



# GREENHOUSE IPM: SUSTAINABLE APHID CONTROL

PEST MANAGEMENT TECHNICAL NOTE

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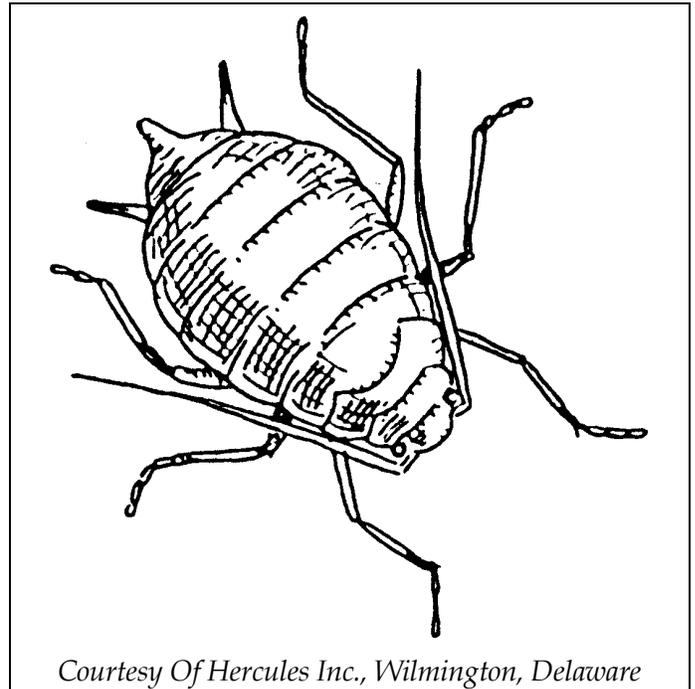
**Abstract:** This publication summarizes IPM for greenhouse aphids on both vegetable and ornamental crops. Focus is on monitoring, sanitation, biological controls, biorational pesticides, and insect growth regulators. Supplemental tables include information on the newest biopesticides and biological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



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*.

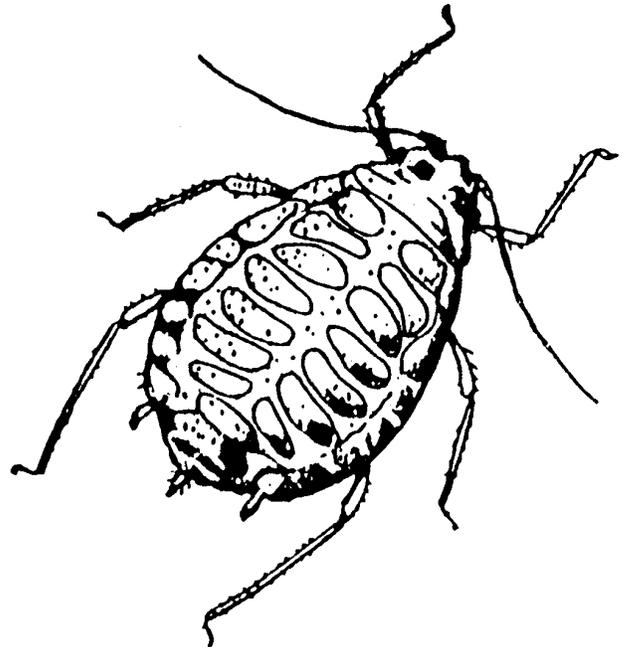
Least-toxic pesticides used against aphids in greenhouses include insecticidal soap (M-Pede™), horticultural oil (UltraFine SunSpray spray oil™), and botanical insecticides such as neem (Azatin™, Neemazad™, and Neemix™), or natural pyrethrums. See **Appendix II: Biorational Pesticides** for more information 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, <b>aphids</b> , cabbage loopers, diamondback moths, armyworms
Enstar II	Wellmark Intl.	whiteflies, fungus gnats, <b>aphids</b> , soft and armored scales, mealybugs
Neemazad	Thermo Trilogy	whiteflies, leafminers, thrips, mealybugs, fungus gnats, <b>aphids</b> , cabbage loopers, diamondback moths, armyworms
Neemix	Thermo Trilogy	whiteflies, leafminers, thrips, mealybugs, fungus gnats, <b>aphids</b> , loopers, diamondback moths, armyworms, cabbage loopers
Preclude	Whitmire Micro-Gen	whiteflies, thrips, scales, <b>aphids</b>

### 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](mailto:soares@mycogen.com)

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

Natural Pest Controls  
8864 Little Creek Dr.  
Orangeville, CA 95662  
916-726-0855  
916-726-0855 fax  
Email: [natpestc@cwnet.com](mailto: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](mailto:bugsn@teleport.com)

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

Praxis  
2723 116<sup>th</sup> Ave.  
Allegan, MI 49010  
616-673-2793  
616-673-2793 fax  
Email: [praxis@datawise.net](mailto: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](mailto: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](mailto:rogers@sepro.com)  
<http://www.sepro.com>

Soil Technologies Corp.  
2103 185<sup>th</sup> St.  
Fairfield, IA 52556  
800-221-7645  
515-472-6189 fax  
Email: [soiltech@lisco.com](mailto: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>

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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**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>

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## Appendix I: Beneficial Organisms

Organism	Supplier	Pests Controlled	Application/Comments
<i>Chrysoperla</i> spp. (predator)	M&R Durango, Florikan, Green Spot	see above	
<i>Coleomegilla imaculata</i> (pink ladybird beetle)	Arbico	<b>aphids</b> , 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	<b>aphids</b> , 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	<b>aphids</b> , whiteflies, thrips	
<i>Diaretiella rapae</i> (parasite)	Arbico, Praxis	<b>aphids</b>	Release rates vary.
<i>Harmonia axyridis</i> (Asian lady beetle)	Green Spot	scale, whiteflies, mealybugs, <b>aphids</b>	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	<b>aphids</b> , 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	<b>aphids</b>	
<i>Lysiphlebus testaceipes</i> (parasitic wasp)	Praxis	<b>aphids</b>	
<i>N. cucumeris</i> and <i>N. barkeri</i>	Hydro-Gardens	thrips, <b>aphids</b> , 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	<b>aphids</b> , 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	<b>aphids</b>	

## 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	<b>aphids</b> , caterpillars, fungus gnats, leafhoppers, leafminers, Western flower thrips, whiteflies, psyllids	4 hours	Apply when pests first appear.
Neemazad	Thermo Trilogy	<b>aphids</b> , 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	<b>aphids</b> , 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, <b>green peach aphid</b> , black vine weevil, <b>other aphids</b> 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 <b>aphids</b> and other insects		
Garlic Barrier	Green Spot	repels <b>aphids</b> 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	<b>aphids</b> , 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	<b>aphids</b> , 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	<b>aphids</b> , 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, <b>aphids</b> , 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	<b>aphids</b> , fungus gnats, lace bugs, leafminers, scales, mealybugs, spider mites, whiteflies	12 hours	