Abstract: This publication summarizes IPM for greenhouse aphids on both vegetable and ornamental crops. Focus is on monitoring, sanitation, biological controls, biorational pesticides, and insect growth regulators. Supplemental tables include information on the newest biopesticides and biological control organisms.

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The following document focuses on least-toxic methods for dealing with aphids in greenhouses. For general information on greenhouse IPM, request ATTRA’s publication Integrated Pest Management for Greenhouse Crops, which covers topics such as screening to eliminate pests, weed management, and disease control.

Introduction

There are approximately 4,000 aphid species in the world. Life cycles and preferred hosts vary with each type of aphid. Common aphid pests of greenhouse crops include the green peach aphid (Myzus persicae), the melon/cotton aphid (Aphis gossypii), the chrysanthemum aphid (Macrosiphoniella sanborni), the rose aphid (Macrosiphum rosae), the potato aphid (Macrosiphum euphorbiae) and the foxglove aphid (Aulacorthum solani) (1).

Aphid management relies on understanding that the females of many aphid species do not have to mate in order to reproduce, and they typically produce live young, rather than eggs. These characteristics contribute to the tendency of aphid populations to "explode."

The green peach aphid is probably the most notorious aphid pest of greenhouse crops because of its wide host range, worldwide distribution, number of viral diseases it vectors, and difficulty of control (2).

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Courtesy Of Hercules Inc., Wilmington, Delaware (Macrosiphum rosae), the potato aphid (Macrosiphum euphorbiae) and the foxglove aphid (Aulacorthum solani) (1).
Crop Scouting and Trapping

Plants should be visually inspected for signs of an aphid infestation. Look especially carefully at plants prone to aphid problems, and at plant parts like the undersides of leaves, stems, and new growth. Choose plants randomly throughout the greenhouse and inspect undersides of leaves, buds or tip growth and watch for honeydew and cast skins. Since aphids are difficult to see on plants with fine foliage, hold such plants over a white piece of paper and gently tap to dislodge any aphids. Avoid moving infested plants to new areas where susceptible plants are growing. Locations where aphids are found should be flagged, so that population development and control efforts can be evaluated.

Different aphid species tend to populate different parts of their host plants. Green peach aphids tend to cluster on the succulent young growth, whereas melon aphids are usually evenly distributed along the plant stems. Melon aphid populations also have fewer winged adults than do green peach aphids. Knowing which species is infesting the crop is very important in successful detection and monitoring of aphid populations. The Cooperative Extension Service is a good resource for identification of specific aphid pests.

Yellow sticky cards placed horizontally at the top of the pot or container (if you are growing containerized plants) can be used for monitoring winged aphids. However, since winged aphids caught during the summer months may have blown in from the outdoors, sticky cards are not as reliable as visual inspections. Sticky cards are more useful in the winter months when aphids caught on the cards are not likely to have come in from the outside. It is better to rely primarily on visual inspections for aphid detection, and use sticky cards as a backup method.

Signs of an aphid infestation include honeydew or sooty mold on leaves, yellow spots on upper leaf surfaces, cast skins on leaves, curling of leaves, and distortion of new growth.

Biological Control

There are several biological control options for greenhouse aphid pests. Some common biological control agents (BCAs) include green lacewings (Chrysoperla carnea, C. rufilabris, Chrysopa spp.), aphid midges (Aphidoletes aphidimyza), parasitic wasps (Aphidius colemani and Aphidius matricariae) and lady beetles (Hippodamia convergens). See Appendix I: Beneficial Organisms for more BCAs and suppliers.

A 1998 study showed that green lacewing larvae did not disperse as well as the parasitic wasp Aphidius colemani (3). To achieve equal aphid suppression, more of the slower-moving species need to be introduced and from more points (lacewings have to be released on each bench because they cannot move to adjacent benches, for instance). A study performed at Colorado State University compared the effectiveness of parasitic wasps, aphid midges, lady beetle larvae, and green lacewing larvae (4). The researchers found that lacewings performed better in hot temperatures, while aphid midges and lady beetles were better in cooler temperatures. At all temperatures, Aphidoletes was the best of the four at controlling aphids.

Biorational Pesticides

Strains of the fungus Beauveria bassiana provide good control of aphids, including green peach aphids. The fungus works by attaching to the outside of the pest, then penetrating into the body and killing it. The fungus is available commercially for greenhouse ornamentals as Naturalis-O™ and for vegetables as BotaniGard™. (See below for suppliers.)

Another fungus, Verticillium lecanii, can also provide good biological control of aphids. Formulations of this fungus are currently being sold in some European countries under the names of Vertalec™ and Mycotal™, but neither of these products is yet registered for use in the United States.
Verticillium lecanii often occurs naturally in greenhouses, so it may be possible to encourage its growth and distribution in the greenhouse without the benefit of a commercially available product. V. lecanii spores require at least 93% relative humidity at temperatures between 59 and 81°F to germinate and grow (6). High humidity must be present for at least 10–12 hours/day. Unfortunately, most plant disease-causing fungi also grow best at these same temperature and humidity ranges. Fungicides used to control the plant disease-causing fungi would probably also kill any beneficial fungi present. Insecticides may also be harmful to V. lecanii.

Least-toxic pesticides used against aphids in greenhouses include insecticidal soap (M-Pede™), horticultural oil (UltraFine SunSpray spray oil™), and botanical insecticides such as neem (Azatin™, Neemazad™, and Neemix™), or natural pyrethrums. See Appendix II: Biorational Pesticides for more information and suppliers.

Insect Growth Regulators

Insect growth regulators (IGRs) are another least-toxic pesticide control option for pests. IGRs typically kill insects by disrupting their development. They have a complex mode of action that precludes insects from rapidly developing resistance. IGRs can work in one of several ways: 1) they can mimic juvenile hormones, so that insects never enter the reproductive stage of development; 2) they can interfere with the production of chitin, which makes up the shell of most insects; or 3) they can interfere with the molting process. IGRs usually work through ingestion, so good spray coverage is essential. They generally don’t affect non-target species, such as humans, birds, fish or other vertebrates. For most IGRs there are minimal re-entry restrictions. IGRs typically take several days to have an effect on pest populations. Because IGRs do not affect mature insects, adult beneficials released into the greenhouse after an IGR application are not likely to be affected. Use of IGRs is generally prohibited by organic certification organizations because the products are synthesized.

IGRs can sometimes be used in conjunction with biological control efforts and may provide growers with a “safety net” should beneficials fail to keep the pests below economically damaging levels. The table below lists some well-known insect growth regulators. (Contact information for suppliers is listed at the end of this document.)

Courtesy of Hercules Inc. Wilmington, Delaware
Table 1. Selected Insect Growth Regulators

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Supplier</th>
<th>Active against:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azatin</td>
<td>Hydro-Gardens, Olympic Horticultural Products</td>
<td>whiteflies, leafminers, thrips, mealybugs, fungus gnats, <strong>aphids</strong>, cabbage loopers, diamondback moths, armyworms</td>
</tr>
<tr>
<td>Enstar II</td>
<td>Wellmark Intl.</td>
<td>whiteflies, fungus gnats, <strong>aphids</strong>, soft and armored scales, mealybugs</td>
</tr>
<tr>
<td>Neemazad</td>
<td>Thermo Trilogy</td>
<td>whiteflies, leafminers, thrips, mealybugs, fungus gnats, <strong>aphids</strong>, cabbage loopers, diamondback moths, armyworms</td>
</tr>
<tr>
<td>Neemix</td>
<td>Thermo Trilogy</td>
<td>whiteflies, leafminers, thrips, mealybugs, fungus gnats, <strong>aphids</strong>, loopers, diamondback moths, armyworms, cabbage loopers</td>
</tr>
<tr>
<td>Prelude</td>
<td>Whitmire Micro-Gen</td>
<td>whiteflies, thrips, scales, <strong>aphids</strong></td>
</tr>
</tbody>
</table>

Summary and Further Resources

Greenhouse aphids are tiny insects, but they demand serious attention on the part of the greenhouse grower. Integrated pest management offers a sustainable approach for dealing with greenhouse aphids, and safer pest control products facilitate the adaptation of least-toxic control measures that dovetail very nicely with the IPM philosophy. In the resources sections below, growers are provided with a list of biological control suppliers; and tables that summarize biocontrol agents and biorational pesticides that control aphids.

Related ATTRA Materials

- Organic Greenhouse Vegetable Production
- Integrated Pest Management of Greenhouse Crops
- Greenhouse IPM: Sustainable Thrips Control
- Greenhouse IPM: Sustainable Whitefly Control
References:


Biological Control Suppliers

A-1 Unique Insect Control
5504 Sperry Dr.
Citrus Heights, CA 95621
916-961-7945
916-967-7082 fax
Email: ladybugs@a-1unique.com
http://www.a-1unique.com

ARBICO Inc.
PO Box 4247 CRB
Tucson, AZ 85738
800-SOS-BUGS
520-825-2038 fax
Email: arbico@aol.com
http://www.arbico.com

Beneficial Insectary
14751 Oak Run Rd.
Oak Run, CA 96069
800-477-3715
530-472-3523 fax
Email: bi@insectary.com
http://www.insectary.com

Caltec Agri-Marketing Services
PO Box 576155
Modesto, CA 95357
209-575-1295
209-575-0366 fax
http://www.caltecag.com

Florikan ESA Corp.
1523 Edger Place
Sarasota, FL 34240
800-322-8666
941-377-3633 fax
Email: buglady@aol.com

The Green Spot, Ltd.
93 Priest Rd.
Nottingham, NH 03290-6204
603-942-8925
603-942-8932
603-942-5027 voice mail
Email: GrnSpt@internetMCI.com

Harmony Farm Supply
3244 Hwy. 116 No. F
Sebastopol, CA 95472
707-823-9125
707-823-1734 fax
Email: kate@harmonyfarm.com
http://www.harmonyfarm.com

Hot Pepper Wax, Inc.
305 Third St.
Greenville, PA 16125
888-667-3785
724-646-2302 fax
Email: lindag@hotpepperwax.com
http://www.hotpepperwax.com

Hydro-Gardens, Inc.
PO Box 25845
Colorado Springs, CO 80932
719-495-2266
719-531-0506 fax
http://www.hydro-gardens.com

International Technology Services Inc.
PO Box 19227
Boulder, CO 80308-2227
303-473-9141
303-473-9143 fax
Email: intertechserv@worldnet.att.net
IPM Laboratories
PO Box 300
Locke, NY 13092-0099
315-497-2063
315-497-3129 Fax
http://www.ipmlabs.com

Koppert Biological Systems
2856 Main St. South
Ann Arbor, MI 48103
313-998-5589
313-998-5557 fax
http://www.koppert.nl/english/index.html

M&R Durango, Inc.
PO Box 886
Bayfield, CO 81122
970-259-3521
970-259-3857 fax
http://www.goodbug.co

Mycogen Crop Protection
5501 Oberlin Dr.
San Diego, CA 92121
800-745-7476
619-453-9089 fax
Email: soares@mycogen.com

Mycotech Corp.
PO Box 4109
Butte, MT 59702-4109
800-383-4310
406-782-9912 fax
Email: mycotech@montana.com

Natural Pest Controls
8864 Little Creek Dr.
Orangeville, CA 95662
916-726-0855
916-726-0855 fax
Email: natpestc@cwnet.com
http://www.natural-pest-controls.com

Nature’s Control
PO Box 35
Medford, OR 97501
800-698-6250
541-899-9121 fax
Email: bugsnc@teleport.com

Olympic Horticultural Products
PO Box 1885
Bradenton, FL 34206-1885
800-659-6745
888-647-4329 fax
Email: olympic@hortnet.com
http://www.hortnet.com/olympic

Praxis
2723 116th Ave.
Allegan, MI 49010
616-673-2793
616-673-2793 fax
Email: praxis@datawise.net
http://www.praxis-ibc.com

Rincon-Vitova Insectaries, Inc.
PO Box 1555
Ventura, CA 93002
800-248-2847
805-643-6267 fax
Email: bugnet@west.net
http://www.rinconvitova.com

SePRO Corp.
11550 N. Meridian St., Suite 180
Carmel, IN 46032-4562
800-419-7779
317-580-8290 fax
Email: rogers@sepro.com
http://www.sepro.com

Soil Technologies Corp.
2103 185th St.
Fairfield, IA 52556
800-221-7645
515-472-6189 fax
Email: soiltech@lisco.com
http://www.lisco.com/soiltech

Stoller Enterprises, Inc.
8582 Katy Freeway, Suite 200
Houston, TX 77024
800-539-5283
713-461-4467 fax

Thermo Trilogy Corp.
9145 Guilford Rd., Ste. 175
Columbia, MD 21046
800-847-5620
301-604-7015 fax
http://www.thermotrilogy.com
### Appendix I: Beneficial Organisms

<table>
<thead>
<tr>
<th>Organism</th>
<th>Supplier</th>
<th>Pests Controlled</th>
<th>Application/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Chrysoperla</em> spp. (predator)</td>
<td>M&amp;R Durango, Florikan, Green Spot</td>
<td>see above</td>
<td></td>
</tr>
<tr>
<td><em>Coleomegilla imaculata</em> (pink ladybird beetle)</td>
<td>Arbico</td>
<td>aphids, caterpillars, mites, scales, thrips, whiteflies</td>
<td>1/sq. ft.; shipped as larvae and eggs.</td>
</tr>
<tr>
<td><em>Cryptolaemus montrouzieri</em> (predator beetle)</td>
<td>Arbico, Caltec, Intl. Technology Services, IPM Laboratories, Natural Pest Controls, Nature’s Control, Florikan, Harmony Farm Supply, Hydro-Gardens, Praxis, Rincon-Vitova, Green Spot</td>
<td>aphids, mealybugs, soft scales</td>
<td>2-5/infested plant; humidity should be 70-80%, temp. 70-80°F. Larvae are cannibalistic; repeat as necessary for control; do not wear white while distributing.</td>
</tr>
<tr>
<td><em>Deraeocoris brevis</em> (predator)</td>
<td>Green Spot</td>
<td>aphids, whiteflies, thrips</td>
<td></td>
</tr>
<tr>
<td><em>Diaretiella rapae</em> (parasite)</td>
<td>Arbico, Praxis</td>
<td>aphids</td>
<td>Release rates vary.</td>
</tr>
<tr>
<td><em>Harmonia axyridis</em> (Asian lady beetle)</td>
<td>Green Spot</td>
<td>scale, whiteflies, mealybugs, aphids</td>
<td>Temps. should be 70-85°F; humidity around 70%.</td>
</tr>
<tr>
<td>Organism</td>
<td>Supplier</td>
<td>Pests Controlled</td>
<td>Application/Comments</td>
</tr>
<tr>
<td>----------------------------------------------</td>
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</tr>
</tbody>
</table>
| *Iphiseius degenerans* or *Amblyseius degenerans*  
(predatory mite) | Intl. Technology Services, IPM Labs., Green Spot | **aphids**                | 1 predator/sq. ft.; humidity should be moderate, temp. 70°F. Establish population early. Repeat every month during periods of warm, dry weather. |
| *Lysiphlebus testaceipes*  
(parasitic wasp) | Praxis                            | **aphids**                |                                                                                                               |
| *N. cucumeris* and *N. barkeri* | Hydro-Gardens                      | thrips, **aphids**, mites  | 1/10 sq. ft. (preventive), 1 every 2 sq. ft. when pests are present. Temperature should be 70-90°F. *Orius* are dormant September–April. Re-apply every 2-3 weeks. Very susceptible to pesticides. Works well in combination with *Neoseiulus cucumeris*. |
| *Orius insidiosus*  
(minute pirate bug)  
(predator) | Florikan, IPM Laboratories, Harmony Farm Supply, Arbico, Hydro-Gardens, Praxis, Koppert, Intl. Tech. Services, Green Spot | **aphids**, caterpillars, thrips, whiteflies, mites |                                                                                                               |
| *Propylea quatuordecimpunctata*  
(predatory beetle) | Praxis                            | **aphids**                |                                                                                                               |
Appendix II: Biorational Pesticides

Azadirachtin – extract of neem seed; IGR that works through contact or ingestion

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Supplier</th>
<th>Pests Controlled</th>
<th>REI</th>
<th>Application/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azatin Green Spot</td>
<td>aphids, caterpillars, fungus gnats, leafhoppers, leafminers, Western flower thrips, whiteflies, psyllids</td>
<td>4 hours</td>
<td>Apply when pests first appear.</td>
<td></td>
</tr>
<tr>
<td>Neemazad Thermo Trilogy</td>
<td>aphids, caterpillars, thrips, greenhouse whitefly, leafminers, sweetpotato whitefly, psyllids, leafhoppers</td>
<td>12 hours</td>
<td>Cannot be applied through irrigation. Low rate can be used as a preventative.</td>
<td></td>
</tr>
</tbody>
</table>

*Beauveria bassiana* – fungus that works through contact; exposure to non-target insects should be avoided

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Supplier</th>
<th>Pests Controlled</th>
<th>REI</th>
<th>Application/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naturalis-O SePro</td>
<td>aphids, caterpillars, mites, psyllids, thrips, whiteflies</td>
<td>4 hours</td>
<td>Apply when insects first appear and repeat every 7-10 days. Need good spray coverage. Not compatible with other fungicides.</td>
<td></td>
</tr>
<tr>
<td>BotaniGard Mycotech</td>
<td>giant whitefly, green peach aphid, black vine weevil, other aphids and whiteflies, thrips, leafhoppers, psyllids, white grubs</td>
<td>12 hours</td>
<td>See above.</td>
<td></td>
</tr>
</tbody>
</table>
Garlic extracts

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Supplier</th>
<th>Pests Controlled</th>
<th>REI</th>
<th>Application/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garlic Gard</td>
<td>Soil Technologies</td>
<td>repels <strong>aphids</strong> and other insects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garlic Barrier</td>
<td>Green Spot</td>
<td>repels <strong>aphids</strong> and other insects</td>
<td>4 hours</td>
<td>Use late in the day. Can be mixed with fish oil or horticultural oil. Do not use in combination with bumblebees or honeybees.</td>
</tr>
</tbody>
</table>

Horticultural oil – includes dormant and summer superior oils

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Supplier</th>
<th>Pests Controlled</th>
<th>REI</th>
<th>Application/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Seasons</td>
<td>Green Spot</td>
<td><strong>aphids</strong>, mealybugs, scales, thrips, whiteflies, spider mites</td>
<td>4 hours</td>
<td>Use on sunny days to promote rapid drying and decrease chance of phytotoxicity. Not compatible with beneficials.</td>
</tr>
</tbody>
</table>

Hot pepper wax – contains capsaicin, paraffin, and mineral oil

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Supplier</th>
<th>Pests Controlled</th>
<th>REI</th>
<th>Application/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Pepper Wax</td>
<td>Green Spot</td>
<td><strong>aphids</strong>, loopers, beet army-worms, mites, whiteflies, thrips, mealybugs, etc.</td>
<td>4 hours</td>
<td>Also contains herbal essential oils. Not compatible with beneficials.</td>
</tr>
<tr>
<td>Hot Pepper Wax</td>
<td>Hot Pepper Wax, Inc.</td>
<td>see above</td>
<td>0 hours</td>
<td></td>
</tr>
</tbody>
</table>
Insecticidal soap – contains potassium salts of fatty acids

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Supplier</th>
<th>Pests Controlled</th>
<th>REI</th>
<th>Application/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-Pede</td>
<td>Mycogen</td>
<td>aphids, mealybugs, scales, thrips, whiteflies, spider mites</td>
<td>12 hours</td>
<td>Phytoxicity is often a concern, esp. after repeated applications.</td>
</tr>
<tr>
<td>Safer</td>
<td>Green Spot</td>
<td>see above</td>
<td>4 hours</td>
<td>See above.</td>
</tr>
<tr>
<td>Insecticidal soap</td>
<td>Olympic</td>
<td>see above</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Neem oil – multi-purpose organic insecticide/fungicide/miticide; kills eggs, larval and adult stages of insects

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Supplier</th>
<th>Pests Controlled</th>
<th>REI</th>
<th>Application/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trilogy 90EC</td>
<td>Thermo</td>
<td>greenhouse whitefly, silver-leaf whitefly, sweetpotato whitefly, thrips, whiteflies, leafminers, aphids, mites, psyllids, San Jose scale, scale, spider mites, downy mildew, powdery mildew, Alternaria, Botrytis, etc.</td>
<td>4 hours</td>
<td>Apply at first signs of damage. Repeat every 7-10 days as needed.</td>
</tr>
<tr>
<td>Triact 90EC</td>
<td>Thermo</td>
<td>see above</td>
<td>4 hours</td>
<td>For ornamental crops only.</td>
</tr>
</tbody>
</table>

Soybean oil

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Supplier</th>
<th>Pests Controlled</th>
<th>REI</th>
<th>Application/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golden Natur’l Spray Oil</td>
<td>Stoller</td>
<td>aphids, fungus gnats, lace bugs, leafminers, scales, mealybugs, spider mites, whiteflies</td>
<td>12 hours</td>
<td></td>
</tr>
</tbody>
</table>