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**ORANGE:** *Citrus sinensis* (L.) Osbeck, 'Valencia'

**SPRAY APPLICATIONS OF INSECTICIDES TO CONTROL ASIAN CITRUS PSYLLID AND CITRUS LEAFMINER ON ORANGE, 2007**

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Asian citrus psyllid (ACP): *Diaphorina citri* Kuwayama

Citrus leafminer (CLM), *Phyllocnistis citrella* Stainton

Nymphs and adults of Asian citrus psyllid (ACP) suck sap from the citrus leaves and are also capable of acquiring and transmitting the bacterium *Candidatus* Liberibacter asiaticus responsible for the citrus greening or huanglongbing disease. Feeding by the citrus leafminer (CLM) larvae damages foliage exposes leaf cuticle to infection by the bacterium *Xanthomonas* *citri* responsible for the citrus canker disease. Therefore, both pests need to be controlled to reduce spread of these diseases. The experimental block at the Southwest Florida Research and Education Center (SWFREC), Immokalee, Florida consisted of 12-yr-old sweet orange *Citrus sinensis* (L) Osbeck 'Valencia' trees planted on double-row raised beds at a density of 132 trees/acre. Trees were irrigated by micro-sprinklers and subjected to conventional cultural practices. Bed sides of the trees were pruned with a tractor-mounted box blade mower to induce new flush and encourage psyllid infestation. Fourteen treatments and an untreated check were randomly distributed across 4 replicates in 30 rows that included a buffer row after every treated row. Each row consisted of 20 trees divided into four plots of 5 trees each.

Treatments were applied on 22 Jun 2007 to the bed side of the trees using a tractor mounted hydraulic sprayer operating at a pressure of 150 psi with an array of fifteen ATR-80 ceramic hollow cone nozzles directed at the tree on 3, 5 foot booms to deliver 66 gpa at a tractor speed of 1.5 mph. A pre-treatment sampling was conducted on 20-Jun and treatment evaluations were made 3, 10, 17, and 24 DAT on Jun 25, Jul 2, 9, and 16, respectively. One and three trees were observed per plot for pre and post treatment samplings, respectively. Adult psyllid density was estimated by a "tap" sample obtained by counting the individuals falling on an 8 ½ × 11 inch white paper sheet (on a clipboard) placed under randomly chosen branches which were then struck three times with the hand. Ten randomly selected shoots were observed and the number infested with psyllid eggs or nymphs recorded. The abundance of ACP immatures on each shoot was rated on a 0 to 3 scale: 0 = none, 1 = eggs and first instars, 2 = second and third instars, 3 = fourth and fifth instars. One infested flush of these was collected and examined in the laboratory under a microscope to count eggs and different live and dead instars of *D. citri*. The number of larvae and adults of four predatory coccinellids, *Curinus coeruleus* Mulsant, *Olla v-nigrum*

Mulsant, *Harmonia axyridis* Pallas and *Cycloneda sanguinea* (L.) were recorded during a one minute observation on each tree. A well developed shoot with pale green leaves was randomly selected and all live CLM larvae were counted on five expanded leaves. All data were subjected to ANOVA to evaluate treatment effects on ACP, CLM, and the ladybeetles and means were separated using LSD (P = 0.05). Numbers of ladybeetles were combined and transformed by log(x+1) for analysis. Only the reported variables were evaluated on any specific date.

Least shoots infested with ACP were observed on trees sprayed with Provado at 3 DAT although not significantly different from GF-1640 or MANA 8412-094B. Actara and MSR at the high rate and Portal with oil were the only other treatments significantly different from the untreated check. Fewest nymphs per flush were seen with the high rate of Actara, although not significantly different from Provado, the high rate of Agri-Mek, or MSR, GF-1640, the low rate of Actara and MANA 8412-094B. The low rate of MSR and Portal with Oil were also different from the untreated check. No adults were seen with the high rate of Actara, although this was not significantly different from the low rate, or GF-1640, Portal with or without oil or MANA 8412-094B. Fewest infested shoots at 10 DAT were seen with MANA 8412-094B although not different from the high rate of Actara. Fewer infested shoots than the untreated check were seen with Provado, the high rate of Agri-Mek, GF-1640, the low rate of Actara and Portal with oil. None of the treatments at that time showed fewer nymphs on the single flush per tree counted in the laboratory than the untreated check. However, the infestation rating was lowest for MANA 8412-094B and the high rate of Actara, though not different from Portal with oil. All treatments except 435 Oil, QRD-400 and Micromite were different from the untreated check. There was no significant treatment effect at that time on numbers of adults. At 17 DAT, percentage of infested shoots was lowest on trees sprayed with the high rate of Actara and MANA AG 8412-094B. No other treatments were significantly different from the untreated check. There were no significant differences among treatments in the number of nymphs counted in the laboratory, but infestation rated in the field was lowest on trees sprayed with the high rate of Actara, the only treatment significantly different from the untreated check. Again, there were no differences in numbers of adults. At 24 DAT, percentage infested shoots was lower on trees treated with the high rate of Actara and MANA AG 8412-094B, though not significantly less than Provado, either rate of Agri-Mek, the low rate of MSR, GF-1640, or QRD 400. There were again no differences in number of nymphs per infested shoot but the infestation rating was lowest for trees treated with MANA AG 8412-094B although not significantly less than the low rates of both Agri-Mek, MSR, and GF-1640, as well as the high rate of Actara. None of the other treatments were significantly different from the untreated check. Fewest adults were observed on trees treated with GF-1640, though not significantly different from all the remaining treatments except 435 Oil, the high rate of Actara, Micromite and MANA AG 8412-094B, none of which were different from the untreated check.

Fewer CLM larvae than the untreated check were seen at 3 DAT from all treatments except 435 Oil and the high rate of MSR. There were no differences among the remaining treatments except for more larvae with the low rate of MSR. No live larvae were seen at 10 DAT on trees treated with MANA AG 8412-094B, although not significantly different from the high rate of Agri-Mek, GF-1640, QRD 400, the low rate of Actara, Micromite, and Portal with or without oil. None of the other treatments were different from the untreated check. No significant differences were seen at 17 DAT but fewest CLM were seen at 24 DAT from MANA AG 8412-094B, although not different from the low rate of MSR or GF-1640. Of the remaining treatments, only the high rate of Agri-Mek was significantly different from the untreated check.

More ladybeetles were seen on untreated trees than all other treatments followed by 435 Oil, although not significantly different from the low rates of Agri-Mek and MRS, or from QRD-400 and Micromite. The activity of ladybeetles on untreated trees may explain the relatively low number of psyllids seen there and thus the lack of significant differences with many of the treatments latter in the trial.

| Treatment/ formulation | Rate amt (AI)/acre | Percent shoots infested with ACP eggs and nymphs | | | | Nymphs/infested shoot | | | | Infestation Rating (0-3)*/flush | | | ACP Adults/tap sample | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3 DAT | 10 DAT | 17 DAT | 24 DAT | 3 DAT | 10 DAT | 17 DAT | 24 DAT | 10 DAT | 17 DAT | 24 DAT | 3 DAT | 10 DAT | 17 DAT | 24 DAT |
| Untreated check | -- | 81.7 abcd | 83.3 ab | 46.7 abcd | 86.1 a | 57.5 ab | 15.0 bcd | 29.9 a | 21.8 a | 1.81 ab | 0.63 abcd | 1.32 abc | 1.7 a | 2.8 a | 3.3 a | 3.1 a |
| 435 Oil | 2 gal | 93.3 ab | 92.5 a | 50.0 abc | 85.8 a | 64.3 a | 23.0 abc | 15.8 a | 18.7 a | 2.03 a | 0.88 a | 1.39 ab | 1.8 a | 2.2 a | 3.1 a | 2.6 abc |
| Provado 1.6 F + 435 Oil | 12 fl oz + 2 gal | 31.7 g | 59.2 cd | 41.7 bcde | 61.7 bcd | 7.2 fg | 16.7 bcd | 26.8 a | 25.4 a | 0.83 ef | 0.68 abc | 0.87 cdef | 0.2 de | 1.2 a | 1.8 a | 0.9 de |
| Agri-Mek 0.15 EC + 435 Oil | 10 fl oz + 2 gal | 71.7 bcde | 72.5 bcd | 34.6 cde | 61.3 bcd | 34.5 bcd | 22.2 abcd | 6.5 a | 8.4 a | 1.26 cde | 0.49 cde | 0.83 def | 1.3 ab | 1.8 a | 2.6 a | 1.6 cde |
| Agri-Mek 0.15 EC + 435 Oil | 20 fl oz + 2 gal | 61.7 de | 63.8 cd | 57.6 ab | 66.3 abcd | 12.8 defg | 19.3 abcd | 31.7 a | 16.6 a | 1.01 def | 0.88 a | 1.08 abcd | 0.5 cde | 1.0 a | 2.2 a | 0.9 de |
| MSR 2E | 24 fl oz | 65.8 cde | 74.2 bc | 34.8 cde | 54.6 cd | 27.3 def | 13.9 bcd | 5.8 a | 9.2 a | 1.28 cde | 0.51 cde | 0.73 def | 0.8 bcd | 2.3 a | 2.2 a | 1.3 de |
| MSR 2E | 48 fl oz | 54.2 ef | 69.2 bcd | 31.4 de | 72.7 abc | 23.6 defg | 9.2 bcd | 11.1 a | 17.3 a | 1.08 de | 0.41 cde | 0.92 cde | 0.8 bcd | 0.7 a | 1.1 a | 1.8 bcde |
| GF-1640 + 435 Oil | 4 oz + 2 gal | 50.8 efg | 54.9 de | 43.3 bcde | 50.1 cd | 7.8 fg | 19.3 abcd | 8.9 a | 15.9 a | 0.83 ef | 0.64 abcd | 0.58 ef | 0.2 de | 0.9 a | 2.2 a | 0.8 e |
| QRD 400 + 435 Oil | 128 fl oz + 2 gal | 86.9 abc | 82.5 ab | 60.8 a | 65.9 abcd | 37.1 bcd | 21.6 abcd | 29.5 a | 14.4 a | 1.39 bcd | 0.83 ab | 0.89 cdef | 1.3 ab | 1.3 a | 1.5 a | 1.3 cde |
| Actara | 4 oz | 62.5 de | 68.3 bcd | 41.7 bcde | 68.0 abc | 22.6 defg | 34.7 a | 16.8 a | 11.2 a | 0.98 def | 0.58 bcde | 0.93 bcde | 0.4 cde | 0.8 a | 1.9 a | 0.8 e |
| Actara | 5.5 oz | 59.2 e | 25.0 fg | 28.3 e | 43.4 d | 0.7 g | 6.5 cd | 7.7 a | 10.1 a | 0.30 g | 0.33 e | 0.48 ef | 0.0 e | 1.2 a | 1.0 a | 2.2 abcd |
| Micromite 80 WDG | 6.25 oz | 93.6 ab | 84.2 ab | 38.5 cde | 81.7 ab | 53.3 abc | 25.4 ab | 4.8 a | 42.8 a | 1.66 abc | 0.54 cde | 1.48 a | 0.9 bc | 2.3 a | 1.3 a | 2.9 ab |
| Portal | 64 fl oz | 57.5 ef | 73.3 bc | 41.1 cde | 80.0 ab | 29.8 cdef | 13.8 bcd | 16.3 a | 31.8 a | 1.18 cde | 0.57 bcde | 0.93 bcde | 0.3 cde | 1.0 a | 2.5 a | 1.1 de |
| Portal + 435 Oil | 64 fl oz + 2 gal | 68.3 cde | 39.2 ef | 31.7 de | 80.4 ab | 32.8 bcde | 6.2 d | 15.8 a | 18.7 a | 0.54 fg | 0.44 cde | 1.14 abcd | 0.3 cde | 1.3 a | 2.0 a | 1.0 de |
| MANA AG 8412-094B | 4.8 fl oz | 36.1 fg | 20.0 g | 29.9 e | 44.2 d | 8.5 efg | 5.9 d | 5.4 a | 18.8 a | 0.27 g | 0.38 de | 0.44 f | 0.2 de | 1.8 a | 2.1 a | 3.2 a |

*****0 = none, 1 = eggs and first instars, 2 = second and third instars, 3 = fourth and fifth instars
Means within columns not followed by the same letter are significantly different (LSD, *P* < 0.05).

| Treatment/ formulation | Rate amt (AI)/acre | CLM larvae/5 leaves/flush | | | |
|---|---|---|---|---|---|
| | | 3 DAT | 10 DAT | 17 DAT | 24 DAT |
| Untreated check | -- | 4.3 a | 1.3 ab | 2.8 abc | 3.7 a |
| 435 Oil | 2 gal | 3.3 ab | 1.2 abc | 2.5 abc | 3.0 abc |
| Provado 1.6 F + 435 Oil | 12 fl oz + 2 gal | 0.0 e | 1.1 abc | 3.2 ab | 3.4 abc |
| Agri-Mek 0.15 EC + 435 Oil | 10 fl oz + 2 gal | 0.0 e | 0.9 bcd | 2.6 abc | 3.0 abc |
| Agri-Mek 0.15 EC + 435 Oil | 20 fl oz + 2 gal | 0.6 de | 0.3 cde | 1.5 c | 2.2 bcd |
| MSR 2E | 24 fl oz | 2.7 bc | 1.3 ab | 2.8 abc | 1.5 de |
| MSR 2E | 48 fl oz | 3.6 ab | 1.8 a | 2.2 bc | 3.2 abc |
| GF-1640 + 435 Oil | 4 oz + 2 gal | 0.0 e | 0.2 de | 1.4 c | 2.0 cde |
| QRD 400 + 435 Oil | 128 fl oz + 2 gal | 1.1 de | 0.8 bcde | 2.7 abc | 3.5 ab |
| Actara | 4 oz | 1.9 cd | 0.8 bcde | 1.8 bc | 2.9 abcd |
| Actara | 5.5 oz | 0.4 e | 0.9 bcd | 2.8 abc | 2.5 abcd |
| Micromite 80 WDG | 6.25 oz | 1.0 de | 0.2 de | 1.3 c | 2.4 abcd |
| Portal | 64 fl oz | 0.1 e | 0.8 bcde | 3.8 a | 2.8 abcd |
| Portal + 435 Oil | 64 fl oz + 2 gal | 0.4 e | 0.8 bcde | 1.5 c | 3.6 ab |
| MANA AG 8412-094B | 4.8 fl oz | 0.0 e | 0.0 e | 1.5 c | 0.6 e |

Means within columns not followed by the same letter are significantly different (LSD, $P < 0.05$).

| **Treatment/ formulation** | **Rate amt (AI)/acre** | **Ladybeetles (adults + larvae)/ 1 min observation/tree Over all species and sampling dates** |
|---|---|---|
| Untreated check | -- | 1.3 a |
| 435 Oil | 2 gal | 0.8 b |
| Provado 1.6 F + 435 Oil | 12 fl oz + 2 gal | 0.3 c |
| Agri-Mek 0.15 EC + 435 Oil | 10 fl oz + 2 gal | 0.4 bc |
| Agri-Mek 0.15 EC + 435 Oil | 20 fl oz + 2 gal | 0.3 c |
| MSR 2E | 24 fl oz | 0.5 bc |
| MSR 2E | 48 fl oz | 0.2 c |
| GF-1640 + 435 Oil | 4 oz + 2 gal | 0.3 c |
| QRD 400 + 435 Oil | 128 fl oz + 2 gal | 0.6 bc |
| Actara | 4 oz | 0.2 c |
| Actara | 5.5 oz | 0.3 c |
| Micromite 80 WDG | 6.25 oz | 0.5 bc |
| Portal | 64 fl oz | 0.2 c |
| Portal + 435 Oil | 64 fl oz + 2 gal | 0.2 c |
| MANA AG 8412-094B | 4.8 fl oz | 0.3 c |

Ladybeetles numbers were small, therefore, totals over four sampling dates are presented.
Means within columns not followed by the same letter are significantly different (LSD, $P < 0.05$).

## II. MATERIALS TESTED FOR ARTHROPOD MANAGEMENT

**ORANGE:** *Citrus sinensis* (L.) 'Valencia'

**SPRAY APPLICATIONS OF INSECTICIDES TO CONTROL ASIAN CITRUS PSYLLID AND CITRUS LEAFMINER ON ORANGE, 2007**

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| Brand Name | Formulation | Common Name | Composition* | Manufacturer** |
|---|---|---|---|---|
| 435 oil 98.8 | 98.8%L | horticultural spray oil | Refined petroleum distillate | Drexel Chemical Company<br>P.O. Box 13327<br>Memphis, TN 38113-0327 |
| Provado | 1.6 F | imidacloprid | 1-[(6-Chloro-3-pyridinyl)methyl]-N- | Bayer Crop Science |

| | | | | |
|---|---|---|---|---|
| | | | nitro-2-imidazolidinimine | |
| Agri-mek | 0.15 EC | abamectin | (Butyl)-7-((2,6-dideoxy-40-2,6-dideoxy3-0-methyl-x-L-arabinohexopyran osyl)-3-0-methyl-x-L-arabino-hexopyranosyl)oxy)-5’c6,6”,7,10,11,14,15,17a,20,20a,20b-dodecanydro-20b-dihydroxy-5’6,8,19-tetramethylsprio (11,16-methano-2H,13H,17H-furo (4,3,2-pg)(2,6) benzodioxacyclootadecin | Syngenta Crop Protection<br>P.O. Box 18300<br>Greensboro, NC 27419 |
| MSR | 2E | None | S-[2-[Ethylsulfinyl]ethyl] O, O-dimethyl phosphorothioate | Gowan Company<br>P.O.Box: 5569<br>Yuma, AZ 85366-5569 |
| GF-1640 | WG | | Experimental | Dow Agrosciences |
| QRD 400 | | | Experimental | Agraquest |
| Actara | WG | thiamethoxam | 4H-1,3,5-Oxadiazin-4-imine,3-((2-chloro-5-thiazolyl)methyl)tetrahydro-5- | Syngenta Crop Protection<br>P.O. Box 18300 |

| | | | | |
|---|---|---|---|---|
| | | | methyl-N-nitro- | Greensboro, NC 27419 |
| Micromite | 80WGS | diflubenzuron | N-[[(4-Chlorophenyl)amino]carbonyl]-2,6-difluorobenzamide | Uniroyal Chemical Company, Inc. A subsidiary of Crompton Corp. Middlebury, CT 06749 |
| Portal | EC | fenpyroximate | tert-Butyl (E)-4-(((((1,3-dimethyl-5-phenoxy-1H-pyrazol-4-yl)methylene)amino)oxy)methyl)benzoate | Nichino America Inc. 4550 New Linden Hill Rd. Suite 501 Wilmington DE 19808 |
| MANA AG 8412-094B | | generic imidacloprid | 1-[(6-Chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimine | |