



GREENHOUSE IPM: SUSTAINABLE APHID CONTROL

PEST MANAGEMENT TECHNICAL NOTE

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ATTRA is the national sustainable agriculture information center funded by the USDA's Rural Business -- Cooperative Service.

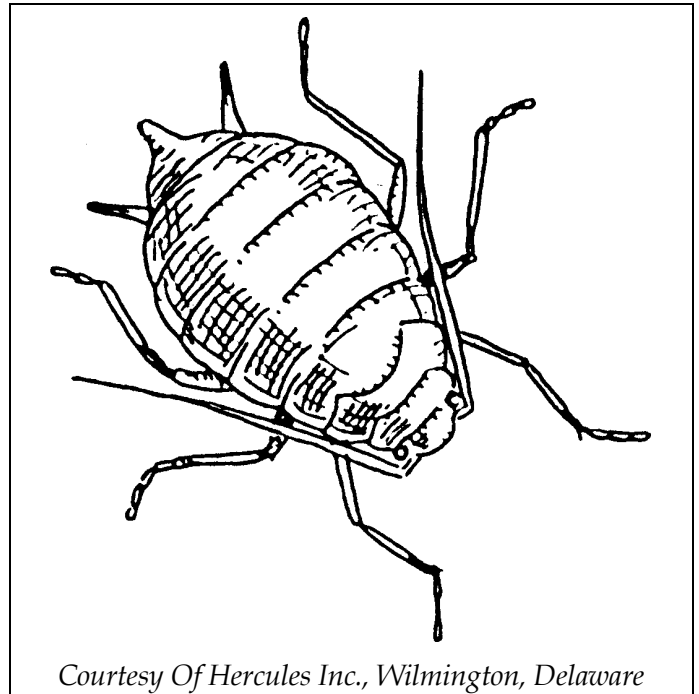
Abstract: This publication summarizes IPM for greenhouse aphids on both vegetable and ornamental crops. Focus is on monitoring, sanitation, biological controls, biorational pesticides, and insect growth regulators. Supplemental tables include information on the newest biopesticides and biological control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

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June 2000

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



Courtesy Of Hercules Inc., Wilmington, Delaware

(*Macrosiphum rosae*), the potato aphid (*Macrosiphum euphorbiae*) and the foxglove aphid (*Aulacorthum solani*) (1).

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).

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."

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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*.

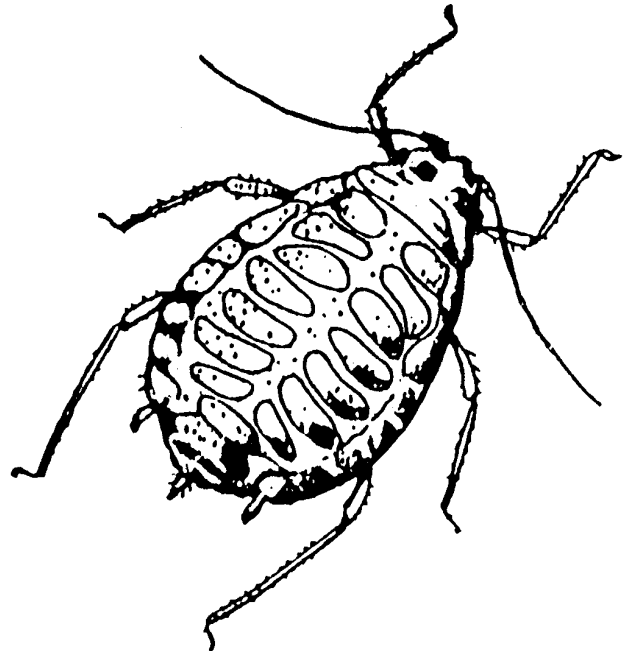
Least-toxic pesticides used against aphids in greenhouses include insecticidal soap (M-Pede™), horticultural oil (UltraFine SunSpray spray oil™), and botanical insecticides such as neem (Azatin™, Neemazad™, and Neemix™), or natural pyrethrums. See **Appendix II: Biorational Pesticides** for more information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

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

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:

- 1) Lindquist, Richard. 1991. A guide to aphid control. *GrowerTalks*. October. p. 75.
- 2) Sunderland, Keith et al. 1992. Integrated pest management of greenhouse crops in Northern Europe: Aphids. p. 23-30. In: Jules Janick (ed.) *Horticultural Reviews*: Vol. 13. John Wiley and Sons, Inc. New York, NY.
- 3) Heinz, K.M. 1998. Dispersal and dispersion of aphids and selected natural enemies in spatially subdivided greenhouse environments. *Environmental Entomology*. Vol. 27, No. 4. p. 1029-1038.
- 4) Anon. 1999. Efficacy of four biocontrol agents on the green peach aphid, *Myzus persicae*, in greenhouse peppers. *Midwest Biological Control News*. January-February. p. 7.

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>

Caltex Agri-Marketing Services
PO Box 576155
Modesto, CA 95357
209-575-1295
209-575-0366 fax
<http://www.caltexag.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: bugsn@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 Trilogly Corp.
9145 Guilford Rd., Ste. 175
Columbia, MD 21046
800-847-5620
301-604-7015 fax
<http://www.thermotrilogly.com>

Wellmark International
1000 Tower Lane, Suite 245
Bensonville, IL 60106
800-842-3135
630-227-6065 fax

Whitmore Micro-Gen
3568 Tree Court Ind. Blvd.

St. Louis, MO 63122
800-777-8570

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June 2000

**Insect drawings courtesy of Hercules
Powder Company; Wilmington, DE-
*Handbook of the Insect World 60p.***

The electronic version of **Greenhouse IPM:
Sustainable Aphid Control** is located at:
<http://www.attra.org/attra-pub/gh-aphid.html>

The ATTRA Project is operated by the National Center for Appropriate Technology under a grant from the Rural Business-Cooperative Service, U.S. Department of Agriculture. These organizations do not recommend or endorse products, companies, or individuals. ATTRA is located in the Ozark Mountains at the University of Arkansas in Fayetteville at P.O. Box 3657, Fayetteville, AR 72702. ATTRA staff members prefer to receive requests for information about sustainable agriculture via the toll-free number 800-346-9140.



Appendix I: Beneficial Organisms

<u>Organism</u>	<u>Supplier</u>	<u>Pests Controlled</u>	<u>Application/Comments</u>
<i>Chrysoperla</i> spp. (predator)	M&R Durango, Florikan, Green Spot	see above	
<i>Coleomegilla imaculata</i> (pink ladybird beetle)	Arbico	aphids , caterpillars, mites, scales, thrips, whiteflies	1/sq. ft.; shipped as larvae and eggs.
<i>Cryptolaemus montrouzieri</i> (predator beetle)	Arbico, Caltec, Intl. Technology Services, IPM Laboratories, Natural Pest Controls, Nature's Control, Florikan, Harmony Farm Supply, Hydro- Gardens, Praxis, Rincon- Vitova, Green Spot	aphids , mealybugs, soft scales	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.
<i>Deraeocoris brevis</i> (predator)	Green Spot	aphids , whiteflies, thrips	
<i>Diaretiella rapae</i> (parasite)	Arbico, Praxis	aphids	Release rates vary.
<i>Harmonia axyridis</i> (Asian lady beetle)	Green Spot	scale, whiteflies, mealybugs, aphids	Temps. should be 70-85°F; humidity around 70%.
<i>Hippodamia convergens</i> (lady beetle) (predator)	A-1 Unique Insect Control, Arbico, Caltec, IPM Labora- tories, Natural Pest Controls, Nature's Control, Harmony Farm Supply, Hydro-Gardens, Praxis, Green Spot	aphids , mites, whiteflies	Release at dusk near an immediate food source. Spray plants with water prior to release.

<u>Organism</u>	<u>Supplier</u>	<u>Pests Controlled</u>	<u>Application/Comments</u>
<i>Iphiseius degenerans</i> or <i>Amblyseius degenerans</i> (predatory mite)	Intl. Technology Services, IPM Labs., Green Spot	aphids	
<i>Lysiphlebus testaceipes</i> (parasitic wasp)	Praxis	aphids	
<i>N. cucumeris</i> and <i>N. barkeri</i>	Hydro-Gardens	thrips, aphids , mites	1 predator/sq. ft.; humidity should be moderate, temp. 70°F. Establish population early. Repeat every month during periods of warm, dry weather.
<i>Orius insidiosus</i> (minute pirate bug) (predator)	Florikan, IPM Labs., Harmony Farm Supply, Arbico, Hydro-Gardens, Praxis, Koppert, Intl. Tech. Services, Green Spot	aphids , caterpillars, thrips, whiteflies, mites	1/10 sq. ft. (preventive), 1 every 2 sq. ft. when pests are present. Temperature should be 70-90°F. <i>Orius</i> are dormant September–April. Re-apply every 2-3 weeks. Very susceptible to pesticides. Works well in combination with <i>Neoseiulus cucumeris</i> .
<i>Propylea</i> <i>quatuordecimpunctata</i> (predatory beetle)	Praxis	aphids	

Appendix II: Biorational Pesticides

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

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

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

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

Garlic extracts

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

Horticultural oil - includes dormant and summer superior oils

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

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

<u>Brand Name</u>	<u>Supplier</u>	<u>Pests Controlled</u>	<u>REI</u>	<u>Application/Comments</u>
Hot Pepper Wax	Green Spot	aphids , loopers, beet armyworms, mites, whiteflies, thrips, mealybugs, etc.	4 hours	Also contains herbal essential oils. Not compatible with beneficials.
Hot Pepper Wax	Hot Pepper Wax, Inc.	see above	0 hours	

Insecticidal soap – contains potassium salts of fatty acids

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

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

<u>Brand Name</u>	<u>Supplier</u>	<u>Pests Controlled</u>	<u>REI</u>	<u>Application/Comments</u>
Trilogy 90EC	Thermo Trilogy	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.	4 hours	Apply at first signs of damage. Repeat every 7-10 days as needed.
Triact 90EC	Thermo Trilogy	see above	4 hours	For ornamental crops only.

Soybean oil

<u>Brand Name</u>	<u>Supplier</u>	<u>Pests Controlled</u>	<u>REI</u>	<u>Application/Comments</u>
Golden Natur'l Spray Oil	Stoller	aphids , fungus gnats, lace bugs, leafminers, scales, mealybugs, spider mites, whiteflies	12 hours	