

# Appendixes

- A. Monitoring and Scouting Techniques for Greenhouse Plants**
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## Appendix A. Monitoring and Scouting Techniques for Greenhouse Plants

|   | Aphids | Plant Bugs | Shore Flies | Fungus Gnats | Leaf-miners | Mealy-bugs | Broad Mites | Spider Mites | Soft Scales | Armored Scales | Slugs | Thrips | White-flies | Caterpillars |
|---|--------|------------|-------------|--------------|-------------|------------|-------------|--------------|-------------|----------------|-------|--------|-------------|--------------|
| <b>MONITORING</b>   |        |            |             |              |             |            |             |              |             |                |       |        |             |              |
| Sticky cards at top of pot                                | X      | X          | X           | X            | X           |            |             |              |             |                |       | X      | X           |              |
| Horizontal sticky trap at top of pot                      | X      |            | X           | X            | X           |            |             |              |             |                |       | X      |             |              |
| Trap/Indicator plants                                     |        | X          |             |              | X           |            |             |              |             |                |       | X      | X           |              |
| Place piece of potato on media                            |        |            | X           | X            |             |            |             |              |             |                |       |        |             |              |
| <b>SCOUTING</b>   |        |            |             |              |             |            |             |              |             |                |       |        |             |              |
| Inspect underside of leaf                                 | X      |            |             |              |             | X          | X           | X            | X           | X              |       | X      | X           | X            |
| Inspect upper surface for stippling/small white spots     |        |            |             |              |             |            |             | X            |             |                |       | X      |             |              |
| Inspect leaves for mines within tissue                    |        |            |             |              | X           |            |             |              |             |                |       |        |             |              |
| Inspect new growth or terminal for feeding                | X      | X          |             |              |             |            | X           |              |             |                |       | X      |             |              |
| Lightly blow into flowers and look for movement           |        |            |             |              |             |            |             | X            |             |                |       | X      |             |              |
| Tap flowers over white surface and look for movement      | X      |            |             |              |             |            |             | X            |             |                |       | X      |             |              |
| Press lower leaf on white card and look for spots on card |        |            |             |              |             |            |             | X            |             |                |       | X      |             |              |
| White or brown spots on flowers                           |        |            |             |              |             |            |             |              |             |                |       |        |             |              |
| Dark area on buds that are just opening                   |        |            |             |              |             |            |             |              |             |                |       |        |             |              |
| Check leaves on media for feeding and larvae beneath      |        |            | X           | X            |             |            |             |              |             |                |       | X      |             |              |
| <b>OBSERVE FOR</b>  |        |            |             |              |             |            |             |              |             |                |       |        |             |              |
| Honeydew or sooty mold on leaves                          | X      |            |             |              |             | X          |             |              | X           | X              |       |        | X           |              |
| Brown, callus-like spots on stems/leaves                  |        |            |             |              |             |            |             |              | X           | X              |       |        |             |              |
| White, cottony mass on stems/leaves                       |        |            |             |              |             | X          |             |              |             |                |       |        |             |              |
| Holes in leaves   |        |            |             |              |             |            |             |              |             |                | X     |        |             | X            |
| Small, clear, skeletonized spot on leaf                   |        |            |             |              |             |            |             |              |             |                | X     |        |             | X            |
| Cut edges of leaves                                       |        |            |             |              |             |            |             |              |             |                | X     |        |             | X            |
| Frass on leaves   |        |            |             |              |             |            |             |              |             |                |       |        |             | X            |
| Small, black spots on leaves (fecal drops)                |        |            | X           |              |             |            |             |              |             |                |       | X      |             |              |
| Chlorotic (yellow) spots on upper leaf surface            | X      |            |             |              |             |            |             | X            | X           | X              |       | X      | X           |              |
| Wilting of new growth                                     |        | X          |             |              |             |            |             |              |             |                |       |        |             |              |
| Cast skins on leaf from molting insect                    | X      |            |             |              |             |            |             |              |             |                |       |        |             |              |
| Curling of leaves   | X      |            |             |              |             |            | X           |              |             |                |       |        |             |              |
| Distortion of new growth                                  | X      | X          |             |              |             | X          | X           |              |             |                |       |        | X           |              |
| Main stems of plants                                      | X      | X          |             |              |             | X          |             |              | X           | X              |       |        |             |              |
| Slime trail on leaf                                       |        |            |             |              |             |            |             |              |             |                | X     |        |             |              |
| Buds fail to open or uneven opening of flowers            |        |            |             |              |             |            |             |              |             |                |       |        |             |              |
| Webbing on leaves or flowers                              |        |            |             |              |             |            |             | X            |             |                |       |        |             |              |
| Gnat-like insects flying among plants                     |        |            | X           | X            |             |            |             |              |             |                |       |        |             |              |

Source: Adapted from Oetting, Ronald D. 1997. "Table: Ornamentals-Greenhouse Plants." In: 1997 *Insect Control Guide*. Willoughby: Meister Publishing.





## APPENDIX B (continued)

**Roof Health:**

| DATE | LOCATION | PLANT | RATING (GOOD, FAIR, POOR) | COMMENTS |
|------|----------|-------|---------------------------|----------|
|      |          |       |                           |          |
|      |          |       |                           |          |
|      |          |       |                           |          |
|      |          |       |                           |          |
|      |          |       |                           |          |
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**Comments:**

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**Map of Greenhouse:**

Source: Adapted from Gill, S. et al. 2003. *Integrated Pest Management for School Greenhouse Operations*. Maryland Cooperative Extension, University of Maryland.

## Appendix C. Beneficial Organisms

The numbers under “Suppliers” refer to those listed in Appendix E.

| BENEFICIAL ORGANISM  | PESTS CONTROLLED  | APPLICATION/COMMENTS<br>(Follow current recommendations from supplier for your particular crop.)  | SUPPLIERS     |
|--|---|---|---------------|
| <i>Aphelinus abdominalis</i><br>(parasitoid, wasp)                       | aphids  | Release 0.5–2 adults/sq yd; release at first sign of pests  | 1, 2, 3, 4, 5 |
| <i>Aphidius colemani</i><br>(parasitoid, wasp)                           | aphids  | Release 0.5–2 pupae/sq yd; release at first sign of pests and for 3 consecutive weeks thereafter; humidity should be 70–85%, temp. 65–77°F; sensitive to pesticides   | 1, 2, 3, 4, 5 |
| <i>Aphidius ervi</i> (parasitoid, wasp)                                  | potato aphids   | Use about 1/2 the rate of <i>A. colemani</i>  | 1, 2, 3, 4, 5 |
| <i>Aphidoletes aphidimyza</i><br>(predator, midge)                       | aphids  | Preventative: 1–3 pupae/sq yd monthly; humidity should be 50–90%, temp. 60–80°F; release when aphids are first observed; active at night; sensitive to day length<br>Curative: 2–9 pupae/sq yd weekly, depending on amount of infestation           | 1, 2, 3, 4, 5 |
| <i>Chrysopa carnea</i> (predator, lacewing)                              | aphids, caterpillars, mealybugs, scales, spider mites, thrips, whiteflies | May arrive as eggs, immatures, or adults. Adults: 1 adult/5–30 aphids. Larvae: 10 larvae/sq yd as curative release. Eggs: 1,000 eggs/200 sq ft. Apply every 1–3 weeks as needed   | 1, 2, 3, 4, 5 |
| <i>Chrysoperla rufilabris</i><br>(predator, lacewing)                    | See above   | See above   | 1, 3, 4, 5    |
| <i>Cryptolaemus montrozieri</i><br>(predator, ladybird beetle)           | aphids, mealybugs, soft scales  | 2–5 adults/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  | 1, 2, 3, 4, 5 |
| <i>Dacnusa siberica</i> (parasitoid, wasp)                               | leafminers  | Preventive: 1–3 adults/sq yd, biweekly; Curative: 2–5 adults/sq yd biweekly, 2–3 times. Apply at first appearance of pests. Humidity should be 50–90%; temp. 60–85°F.   | 1, 2, 3, 4, 5 |
| <i>Delphastus pusillus</i> (=catalinae)<br>(predator, beetle)            | greenhouse whitefly, sweetpotato whitefly                                 | 100 adults/10 plants; will feed on spider mites if no whiteflies are available; should be used along with <i>Encarsia formosa</i> and traps; temp. should be 60–85°F  | 1, 2, 3, 5    |
| <i>Diglyphus isaea</i> (parasitoid, wasp)                                | leafminers  | Preventative: 1–2 adults/sq yd triweekly. Curative: 2–4 adults/sq yd biweekly, 2–3 times. Temps. should be 75–90°F and humidity around 80%  | 1, 2, 3, 4, 5 |
| <i>Encarsia formosa</i> (parasitoid, wasp)                               | greenhouse whitefly, sweetpotato whitefly, silverleaf whitefly            | 3–6 pupae/sq yd weekly for 3 weeks; apply when pests are first observed; should be used in conjunction with traps, may be used along with other beneficials; <i>E. formosa</i> is very susceptible to chemicals; temp. should be at least 64°F      | 1, 2, 3, 4, 5 |
| <i>Eretmocerus californicus</i> or <i>E. eremicus</i> (parasitoid, wasp) | greenhouse whitefly, sweetpotato whitefly, silverleaf whitefly            | 4–6 adults/sq yd; introduce when whiteflies are first observed; may be used in combination with other beneficials such as green lacewings; <i>Eretmocerus</i> is more tolerant of pesticides and hot, dry temperatures than <i>Encarsia formosa</i> | 1, 2, 3, 4, 5 |
| <i>Feltiella acarisuga</i> (predator, midge)                             | mites   | 1–5 adults/sq yd/week for 4 weeks   | 1, 2, 3, 4, 5 |
| <i>Hippodamia convergens</i><br>(predator, ladybird beetle)              | aphids, mites, whiteflies   | 1–4 beetles/sq yd biweekly, 2–4 times; release at dusk near an immediate food source; spray plants with water prior to release  | 1, 2, 3       |
| <i>Hypoaspis miles</i> (predator, mite)                                  | fungus gnats, shore flies, mites, springtails                             | Preventive: 35–70 mites/sq yd. Curative: 45–200 mites/sq yd, depending on amount of infestation; live and breed in the top 0.5 inch of soil   | 1, 2, 3, 4, 5 |
| <i>Hypoaspis miles</i> (predator, mite)                                  | thrips  | 100–300 mites/sq yd   | 1, 2, 3, 4, 5 |
| <i>Leptomastix dactylopii</i><br>(parasitoid, wasp)                      | mealybug  | 2 adults/sq yd or 5 adults/infested plant; repeat 1 or 2 times/year   | 2, 3, 4, 5    |
| <i>Metaphycus hevolus</i><br>(parasitoid, wasp)                          | scales  | 5–10 pupae/plant; temp. should be 73–90°F; humidity 50%; do not overwinter in cold climates; attracted to lights and sticky traps   | 1, 3          |
| <i>Neoseiulus (Amblyseius) barkeri</i> (predator, mite)                  | broad mites, thrips   | 10–30 mites/plant per week  |               |

## APPENDIX C (continued)

The numbers under “Suppliers” refer to those listed in Appendix E.

| BENEFICIAL ORGANISM  | PESTS CONTROLLED                                | APPLICATION/COMMENTS<br>(Follow current recommendations from supplier for your particular crop.)   | SUPPLIERS     |
|--|---|--|---------------|
| <i>Neoseiulus (Amblyseius) californicus</i> (predator, mite) | spider mites                                    | 6 mites/sq yd; introduce at first sign of spider mites; can tolerate hot conditions (temp. 70–90°F; humidity 60%); can survive absence of prey longer than other predator mites  | 1, 2, 3, 4, 5 |
| <i>Neoseiulus (Amblyseius) cucumeris</i> (predator, mite)    | thrips, mites                                   | 100 mites/sq yd; introduce at first sign of pests; temp. should be 50–85°F; humidity 70–90%  | 1, 2, 3, 4, 5 |
| <i>Orius insidiosus</i> (predator, minute pirate bug)        | aphids, caterpillars, thrips, whiteflies, mites | 1 adult/sq yd, 1 adult every 2 sq ft when pests are present; temp. should be 70–90°F; <i>Orius</i> are dormant September–April; reapply every 2–3 weeks; very susceptible to pesticides; works well in conjunction with <i>Neoseiulus cucumeris</i>  | 1, 2, 3, 4, 5 |
| <i>Phytoseiulus persimilis</i> (predator, mite)              | spider mites                                    | 1 mite/sq ft plus 10 mites/mite-infested leaf; apply at first sign of spider mites; if pests persist, reapply every 3–5 weeks; can be used in conjunction with <i>Neoseiulus californicus</i> ; may be used in combination with <i>Bt</i> or Enstar II; temp. should be 65–80°F; humidity 60–90% | 1, 2, 3, 4, 5 |
| <i>Steinernema feltiae</i> (beneficial nematode)             | fungus gnats                                    | 100,000–350,000/sq yd; apply when media temps. are 55–90°F; apply in evening, directly to growing media; water in after application; needs moist environment to thrive   | 1, 2, 3, 4, 5 |
| <i>Trichogramma</i> spp. (parasitoid, wasps)                 | caterpillars                                    | 1–4 wasps/sq ft  | 1, 2, 3, 4    |

Sources: Greer, L., and S. Diver. 1999. *Integrated Pest Management for Greenhouse Crops: Pest Management Systems Guide*. Appropriate Technology Transfer for Rural Areas. 34 pp. <http://attra.ncat.org/attra-pub/gh-ipm.html#general> (accessed November 20, 2003); Orr, D. B., and J. R. Baker. No date. *Biocontrol in Greenhouses*. Biological Control Virtual Information Center, North Carolina State University. 7 pp <http://cjpnm.ncsu.edu/ent/biocontrol/2a.htm> (accessed 6/2/2004).

## Appendix D. Quick Methods for Evaluating Biocontrol Shipments

| Biocontrol Agent                                     | Stage shipped                            | Packaging method   | How to determine viability  | How to estimate quantity  | How to determine establishment and reproductive success   |
|--|--|--|---|---|---|
| <i>Aphelinus abdominalis</i><br><i>Aphidius</i> spp. | Adults                                   | In tube  | Movement, adults will fly   | Visual count  | Parasitized aphid mummies after about 8 days  |
|  | Adults, parasitized mummies              | Loose in container   | Movement, released adults will fly immediately  | Visual count  | Parasitized aphid mummies after 2 weeks   |
| <i>Aphidoletes aphidimyza</i>                        | Pupae                                    | Loose in container of vermiculite                              | Hold container in warm place until hatch  |   | Look for tiny, orange larvae in aphid colonies  |
|  | Eggs                                     | Loose in vial or stuck to card                                 | Hatching larvae within 3 days of receipt, if held at 75–80°F  | Visual count  | Look for pest reduction within 10 days; lacewings normally do not reproduce in most greenhouses   |
| <i>Chrysopa</i> , <i>Chrysoperla</i> spp.            | Larvae                                   | Cold bottle of rice hulls or vermiculite or in cardboard frame | Movement  | Visual count  | See above   |
|  | Adults                                   |  | Movement, interest in flight  | Visual count  | Eggs laid on foliage  |
| <i>Cryptolaemus montrouzieri</i>                     | Adults                                   | In tube or bottle with paper or wood strips                    | Movement, less than 10% mortality   | Count active adults   | Reduction in pest numbers, mobile, large, mealybug-like larvae after 4 weeks  |
|  | Adults                                   | Loose in tube  | Movement, released adults will fly immediately  | Visual count  | Place leafminer pupae in glass container; count wasps and leafminers that emerge  |
| <i>Delphastus pusillus (=catalinae)</i>              | Adults                                   | Loose in container   | Movement, less than 10% mortality   | Count active adults   | Mobile larval stage, after 4 weeks, active adults   |
|  | Adults                                   | Tube with screw cap  | Movement  | Count active adults   | Put leaf samples in container; see if wasps or flies emerge   |
| <i>Encarsia formosa</i>                              | Parasite pupae inside of whitefly scales | Glued to card  | 7–10 days after release, look for emergence holes in pupae using microscope or high-powered hand lens | Keep 1 card in small jar to observe number of adults that emerge over 2 week period; smear of Vaseline on lid will capture new adults to make counting easier | Black parasitized scale after 5 weeks, or golden parasitized scale if silverleaf whitefly was attacked; wasp body is visible inside parasitized scale observed under microscope |
|  | Parasite pupae inside of whitefly scales | Loose in vial  | Low number of emerged adults, few should emerge during shipment                                       | Measure portion into clear vial and proceed as above  | See above   |
| <i>Eretmocerus</i> spp.                              | Pupae, adults                            | Loose or in sawdust or glued to cards                          | See <i>Encarsia</i>   | See <i>Encarsia</i> entry for cards   | Parasitized whitefly pupa turns yellow  |
|  | Pupae                                    | On paper pieces  | Look for “emergence tubes” on pupae   | Visual count of pupae with “emergence tubes”  | Look for tiny white larvae in spider mite colonies  |
| <i>Feltiella acarisuga</i>                           | Adults                                   | In bag or container with packing materials                     | Movement, less than 10% mortality   | Visual count  | Only establish on enormous aphid populations; eggs and larvae will be seen if abundant  |
|  | Adults                                   | In peat mix in tube or bottle                                  | Movement  | See predator mites  | Mobile mites on substrate after 5 weeks   |
| <i>Hippodamia convergens</i>                         | Adults                                   |  |   |   |   |
| <i>Hypoaspis miles</i>                               | Adults                                   |  |   |   |   |
| <i>Leptomastix dactylopii</i>                        | Adults                                   | In bottle or deli container, no carrier                        | Movement, less than 10% mortality   | Count active adults   | Parasitized mealybug is an empty shell with emergence hole that can be seen with hand lens  |

## APPENDIX D. (continued)

| Biocontrol Agent   | Stage shipped                    | Packaging method                                     | How to determine viability  | How to estimate quantity  | How to determine establishment and reproductive success            |
|--|----------------------------------|--|---|---|--|
| <i>Metaphycus helvolus</i>   | Adults                           | In deli container, no carrier                        | Movement, less than 10% mortality   | Count active adults   | Parasitized scale after 4 weeks; are identified by emergence holes |
| <i>Orius</i> spp.  | Adults and nymphs                | In buckwheat hulls                                   | Mix well, pour measured sample into dish under light source and watch for activity  | Mix well, measure sample and count individuals  | <i>Orius</i> nymphs in flowers after 2 weeks                       |
| Beneficial nematodes ( <i>Steinernema</i> spp.)  | Infective stage (juvenile stage) | On sponge or some other carrier in plastic container | Push pin point into nematode mass, withdraw and place in drop of water with a few grains of salt and wait 5 minutes; inactive or dead nematodes are straight; living nematodes are curved or curled | Small microscope necessary, 30x is acceptable   | Decline in pest population; dead host larvae                       |
| Predatory mites ( <i>Hypoaspis</i> spp., <i>Neoseiulus</i> spp., <i>Phytoseiulus</i> spp.) | Adults                           | In vermiculite, corn cob grits, or wheat bran        | Active, mobile stages   | Empty container into small bucket and mix well; sample a given volume and spread on flat surface, shine bright light on carrier, count mites as they try to escape heat and light | Various predatory mite stages, including eggs, after 2 weeks       |
|  | All stages                       | On leaves  | Movement on leaf  | Count sample of 10 leaves   | See above  |
| <i>Trichogramma</i> spp.   | All stages                       | Slow-release bag                                     | Movement  | Pour entire bag onto flat surface, look for dark-colored, rapid-moving adults   | Mobile predators on plant after 1 week                             |
|  | Parasitized eggs                 | Glued to card, or loose in container                 | Tiny wasps hatch within 3-5 days of receipt, look for emergence holes under microscope  |   | Caterpillar eggs darker than normal                                |

Source: Spencer, B., and C. Glenister. In production. "Quick Methods for Evaluating Biocontrol Shipments." In Moorman, G. W., and R. Berghage, eds. In production. *Total Crop Management in Greenhouses: A Guide to Greenhouse Crop Production*. Penn State Cooperative Extension. Funded by the PA IPM Program and Pennsylvania Department of Agriculture.

## Appendix E. Biocontrol Suppliers

The Association of Natural Biocontrol Producers has a listing of members' products at <http://www.anbp.org/a-websites.htm>. This manual lists only a few of the members' contact information. The numbers associated with the supplier are the numbers listed in Appendix C. Other sources for biocontrols are available.

### 1. The Green Spot, Ltd.

93 Priest Rd  
Nottingham, NH 03290-6204  
Phone: 603-942-8925  
Fax: 603-942-8932  
Voicemail: 603-942-5027  
E-mail: [GrnSpt@internetMCI.com](mailto:GrnSpt@internetMCI.com)  
Web site: <http://www.anbp.org/Green%20Spot.htm>

### 2. International Technology Services, Inc.

(Distributor for BioBest)  
PO Box 19227  
Boulder, CO 80308-2227  
Phone: 303-473-9141  
Fax: 303-473-9143  
E-mail: [intertechserv@worldnet.att.net](mailto:intertechserv@worldnet.att.net)  
Web site: <http://www.biobest.be/>

### 3. IPM Laboratories

PO Box 300  
Locke, NY 13092-0099  
Phone: 315-497-2063  
Fax: 315-497-3129  
Web site: <http://www.anbp.org/IPM%20Labs.htm>

### 4. Koppert Biological Systems

2856 Main St South  
Ann Arbor, MI 48103  
Phone: 313-998-5589  
Fax: 313-998-5557  
Web site: <http://www.koppert.nl/>

### 5. Syngenta Bioline

Oxnard, CA  
Phone: 805-986-8265  
Fax: 805-986-8267  
E-mail: [info@syngentabioline.com](mailto:info@syngentabioline.com)  
Web site: <http://www.anbp.org/b-novartis.htm>

## Appendix F. Biorational Pesticides

| Product  | Brand Name     | Pests Controlled  | Reentry Interval (REI) | Application/Comments   |
|--|----------------|---|------------------------|--|
| <b>Abamectin</b> —produced by the soil organism <i>Streptomyces avermitilis</i>  |                |   |                        |  |
|  | Avid           | spider mites, leafminers  | 12 hours               | Many beneficials can be released 1 week after use  |
| <b>Ampelomyces quisqualis</b> —fungus that parasitizes powdery mildew  |                |   |                        |  |
|  | AQ10           | powdery mildew  | 4 hours                | Begin application as soon as host tissue emerges; apply at least 2 sequential sprays 7–14 days apart; works best under conditions of high humidity                                       |
| <b>Azadirachtin</b> —extract of neem seed; IGR that works through contact or ingestion   |                |   |                        |  |
|  | Azatin-XL+     | aphids, caterpillars, fungus gnats, leafhoppers, leafminers, western flower thrips, whiteflies, psyllids                      | 4 hours                | Apply when pests first appear  |
|  | Neemix 4.5     | aphids, caterpillars, thrips, greenhouse whitefly, sweetpotato whitefly, psyllids, leafhoppers                                | 12 hours               | Cannot be applied through irrigation; low rate can be used as a preventative   |
| <b>Beauveria bassiana</b> —fungus that works through contact; exposure to non-target insects should be avoided   |                |   |                        |  |
|  | BotaniGard     | giant whitefly, green peach aphid, black vine weevil, other aphids and whiteflies, thrips, leafhoppers, psyllids, white grubs | 12 hours               | See above  |
|  | Naturalis T&O  | aphids, caterpillars, mites, psyllids, thrips, whiteflies   | 4 hours                | Apply when pests first appear and repeat every 7–10 days; need good spray coverage; not compatible with other fungicides   |
| <b>Burkholderia cepacia</b> —see <i>Pseudomonas (Burkholderia) cepacia</i>   |                |   |                        |  |
| <b>ClandoSan</b> —dried material isolated from crustacean exoskeletons; product acts in soils to stimulate growth of soil microorganisms and destroy nematodes |                |   |                        |  |
|  | ClandoSan 618  | plant-pathogenic nematodes  | 12 hours               | Single annual application  |
| <b>Garlic extracts</b>   |                |   |                        |  |
|  | Garlic Gard    | repels many insects   |                        |  |
|  | Garlic Barrier | repels many 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   |
| <b>Gliricladium virens</b> —naturally occurring soilborne fungus that attacks soilborne, plant pathogenic fungi  |                |   |                        |  |
|  | SoilGard       | <i>Rhizoctonia</i> , <i>Fusarium</i> , <i>Pythium</i> , <i>Phytophthora</i> , <i>Thielaviopsis</i>                            | 4 hours                | Incorporate into soil before planting  |
| <b>Herbicides</b> —sustainable herbicides labeled for greenhouse use   |                |   |                        |  |
|  | DeMoss         | mosses, liverworts  |                        | Contains potassium salts of fatty acids; avoid contact with desirable foliage; apparently nonvolatile  |
|  | Seythe         | nonspecific   |                        | Contains pelargonic acid and related fatty acids; nonselective postemergence weed control in noncrop areas; reportedly nonvolatile; avoid contact with desirable foliage and green stems |
| <b>Horticultural oil</b> —includes dormant and summer superior oils  |                |   |                        |  |
|  | All Seasons    | 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  |
| <b>Hot pepper wax</b> —contains capsaicin, paraffin, and mineral oil   |                |   |                        |  |
|  | Hot Pepper Wax | aphids, loopers, beet armyworms, mites, whiteflies, thrips, mealybugs, etc.   | 4 hours                | Also contains herbal essential oils; not compatible with beneficials   |
|  | Hot Pepper Wax |   | See above              |  |

## APPENDIX F. (continued)

| Product  |   |          |  |
|--|---|----------|--|
| Brand Name   | Pests Controlled  | REI      | Application/Comments   |
| <b>Insecticidal soap—contains potassium salts of fatty acids</b>   |   |          |  |
| M-Pede   | aphids, mealy bugs, scales, thrips, whiteflies, spider mites  | 12 hours | Phytotoxicity is often a concern, especially after repeated applications |
| Safer  | See above   | 4 hours  | See above  |
| Insecticidal soap  | See above   |          |  |
| <b><i>Myrothecium verrucaria</i>—biological nematode</b>   |   |          |  |
| DiTera   | plant-pathogenic nematodes  | 4 hours  | Can be used before or after planting                                     |
| <b>Neem oil—multipurpose organic insecticide/fungicide/miticide; kills eggs, larval, and adult stages of insects</b> |   |          |  |
| Trilogy 90EC   | whiteflies, thrips, leafminers, aphids, mites, psyllids, scales, spider mites, downy mildew, powdery mildew, <i>Alternaria</i> , <i>Botrytis</i> , etc. | 4 hours  | Apply at first signs of damage; repeat every 7–10 days as needed         |
| Triact 90EC  | See above   | 4 hours  | For ornamental crops only  |
| <b>Prosper Nema—pathogenic fungi</b>   |   |          |  |
| Prosper Nema   | nematodes   | 0 hours  | Apply as needed to maintain control                                      |
| <b><i>Pseudomonas (Burkholderia) cepacia</i>—bacterium to control root-rot diseases</b>                              |   |          |  |
| Deny   | <i>Rhizoctonia</i> , <i>Fusarium</i> , <i>Pythium</i>   |          |  |
| Intercept  | <i>Rhizoctonia</i> , <i>Fusarium</i> , <i>Pythium</i> , nematodes   |          |  |
| <b><i>Saccharopolyspora spinosa</i>—soil-inhabiting actinomycete</b>   |   |          |  |
| Conserve   | caterpillars, leafminers, thrips  |          |  |
| <b>Soybean oil</b>   |   |          |  |
| Golden Natur <sup>1</sup>  | aphids, fungus gnats, lace bugs, leafminers, scales, mealy bugs, spider mites, whiteflies   | 12 hours |  |
| Spray Oil  |   |          |  |
| <b><i>Streptomyces griseoviridis</i>—naturally occurring, soilborne bacterium</b>                                    |   |          |  |
| Mycostop   | <i>Fusarium</i> , <i>Alternaria</i> , <i>Phomopsis</i>  |          | Can be incorporated into medium or applied to seed                       |
| <b><i>Streptomyces lydicus</i>—naturally occurring, soilborne actinomycete</b>                                       |   |          |  |
| Actinovate   | <i>Pythium</i> , <i>Fusarium</i> , <i>Phytophthora</i> , <i>Sclerotinia</i>   |          | Can be incorporated into medium or applied to seed                       |
| <b><i>Trichoderma harzianum</i>—fungus</b>   |   |          |  |
| Bio-Trek HB  | <i>Fusarium</i> , <i>Pythium</i> , <i>Rhizoctonia</i>   | 12 hours | Apply to seed  |
| Bio-Trek Nursery   |   |          |  |
| Drench   | <i>Fusarium</i> , <i>Pythium</i> , <i>Rhizoctonia</i>   | 12 hours |  |
| RootShield   | <i>Fusarium</i> , <i>Pythium</i> , <i>Rhizoctonia</i> , <i>Sclerotinia</i>  |          |  |
| Trichodex  | <i>Botrytis</i>   |          |  |
| TopShield  | <i>Botrytis</i> , powdery mildew  |          |  |

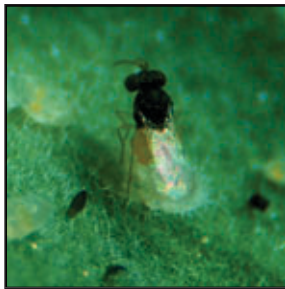
Source: Greer, L., and S. Diver. 1999. *Integrated Pest Management for Greenhouse Crops*. Appropriate Technology Transfer for Rural Areas.











*Encarsia formosa* adult

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