</tr>
<tr>
<td>Imidan 70WP</td>
<td>5.3 lb</td>
<td>1</td>
<td>2.3 abc</td>
<td>14.3 bc</td>
<td>5.6 a</td>
<td>6.9 ab</td>
</tr>
<tr>
<td>Guthion 50WP</td>
<td>3.0 lb</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td></td>
<td>0</td>
<td>15.5 g</td>
<td>17.3 c</td>
<td>69.0 k</td>
<td>11.9 abcde</td>
</tr>
</tbody>
</table>

*Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, P <0.05).

*Percent CM damaged fruit was analyzed using an arcsine transformation.

*Treatments contained 0.25% PureSpray Green horticultural oil by volume.

*Treatments contained 0.25% Latron B-1956 by volume.

*Treatment pH was adjusted to < 5.0.
Table 2. Mean percent infestation or damage by codling moth and San Jose scale at first generation and by codling moth, San Jose scale and russetting at harvest on Fuji cultivar in Brentwood, CA – 2005

<table>
<thead>
<tr>
<th>Treatment/formulation</th>
<th>Rate form/acre</th>
<th>No. appl.</th>
<th>Mean(^a) percent infestation at first generation</th>
<th>Mean(^a) percent infestation or damage at harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>CM</td>
<td>SJS</td>
</tr>
<tr>
<td>1. GF-1640 25WDG</td>
<td>6.0 oz</td>
<td>5</td>
<td>1.3 ab</td>
<td>7.7 abc</td>
</tr>
<tr>
<td>2. GF-1640 25WDG</td>
<td>7.2 oz</td>
<td>5</td>
<td>0.7 a</td>
<td>13.0 abcd</td>
</tr>
<tr>
<td>3. GF-1640 25WDG</td>
<td>6.0 oz</td>
<td>7</td>
<td>1.0 a</td>
<td>6.7 abc</td>
</tr>
<tr>
<td>4. GF-1640 25WDG</td>
<td>7.2 oz</td>
<td>7</td>
<td>1.0 a</td>
<td>17.3 bcd</td>
</tr>
<tr>
<td>5. Success 2SC</td>
<td>6.0 oz</td>
<td>5</td>
<td>7.7 bcd</td>
<td>11.7 abcd</td>
</tr>
<tr>
<td>6. Rimon 0.83EC(^c)</td>
<td>32.0 oz</td>
<td>6</td>
<td>0.7 a</td>
<td>1.3 a</td>
</tr>
<tr>
<td>7. Rimon 0.83EC</td>
<td>32.0 oz</td>
<td>5</td>
<td>5.0 abcd</td>
<td>11.3 abcd</td>
</tr>
<tr>
<td>8. Assail 30SG</td>
<td>8.0 oz</td>
<td>5</td>
<td>3.7 abcd</td>
<td>3.0 ab</td>
</tr>
<tr>
<td>9. Assail 30SG + Rimon 0.83EC</td>
<td>8.0 oz</td>
<td>5</td>
<td>4.7 abcd</td>
<td>2.7 a</td>
</tr>
<tr>
<td>10. Calypso 4F</td>
<td>4.0 oz</td>
<td>5</td>
<td>8.0 cd</td>
<td>4.0 ab</td>
</tr>
<tr>
<td>11. Calypso 4F + Rimon 0.83EC</td>
<td>4.0 oz</td>
<td>5</td>
<td>2.7 abc</td>
<td>6.7 abc</td>
</tr>
<tr>
<td>12. Warrior 1CS(^d)</td>
<td>5.0 oz</td>
<td>5</td>
<td>2.0 abc</td>
<td>4.3 ab</td>
</tr>
<tr>
<td>13. Proclaim 5WDG(^d)</td>
<td>4.8 oz</td>
<td>5</td>
<td>2.3 abc</td>
<td>22.7 d</td>
</tr>
<tr>
<td>14. Proclaim 5WDG(^d)</td>
<td>4.8 oz</td>
<td>3</td>
<td>2.0 abc</td>
<td>0.7 a</td>
</tr>
<tr>
<td>15. Clutch 50WDG</td>
<td>3.0 oz</td>
<td>5</td>
<td>8.0 cd</td>
<td>2.7 a</td>
</tr>
<tr>
<td>16. Clutch 50WDG</td>
<td>6.0 oz</td>
<td>5</td>
<td>9.3 d</td>
<td>7.7 abc</td>
</tr>
<tr>
<td>17. Carpovirusine</td>
<td>13.5 oz</td>
<td>5</td>
<td>6.7 abcd</td>
<td>9.3 abcd</td>
</tr>
<tr>
<td>18. Carpovirusine</td>
<td>13.5 oz</td>
<td>8</td>
<td>4.3 abcd</td>
<td>7.7 abc</td>
</tr>
<tr>
<td>19. Imidan 70WP(^e)</td>
<td>5.3 lb</td>
<td>1</td>
<td>3.0 abcd</td>
<td>19.7 cd</td>
</tr>
<tr>
<td>Guthion 50WP</td>
<td>3.0 lb</td>
<td>3</td>
<td>3.0 abcd</td>
<td>19.7 cd</td>
</tr>
<tr>
<td>Imidan 70WP(^e)</td>
<td>5.3 lb</td>
<td>1</td>
<td>3.0 abcd</td>
<td>19.7 cd</td>
</tr>
<tr>
<td>20. Untreated</td>
<td>–</td>
<td>0</td>
<td>26.3 e</td>
<td>21.0 cd</td>
</tr>
</tbody>
</table>

\(^a\) Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, \(P < 0.05\)).

\(^b\) Percent CM damaged fruit was analyzed using an arcsine transformation.

\(^c\) Treatments contained 0.25\% PureSpray Green horticultural oil by volume.

\(^d\) Treatments contained 0.25\% Latron B-1956 by volume.

\(^e\) Treatment pH was adjusted to < 5.0.
Table 3. Mean percent infested shoots by rosy apple aphid and woolly apple aphid on Gala cultivar in Brentwood, CA – 2005

<table>
<thead>
<tr>
<th>Treatment/formulation</th>
<th>Rate form/acre</th>
<th>No. appl.</th>
<th>Mean(^a) percent infested shoots</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Spring RAA RAA(^b) Summer WAA(^b)</td>
</tr>
<tr>
<td>1. GF-1640 25WDG</td>
<td>6.0 oz</td>
<td>4</td>
<td>40.0 ab 37.5 bcde 0.0 a</td>
</tr>
<tr>
<td>2. GF-1640 25WDG</td>
<td>7.2 oz</td>
<td>4</td>
<td>42.5 ab 40.0 bcde 0.0 a</td>
</tr>
<tr>
<td>3. GF-1640 25WDG</td>
<td>6.0 oz</td>
<td>5</td>
<td>32.5 ab 50.0 e 2.5 ab</td>
</tr>
<tr>
<td>4. GF-1640 25WDG</td>
<td>7.2 oz</td>
<td>5</td>
<td>35.0 ab 47.5 de 0.0 a</td>
</tr>
<tr>
<td>5. Success 2SC</td>
<td>6.0 oz</td>
<td>4</td>
<td>42.5 ab 40.0 bcde 0.0 a</td>
</tr>
<tr>
<td>6. Rimon 0.83EC(^c)</td>
<td>32.0 oz</td>
<td>4</td>
<td>37.5 ab 20.0 abc 5.0 ab</td>
</tr>
<tr>
<td>7. Rimon 0.83EC</td>
<td>32.0 oz</td>
<td>4</td>
<td>35.0 ab 40.0 bcde 17.5 b</td>
</tr>
<tr>
<td>8. Assail 30SG</td>
<td>8.0 oz</td>
<td>4</td>
<td>22.5 ab 15.0 ab 0.0 a</td>
</tr>
<tr>
<td>9. Assail 30SG + Rimon 0.83EC</td>
<td>8.0 oz</td>
<td>4</td>
<td>32.5 ab 10.0 a 0.0 a</td>
</tr>
<tr>
<td>10. Calypso 4F</td>
<td>4.0 oz</td>
<td>4</td>
<td>35.0 ab 15.0 ab 0.0 a</td>
</tr>
<tr>
<td>11. Calypso 4F + Rimon 0.83EC</td>
<td>4.0 oz</td>
<td>4</td>
<td>22.5 ab 12.5 ab 5.0 ab</td>
</tr>
<tr>
<td>12. Warrior 1CS(^d)</td>
<td>5.0 oz</td>
<td>4</td>
<td>25.0 ab 22.5 abcde 2.5 ab</td>
</tr>
<tr>
<td>13. Proclaim 5WDG(^d)</td>
<td>4.8 oz</td>
<td>4</td>
<td>45.0 b 42.5 cde 7.5 ab</td>
</tr>
<tr>
<td>14. Proclaim 5WDG(^d)</td>
<td>4.8 oz</td>
<td>2</td>
<td>22.5 ab 22.5 abcde 0.0 a</td>
</tr>
<tr>
<td>15. Clutch 50WDG</td>
<td>3.0 oz</td>
<td>4</td>
<td>22.5 ab 25.0 abcde 2.5 ab</td>
</tr>
<tr>
<td>16. Clutch 50WDG</td>
<td>6.0 oz</td>
<td>4</td>
<td>12.5 a 27.5 abcde 0.0 a</td>
</tr>
<tr>
<td>17. Carpovirusine</td>
<td>13.5 oz</td>
<td>4</td>
<td>40.0 ab 35.0 bcde 0.0 a</td>
</tr>
<tr>
<td>18. Carpovirusine</td>
<td>13.5 oz</td>
<td>6</td>
<td>25.0 ab 35.0 bcde 0.0 a</td>
</tr>
<tr>
<td>19. Imidan 70WP(^e)</td>
<td>5.3 lb</td>
<td>1</td>
<td>45.0 b 37.5 bcde 2.5 ab</td>
</tr>
<tr>
<td>20. Untreated</td>
<td>–</td>
<td>0</td>
<td>50.0 b 40.0 bcde 5.0 ab</td>
</tr>
</tbody>
</table>

\(^a\)Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, \(P \leq 0.05\)).

\(^b\)Percent CM damaged fruit was analyzed using an arcsine transformation.

\(^c\)Treatments contained 0.25% PureSpray Green horticultural oil by volume.

\(^d\)Treatments contained 0.25% Latron B-1956 by volume.

\(^e\)Treatment pH was adjusted to <5.0.
### Table 4. Mean percent infested shoots by rosy apple aphid and woolly apple aphid on Fuji cultivar in Brentwood, CA – 2005

<table>
<thead>
<tr>
<th>Treatment/formulation</th>
<th>Rate form/acre</th>
<th>No. appl.</th>
<th>Mean(^\text{a}) percent infested shoots</th>
<th>Spring</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>RAA(^b)</td>
<td>RAA</td>
<td>WAA(^b)</td>
</tr>
<tr>
<td>1. GF-1640 25WDG</td>
<td>6.0 oz</td>
<td>5</td>
<td>63.3 d</td>
<td>46.7 cde</td>
<td>0.0 a</td>
</tr>
<tr>
<td>2. GF-1640 25WDG</td>
<td>7.2 oz</td>
<td>5</td>
<td>50.0 cd</td>
<td>40.0 bcd</td>
<td>0.0 a</td>
</tr>
<tr>
<td>3. GF-1640 25WDG</td>
<td>6.0 oz</td>
<td>7</td>
<td>50.0 cd</td>
<td>76.7 ef</td>
<td>6.7 ab</td>
</tr>
<tr>
<td>4. GF-1640 25WDG</td>
<td>7.2 oz</td>
<td>7</td>
<td>50.0 cd</td>
<td>76.7 ef</td>
<td>6.7 ab</td>
</tr>
<tr>
<td>5. Success 2SC</td>
<td>6.0 oz</td>
<td>5</td>
<td>50.0 cd</td>
<td>36.7 bcd</td>
<td>0.0 a</td>
</tr>
<tr>
<td>6. Rimon 0.83EC(^c)</td>
<td>32.0 oz</td>
<td>6</td>
<td>40.0 abcd</td>
<td>26.7 abcd</td>
<td>13.3 ab</td>
</tr>
<tr>
<td>7. Rimon 0.83EC</td>
<td>32.0 oz</td>
<td>5</td>
<td>56.7 cd</td>
<td>80.0 f</td>
<td>13.3 ab</td>
</tr>
<tr>
<td>8. Assail 30SG</td>
<td>8.0 oz</td>
<td>5</td>
<td>30.0 abcd</td>
<td>13.3 ab</td>
<td>0.0 a</td>
</tr>
<tr>
<td>9. Assail 30SG +</td>
<td>8.0 oz</td>
<td>5</td>
<td>23.3 abc</td>
<td>10.0 ab</td>
<td>0.0 a</td>
</tr>
<tr>
<td></td>
<td>Rimon 0.83EC</td>
<td>32.0 oz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Calypso 4F</td>
<td>4.0 oz</td>
<td>5</td>
<td>10.0 a</td>
<td>0.0 a</td>
<td>3.3 ab</td>
</tr>
<tr>
<td>11. Calypso 4F +</td>
<td>4.0 oz</td>
<td>5</td>
<td>23.3 abc</td>
<td>26.7 abcd</td>
<td>3.3 ab</td>
</tr>
<tr>
<td></td>
<td>Rimon 0.83EC</td>
<td>32.0 oz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Warrior 1CS(^d)</td>
<td>5.0 oz</td>
<td>5</td>
<td>26.7 abcd</td>
<td>23.3 abc</td>
<td>0.0 a</td>
</tr>
<tr>
<td>13. Proclaim 5WDG(^d)</td>
<td>4.8 oz</td>
<td>5</td>
<td>46.7 cd</td>
<td>53.3 cdef</td>
<td>13.3 ab</td>
</tr>
<tr>
<td>14. Proclaim 5WDG(^d)</td>
<td>4.8 oz</td>
<td>3</td>
<td>16.7 ab</td>
<td>23.3 abc</td>
<td>6.7 ab</td>
</tr>
<tr>
<td></td>
<td>Warrior 1CS(^d)</td>
<td>5.0 oz</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Clutch 50WDG</td>
<td>3.0 oz</td>
<td>5</td>
<td>23.3 abc</td>
<td>13.3 ab</td>
<td>0.0 a</td>
</tr>
<tr>
<td>16. Clutch 50WDG</td>
<td>6.0 oz</td>
<td>5</td>
<td>23.3 abc</td>
<td>0.0 a</td>
<td>0.0 a</td>
</tr>
<tr>
<td>17. Carpovirusine</td>
<td>13.5 oz</td>
<td>5</td>
<td>56.7 cd</td>
<td>53.3 cdef</td>
<td>0.0 a</td>
</tr>
<tr>
<td>18. Carpovirusine</td>
<td>13.5 oz</td>
<td>8</td>
<td>40.0 abcd</td>
<td>56.7 def</td>
<td>0.0 a</td>
</tr>
<tr>
<td>19. Imidan 70WP(^e)</td>
<td>5.3 lb</td>
<td>1</td>
<td>33.3 abcd</td>
<td>50.0 cdef</td>
<td>0.0 a</td>
</tr>
<tr>
<td></td>
<td>Guthion 50WP</td>
<td>3.0 lb</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imidan 70WP(^e)</td>
<td>5.3 lb</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Untreated</td>
<td>—</td>
<td>0</td>
<td>43.3 bcd</td>
<td>56.7 def</td>
<td>16.7 b</td>
</tr>
</tbody>
</table>

\(^a\)Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, P ≤ 0.05).

\(^b\)Percent CM damaged fruit was analyzed using an arcsine transformation.

\(^c\)Treatments contained 0.25% PureSpray Green horticultural oil by volume.

\(^d\)Treatments contained 0.25% Latron B-1956 by volume.

\(^e\)Treatment pH was adjusted to <5.0.
Fig. 1 - Seasonal CM flight activity at Brentwood, CA - 2005

Chavez Trap A
Chavez Trap B

Date and Day Degrees