TIPS

Identification of Insects and Related Pests of Horticultural Plants

another publication of OFA Services Inc.
The purpose of this book is to help you identify and manage the major insect, mite, and associated pests of greenhouse crops. In addition to photos of the pests, there are photos of some beneficial insects and mites as well. This is to help determine if the insect or mite you see is a friend or foe. The photos show pests and beneficials in different views and magnifications. Sometimes, plant injury symptoms are good ways to identify particular pest problems. Where appropriate, photos of plant injury are included. Line drawings of life cycles, common species within each pest group, and brief descriptions of pest biology are included.

This book and format should be useful to commercial and hobby greenhouse growers, interior plantscapers, pest management scouts, Extension specialists, and teachers of courses in greenhouse horticulture.

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**Aphids**

**Aphid Life Cycle**

- Winged Adult
- Non-winged Adult
- Nymph

**Common Species**
- Green peach aphid (*Myzus persicae*)
- Cotton/melon aphid (*Aphis gossypii*)
- Chrysanthemum aphid (*Macrosiphoniella sanborni*)
- Foxglove aphid (*Aulacorthum solani*)
- Rose aphid (*Macrosiphum rosae*)

**Developmental Stages**

Nymphs and adults may or may not have wings. Winged aphids appear when crowding or environmental stresses occur. Individual aphid species may vary considerably in color. Eggs are seldom produced in greenhouses. Favorable temperatures for development vary with the species. For example, the chrysanthemum aphid develops best at 68°F (20°C), the green peach aphid at 73°F (23°C), and the melon aphid at temperatures above 75°F (24°C). Plant nutrition affects aphid development and reproduction. Moisture stress often increases aphid numbers. Temperatures above 86°F (30°C) and relative humidities above 85 percent reduce green peach aphid longevity and reproduction. Food quality also has a significant effect on development and reproduction.

**Where Found**

Found on all areas of the plant, from roots to flowers. Primarily feed on new terminal growth.

**Economic Importance**

The presence of aphids or white skins detracts from the plant value. Honeydew produced by aphids is a substrate for black sooty mold fungi. Many aphid species transmit viruses affecting vegetable and ornamental plants. Almost all greenhouse plants are attacked by aphids.

**Pesticides Most Effective Against**

Both nymphs and adults. However, resistance may be widespread.

**Biological Control**

Predators such as lacewings (*Chrysoperla spp.*), ladybird beetles (*Hippodamia convergens*), aphid midge (*Aphidoletes aphidimyza*), and parasitic wasps (*Aphidius spp.*).
APHIDS

Figure 1. Close-up of adult female aphid and nymph. Note the cornicles, or "honey tubes," projecting from the rear of the adult. Aphids are the only insects that have these tubes.

Figure 2. Close-up of aphid feeding. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 3. Adult winged aphid. Adult aphids may be winged or wingless.

Figure 4. Melon aphids, *Aphis gossypii*, on chrysanthemum. Both light and dark green color forms may be seen.

Figure 5. Aphid infestation on chrysanthemum. Aphids can be found on the upper and undersides of leaves.

Figure 6. Melon aphids in a chrysanthemum flower. These aphids are all the dark form of the species.
Figure 7. Chrysanthemum aphid, Macrosiphoniella sanborni, on chrysanthemum stem. This species usually occurs in vertical rows on plant stems.

Figure 8. Green peach aphids, Myzus persicae, on pepper plant.

Figure 9. White aphid molting skins on leaves. Aphids (as do other insects) shed their skins as they mature from one development stage to another, which is often referred to as molting. The skins often are more evident than the aphids themselves.

Figure 10. White aphid skins on rose bud.

Figure 11. Adult aphid parasitic wasp (=parasitoid) Aphidius colemani (left), and aphid "mummy" from which the parasitic wasp emerged. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 12. Aphid mummy. Note the emergence hole where the adult parasitic wasp (=parasitoid) emerged. The presence of mummies indicates that parasitic wasps are present.
**APHIDS**

Figure 13. Aphid midge, *Aphidoletes aphidimyza*, larvae (small, orange, and wormlike) among melon aphids. The larvae are predators of many aphid species.

Figure 14. Enlarged view of an aphid midge attacking an aphid. (Photo: Marilyn Steiner, New South Wales [Australia] Ministry of Agriculture)

Figure 15. Lacewing adult, *Chrysoperla* sp. The larvae are predators of many insects. Adults primarily feed on pollen and nectar.

Figure 16. Green lacewing larvae feeding on an aphid. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 17. Adult ladybird beetle, *Hippodamia convergens*. Ladybird beetles are perhaps the most famous beneficial insect, although their actual value in commercial biological control is questionable.

Figure 18. Ladybird beetle larva (orange and black) on a chrysanthemum plant feeding on aphids.
Order Lepidoptera, Several families such as Noctuidae, Tortricidae, Pyralidae, Arctiidae

**Lepidoptera Life Cycle**

- **Common Species**
  - Cabbage loopers (Trichoplusia ni)
  - Beet armyworm (Spodoptera exigua)
  - Variegated cutworm (Peridroma saucia)
  - Omnivorous leafroller (Platynota stultana)
  - Imported cabbageworm (Artogeia rapae)

- **Where Found**
  - Nearly all parts of the plant can be infested. Cutworm larvae may be in the growing medium or beneath pots.

- **Economic Importance**
  - Larvae consume leaves and flowers, bore into stems, and roll/tie leaves. All greenhouse plants are susceptible.

- **Pesticides Most Effective Against**
  - Very small larvae. The larvae become progressively more difficult to kill when they are large.

- **Biological Control**
  - Microbial insecticide formulations containing Bacillus thuringiensis var. kurstaki. Parasitic wasps (Trichogramma spp.) attack eggs.

**Developmental Stages**

- Egg, larva (number of instars depends on the species), pupa, and adult (moth). Egg to adult takes about 30 days, but this is highly variable depending upon the species and temperature. Plants high in nitrogen from excessive fertility may be more heavily damaged.
Figure 1. Beet armyworm, *Spodoptera exigua*, adult. (Photo: Jim Price, University of Florida)

Figure 2. Beet armyworm egg mass on underside of leaf. (Photo: Jim Price, University of Florida)

Figure 3. Beet armyworm larva and feeding injury. (Photo: Jim Price, University of Florida)

Figure 4. Feeding injury by small (left), medium (lower right), and large (upper right) beet armyworm larvae. (Photo: Jim Price, University of Florida)

Figure 5. Beet armyworm larva on coleus. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 6. Variegated cutworm, *Peridroma saucia*, larva on geranium.
Caterpillars

Figure 7. Cabbage looper, *Trichoplusia ni*, adult.

Figure 8. Cabbage looper larva.

Figure 9. Feeding injury on chrysanthemum by cabbage looper larvae.

Figure 10. Fecal pellets or deposits of cabbage looper larva.

Figure 11. Omnivorous leafroller, *Platynota stultana*, adult and egg mass (upper left).

Figure 12. Omnivorous leafroller larva within rolled leaf.
**CATERPILLARS**

**Figure 13.** Omnivorous leafroller larva and injury to poinsettia bracts.

**Figure 14.** Entry point of European corn borer, *Ostrinia nubilalis*, into chrysanthemum stem. Note the sawdust-like material (frass) produced by the larva as it feeds within the stem.

**Figure 15.** Adult moth on yellow sticky card. (Photo: Raymond A. Cloyd, University of Illinois)

**Figure 16.** Caterpillar feeding on rose bud.

**Figure 17.** Imported cabbageworm, *Artogeia rapae*, adult.

**Figure 18.** Imported cabbageworm larva.
FUNGUS GNATS

Common Species

- Bradysia coprophila
- Bradysia impatiens

Developmental Stages

Egg, larva (four instars), pupa, and adult. Egg to adult takes anywhere from 12 (80°F, 27°C) to 27 (35°F, 13°C) days. Females can lay up to 200 eggs in the cracks and crevices of the growing medium. High growing medium moisture and organic matter (composted manure, bark, leaf litter) are most favorable for development.

Where Found

Adults are usually near the growing medium surface, but may rest on plants. Larvae are in the growing medium or in plant stems below the growing medium surface.

Economic Importance

Larvae feed on roots or root hairs, stunting or killing young plants. Injury provides a possible entry site for plant pathogens. Adults may carry plant pathogens on their body that cause root rot and other plant diseases.

Pesticides Most Effective Against

Larvae (drench or "sprench") and adults (space sprays, aerosols, smokes, or fogs).

Biological Control

Microbial insecticide Bacillus thuringiensis var. israelensis (Gnatrol), nematode (Steinernema feltiae), and predatory mite (Hypoaspis miles).
**Shore Fly**

**Life Cycle**

**Common Species**
- *Scatella stagnalis*

**Developmental Stages**
Egg, larva, pupa, and adult. Females lay up to 300 eggs during their two-week life span. Development time from egg to adult is 10 to 16 days at greenhouse temperatures between 73 and 93°F (23 to 34°C). Both adults and larvae feed on algae, bacteria, and protozoans.

**Where Found**
Larvae and adults are found in areas with algae. Adults can also be found resting on plants, pots, or flats. Shore flies are more abundant during the spring and summer months. Shore flies are found in areas of high moisture such as propagation beds.

**Economic Importance**
Direct feeding injury is not likely, but some root or seed injury may occur by the larvae. Adults may spread plant pathogens. Adults are primarily a nuisance and produce "fly specks" (fecal deposits) on leaves.

**Pesticides Most Effective Against**
Pesticides are not generally effective against any stage. However, some may reduce the numbers of larvae and adults. Preventing or avoiding algae growth is the best method of dealing with shore flies.

**Biological Control**
No commercial biological control agents are effective. Parasitic wasps and predatory flies sometimes appear if pesticides are not used.
FUNGUS GNATS and SHORE FLIES

Figure 1. Close-up of a fungus gnat, *Bradyus* spp., adult.

Figure 2. Fungus gnat larvae. Larvae are translucent white with shiny black heads. Part of pupal case is also shown.

Figure 3. Fungus gnat larvae in stem of cutting. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 4. Poinsettia cuttings. The two plants on the right were injured by fungus gnat larvae, whereas the three plants on the left were not fed upon by fungus gnat larvae.

Figure 5. Fungus gnat larval damage to dahlia. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 6. Close-up of fungus gnat pupa. (Photo: Raymond A. Cloyd, University of Illinois)
FUNGUS GNATS and SHORE FLIES

Figure 7. Fungus gnat adult on yellow sticky card.

Figure 8. Fungus gnat larva being attacked by predatory mites, *Hypoaspis miles*.

Figure 9. Entomopathogenic nematodes, *Steinernema feltiae*. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 10. Close-up of a shore fly, *Scatella* spp., adult. Note the light-colored spots on the wings.

Figure 11. Shore fly adults in wet algae-covered area beneath a greenhouse bench. Both adults and larvae feed on algae and are found in moist areas.

Figure 12. Shore fly adult residing on algae.
FUNGUS GNATS and SHORE FLIES

Figure 13. Shore fly larvae. Larvae have breathing tubes on their posterior (hind) ends.

Figure 14. Shore fly larvae and pupae on an algae-covered irrigation mat. (Photo: Ian Greene, Whitmire Laboratories)

Figure 15. Shore fly pupa. An egg is located at the upper right.

Figure 16. Shore fly adult resting on a leaf. Adults are active fliers.

Figure 17. Fecal spots on plant left by shore fly adults. In addition to being unsightly, these spots may contain plant pathogens.

Figure 18. Shore fly adult fecal deposits on plant leaf. (Photo: Raymond A. Cloyd, University of Illinois)
FUNGUS GNATS and SHORE FLIES

Figure 19. Shore fly adult on yellow sticky card.

Figure 20. Shore fly and fungus gnat adults, showing differences between the two insects.

Figure 21. Shore fly (left) and fungus gnat (right) larvae.
(Photo: John Sanderson, Cornell University)
Order Diptera, Family Agromyzidae

LEAFMINERS

Leafminer Life Cycle

Common Species
- Serpentine leafminer (Liriomyza trifolii)
- Pea leafminer (Liriomyza huidobrensis)
- Vegetable leafminer (Liriomyza sativae)

Developmental Stages
Egg, larva (three instars), pupa (depending on the species may occur on or off the plant), and adult. Serpentine leafminer develop from egg to adult in 14 (95°F, 35°C) to 64 (59°F, 15°C) days. Other species have different lower and upper limits for development, but development times are similar. Leafminers are generally more of a problem when foliar nitrogen levels are high.

Economic Importance
Adult feeding, egg-laying punctures, and larval leaf mines disfigure ornamental plants. Vegetable plants may have reduced yields if numbers of leaf mines are high. Leafminers have a very wide host plant range.

Where Found
Leaf mines are usually found on leaves; but during heavy infestations, flowers may also have mines present. Adults are found mostly on the upper leaves.

Pesticides Most Effective Against
Adults and larvae are the susceptible life stages. Insecticide resistance is widespread.

Biological Control
Parasitic wasps such as Dacnusa siberica, or Diglyphus isaea may be used against the larvae.
LEAFMINERS

Figure 1. Serpentine leafminer, *Liriomyza trifolii*, adult. (Photo: Michael Parrella, University of California-Davis)

Figure 2. Pea leafminer, *Liriomyza huidobrensis*, adult. (Photo: Michael Parrella, University of California-Davis)

Figure 3. *Liriomyza trifolii* adult and feeding/egg laying punctures on chrysanthemum leaf.

Figure 4. Close-up of leaf punctures made by female leafminer.

Figure 5. *Liriomyza trifolii* larva and leaf mine. The black material is fecal deposits.

Figure 6. Close-up of *Liriomyza trifolii* larva in a leaf mine.
Figure 7. Cucumber leaf with many leaf mines.

Figure 8. Leafminer larval damage to verbena leaf. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 9. *Liriomyza huidobrensis* infestation on petunia.

Figure 10. Leafminer larval damage to chrysanthemum leaf. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 11. *Liriomyza huidobrensis* larva exiting from a leaf mine. Larvae of this species are lighter in color than *L. trifolii*.

Figure 12. The parasitic wasp, *Opius* spp., locating a leafminer larva inside a leaf mine.
**MEALYBUGS**

Order Homiptera, Family Pseudococcidae

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### Mealybug Life Cycle

- **Eggs**
- **Nymph**
- **Adults**

**Egg to Adult 30-70 Days**

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### Common Species

- Citrus mealybug (*Planococcus citri*)
- Longtailed mealybug (*Pseudococcus longispinus*)
- Root mealybug (*Rhizoecus spp.*)

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### Economic Importance

Mealybugs remove plant fluids, which weakens and may kill plants. Honeydew is a substrate for black sooty mold fungi. Mealybugs may infest flower and vegetable crops, and foliage plants.

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### Pesticides Most Effective Against

Exposed young crawler stage. Insecticides are less effective on adults that have a waxy covering.

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### Biological Control

Ladybird beetles (*Cryptolaemus montrouzieri*) and parasitic wasps (*Leptomastix dactylopii*).

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### Developmental Stages

- Egg, larvae (females, four instars; males, five instars), and adult. Egg to adult takes about 60 days, but this varies widely with individual species and may take up to one year under cool temperatures. Females can lay up to 300 eggs in a white, cottony mass. Longtailed mealybug females give birth to live young; they don't lay eggs.

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### Where Found

Leaves, nodes, crotches, and roots. Look for honeydew, sooty mold fungus, leaf yellowing, and stunted growth.
Figure 1. Crawler stage (first instar) of citrus mealybug, *Planococcus citri*. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 2. Early instar stages of citrus mealybug. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 3. Adult female citrus mealybug. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 4. Adult male citrus mealybug — very different from the female in Figure 3. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 5. Citrus mealybug on poinsettia.

Figure 6. Citrus mealybugs. (Photo: Raymond A. Cloyd, University of Illinois)
MEALYBUGS

Figure 7. Citrus mealybug adult females with cotton-like egg sacs.

Figure 8. Longtailed mealybugs, *Pseudococcus longispinus*. It is easy to see how this species got its common name. Longtailed mealybugs do not produce cotton-like egg sacs. They give birth to live young.

Figure 9. Severe mealybug infestation on jade plants. Note the concentration of damage at the growing tips.

Figure 10. Sooty mold fungus growing on honeydew produced by citrus mealybugs. Aphids, soft scales, and whiteflies also produce honeydew.

Figure 11. Root mealybugs, *Rhizoecus* spp. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 12. Adult stage of the predator called the mealybug destroyer, *Cryptolaemus montrouzieri*.
MEALYBUGS

Figure 13. Mealybug destroyer larva (center) among citrus mealybugs. The larvae resemble large mealybugs, and are therefore a type of "wolf in sheep's clothing."

Figure 14. Lacewing larva, Chrysoperla sp. Lacewings are general predators of many different insects. An adult can be seen in Figure 15 under Aphids (page 6).

Figure 15. Mealybug parasitic wasp, Leptomastix dactylopii, adult female. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 16. Mummified citrus mealybug parasitized by the parasitoid, Leptomastix dactylopii. (Photo: Raymond A. Cloyd, University of Illinois)
SOFT SCALES
Order Homoptera, Family Coccidae

Soft Scale Life Cycle

Common Species
- Brown soft scale (Coccus hesperidum)
- Hemispherical scale (Saissetia coffeae)

Developmental Stages
Egg (or live nymph), nymph (females, three instars; males, five instars), and adult. Females of some species reproduce without mating (parthenogenesis). Egg to adult takes about 60 days, but varies widely with individual species. Warmer temperatures are most favorable for development.

Economic Importance
Remove plant fluids, which weakens and may kill plants. The honeydew produced is a substrate for black sooty mold fungi. Soft scales tend to infest foliage plants.

Pesticides Most Effective Against
First-instar nymphs or crawlers.

Biological Control
Parasitic wasps (Metaphycus helvolus) and ladybird beetles (Rhyzobius leaphantiae).

Where Found
Leaves and stems. Look for honeydew, sooty mold fungus, and leaf yellowing.
SOFT SCALES

Figure 1. Close-up of soft scales on plant stem.

Figure 2. Soft scales on cyclamen leaf. Scale infestations normally occur on greenhouse crops with a long production cycle.

Figure 3. Hemispherical scale, *Saissetia coffeae*, crawlers just after egg hatch. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 4. Close-up of soft scale nymphs.

Figure 5. Hemispherical scale on leaf. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 6. Soft scale parasitic wasp, *Metaphycus helvolus*. (Photo: Raymond A. Cloyd, University of Illinois)
ARMORED SCALES
Order Homoptera, Family Diaspididae

Armored Scale Life Cycle

Eggs → Crawler → Adult → Nymph → Eggs

Common Species
- Oystershell scale (Lepidosaphes ulmi)
- Greedy scale (Hemiberlesia rapax)
- California red scale (Aonidiella aurantii)
- Oleander scale (Aspidiotus nerii)
- San Jose scale (Quadraspidiotus perniciosus)

Developmental Stages
Egg, nymph (females, three instars; males, five instars), and adult. Egg to adult takes six to seven months, but varies widely with individual species. Warmer temperatures are most favorable for development.

Economic Importance
Remove plant fluids, which weakens and may kill plants. Armored scales do not produce honeydew. In greenhouses, foliage plants are most often infested.

Pesticides Most Effective Against
First-instar nymphs or young crawlers.

Biological Control
Parasitic wasps (Aphytis melinus) and ladybird beetles (Rhyzobius lophanthae).

Where Found
Stems and leaves. High populations give plant parts a "crusty" appearance. Plant growth may be stunted. Look for leaf yellowing.
Figure 1. Close-up of armored scales. The females have a circular armor.

Figure 2. Armored scales. The females have an elongated oval armor.

Figure 3. Immature male armored scales. Males and females are very different in appearance.

Figure 4. Scale crawlers after hatching from eggs. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 5. Armored scales on leaf.

Figure 6. Close-up of armored scales on rose stem. Heavy infestations like this develop over long periods of time.
ARMORED SCALES

Figure 7. Botsduval scale, Diaspis boisduvalii.
(Photo: Raymond A. Cloyd, University of Illinois)

Figure 8. Close-up of Nigra scale, Parasaissetia nigra.
(Photo: Raymond A. Cloyd, University of Illinois)

Figure 9. Close-up of Florida red scale, Chrysomphalus aonidum.
(Photo: Raymond A. Cloyd, University of Illinois)
Order Acari, Family Tetranychidae

**SPIDER MITES**

Spider Mite Life Cycle

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**Common Species**

- Twospotted spider mite (*Tetranychus urticae*)
- Carmine spider mite (*Tetranychus cinnabarinus*)
- Lewis spider mite (*Eotetranychus lewisi*)

**Developmental Stages**

Egg, larva, protonymph, deutonymph, and adult. The development time from egg to adult can take 8 (77 to 95°F, 25 to 35°C) to 28 (50 to 68°F, 10 to 20°C) days. Hot and dry conditions are most favorable for development. Spider mite populations are affected by the host plant, plant nutrition, leaf age, and moisture stress. Moisture-stressed plants often have higher spider mite populations. High moisture levels inhibit mite dispersal. Plants fertilized with excessive nitrogen have higher populations of spider mites.

**Where Found**

Generally on the undersides of leaves nearly anywhere on the plant; tend to move toward the top as plants mature.

**Economic Importance**

Heavy infestations can kill plants or cause leaves to drop off. Webbing can cover plant terminals, resulting in aesthetic injury. Most greenhouse plants are susceptible to spider mites.

**Pesticides Most Effective Against**

Larvae, nymphs, and adults (some miticides will kill eggs). Miticide resistance is widespread. Proper coverage of leaf undersides is very important. Systemic insecticides are not effective on spider mites.

**Biological Control**

Several species of predatory mites in the family Phytoseiidae. Phytoseiulus persimilis is the most widely used predator in greenhouses. Some commercial insectaries will provide a mixture of predatory mites to deal with different environmental conditions.
SPIDER MITES

Figure 1. Close-up of twospotted spider mite, *Tetranychus urticae*, adult and egg.

Figure 2. Mature and immature spider mites and cast skins.

Figure 3. Marigold plant covered with webbing produced by spider mites.

Figure 4. Spider mite feeding injury on leaves, plus mites and webbing. (Photo: Florida Foliage Association)

Figure 5. Twospotted spider mite damage on New Guinea impatiens. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 6. Webbing on plant caused by twospotted spider mite. (Photo: Raymond A. Cloyd, University of Illinois)
Figure 7. Spider mite feeding injury on tomato. Spider mite injury is referred to as “stippling.”

Figure 8. *Phytoseiulus persimilis*, a predator of twospotted spider mite.

Figure 9. Close-up of Lewis spider mite, *Eotetranychus lewisi*. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 10. Lewis spider mite damage to poinsettia. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 11. Severe Lewis spider mite infestation, including webbing, on poinsettia.

Figure 12. View of poinsettias with a Lewis spider mite infestation. Note that damage is most severe near the heat pipes, where temperatures are warmer and plants may be moisture stressed.
**Common Species**
- Western flower thrips (*Frankliniella occidentalis*)
- Eastern flower thrips (*Frankliniella tritici*)
- Onion thrips (*Thrips tabaci*)
- Greenhouse thrips (*Heliothrips haemorrhoidalis*)
- Gladiolus thrips (*Laemaothrips simplex*)
- Melon thrips (*Thrips palmi*)
- Cuban laurel thrips (*Gynaikothrips ficorum*)

The following information is based primarily on the Western flower thrips.

**Developmental Stages**
Egg, nymph (two instars), pseudopupae (two non-feeding stages, usually in/on the growing medium), and adult (predominately females, and in some species males are rare). Egg to adult takes 10 to 15 days (76 to 86°F, 25 to 30°C) to 57 days (54°F, 12°C). Hot, dry conditions are best for development. In general, any environmental stress that weakens plants (such as moisture stress) makes them more susceptible to thrips. Wet and cool conditions inhibit development, but thrips will survive.

**Where Found**
Flowers are preferred, but thrips will also feed on leaves. Thrips prefer to hide within buds, flowers, or developing leaves. Thrips are attracted to yellow- and blue-colored flowers.

**Economic Importance**
Feeding injury distorts and discolors leaves and flowers. Feeding on pollen causes premature senescence. The Western flower thrips is one of the main vectors of impatiens necrotic spot virus (INSV) and tomato spotted wilt virus (TSWV). Thrips feed on a wide range of greenhouse plants.

**Pesticides Most Effective Against**
First- and second-instar larvae and adults are most susceptible. Insecticide resistance is widespread.

**Biological Control**
Predatory mites (*Iphiseius degenerans* and *Neoseiulus cucumeris*), predatory bugs (*Orius insidiosus*), and fungi (*Beauveria bassiana*). Predators need to be released before thrips populations are high.
THRIPS

Figure 1. Two adult thrips on the underside of a leaf. Note the narrow wings. Feeding injury (light-colored areas) and fecal deposits (dark-colored dots) are also visible.

Figure 2. Close-up of adult Western flower thrips, Frankliniella occidentalis. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 3. Close-up of nymphal stage of Western flower thrips. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 4. Adult Western flower thrips on a sticky card. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 5. Thrips feeding injury on petunia leaves. Certain petunia cultivars may be used as indicator plants — to provide an early warning of thrips and/or virus problems on other crops.

Figure 6. Western flower thrips injury on a chrysanthemum leaf.
THRIPS

Figure 7. Western flower thrips injury to an impatiens plant. Note the stunted appearance and the small, deformed leaves.

Figure 8. Impatiens necrotic spot virus (INSV) on snapdragon. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 9. Thrips injury to greenhouse cucumber leaves.

Figure 10. Thrips on a rose flower bud.

Figure 11. Western flower thrips injury on the edges of a Streptocarpus flower.

Figure 12. Close-up of Western flower thrips and feeding injury to Streptocarpus flower.
Figure 13. Western flower thrips injury to Brachycome flowers. Note the light-colored feeding injury and darker fecal deposits. Brachycome flowers are very attractive to Western flower thrips, and they are good indicators of thrips presence.

Figure 15. Pollen "tracks" on African violet flower. Western flower thrips will feed on pollen, and such "tracks" are indicators of an infestation.

Figure 14. Western flower thrips injury to chrysanthemum flowers. Fifty or more thrips can be found in a single flower during heavy infestations.

Figure 16. Cuban laurel thrips, Gynaikothrips ficorum. These large, jet black thrips with red eyes are often found on Ficus nitida in interiorscapes.

Figure 17. Gladiolus thrips, Taeniothrips simplex, feeding injury on gladiolus leaves.

Figure 18. Gladiolus thrips feeding injury on gladiolus flowers.
THRIPS

Figure 19. Enlarged view of a predatory mite, Neoseiulus spp., attacking a thrips larva. One or more species of these small predators are used for biological control of thrips — especially on greenhouse vegetable crops. (Photo: Marilyn Steiner, New South Wales [Australia] Ministry of Agriculture)

Figure 20. Adult Orius spp., a predatory insect that is used in biological control programs for Western flower thrips. (Photo: Raymond A. Cloyd, University of Illinois)
Whiteflies

Order Homoptera, Family Aleyrodidae

Common Species
- Greenhouse whitefly (Trialeurodes vaporariorum)
- Silverleaf whitefly (Bemisia argentifolii)
- Bandedwing whitefly (Trialeurodes abutilonea)

Developmental Stages
Egg, nymph (four instars), "pupa", and adult. Greenhouse whitefly takes 21 to 26 days (81°F, 27°C) to go from egg to adult; whereas silverleaf whitefly takes 16 (86°F, 30°C) to 31 (68°F, 20°C) days to go from egg to adult.

Where Found
All stages normally occur on the undersides of leaves. Infestations are localized at first, spreading to all areas as plants grow.

Economic Importance
The presence of whiteflies detracts from the value of plants. High populations can reduce plant growth or vegetable yields. Honeydew produced by nymphs and adults makes leaves and fruits sticky and is a substrate for black sooty mold fungi. Whiteflies attack nearly all greenhouse plants. Silverleaf whitefly infestations cause white stem on poinsettia.

Pesticides Most Effective Against
Early instar nymphs, and adults. Proper spray coverage is essential. Insecticide resistance is widespread.

Biological Control
Parasitic wasps (Encarsia formosa, Eretmocerus spp.), predators (Delphastus catalinae), and fungi (Beauveria bassiana).
WHITEFLIES

Figure 1. Adult greenhouse whitefly, *Trialeurodes vaporariorum*.

Figure 2. Adult silverleaf whitefly, *Bemisia argentifoli*ii. Silverleaf whitefly adults generally are smaller than greenhouse whitefly adults. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 3. Adult bandedwing whitefly, *Trialeurodes abutilonea* on yellow sticky card. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 4. Close-up of greenhouse whitefly eggs. When first laid, eggs are white, turning darker before hatching.

Figure 5. Close-up of greenhouse whitefly eggs (small, dark gray objects) and oval, white, first-instar nymphs, called crawlers, on the underside of a leaf.

Figure 6. Eggs and all stages of nymphs, including a white "pupa" of silverleaf whitefly. (Photo: Lance Osborne, University of Florida)
Figure 7. Last instar nymph ("pupa") of silverleaf whitefly. Note: the red eyes. The adult whitefly will soon emerge. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 8. Last instar nymph ("pupal") cases of greenhouse (left) and silverleaf (right) whiteflies. Adults have already emerged. Greenhouse whitefly pupae have long projections, whereas silverleaf whitefly pupae do not.

Figure 9. Greenhouse whitefly adults and nymphs on the underside of a chrysanthemum leaf.

Figure 10. Heavy infestation of silverleaf whitefly on poinsettia. This picture shows mostly nymphs, but a few adults can also be seen.

Figure 11. This picture shows a poinsettia with a condition known as "white stem," which is associated with silverleaf whitefly infestations.

Figure 12. Reduction in poinsettia bract formation at lower right, due to silverleaf whitefly infestation. Uninfested plants of comparable age are visible in the background.
WHITEFLIES

**Figure 13.** Silverleaf whitefly damage to basil. (Photo: Raymond A. Cloyd, University of Illinois)

**Figure 14.** Greenhouse rose leaves with shiny honeydew accumulation due to infestation of greenhouse whiteflies.

**Figure 15.** Sooty mold fungus on gerbera leaves. Sooty mold is one of several species of fungi that grow on honeydew — in this case, it is produced by greenhouse whiteflies.

**Figure 16.** The whitefly parasitic wasp, *Encarsia formosa*, attacking a greenhouse whitefly nymph.

**Figure 17.** The whitefly parasitic wasp, *Encarsia formosa*, and silverleaf whitefly nymphs. *Encarsia* is used more successfully for greenhouse whiteflies.

**Figure 18.** Silverleaf whitefly nymphs (brown in color) parasitized by *Encarsia formosa*. Several empty whitefly skins are also shown with adult emergence holes visible.
Figure 19. The whitefly predator, *Delphastus catalinae* (=pusillus). This tiny beetle feeds on whitefly eggs and the immature stages.
OTHER INSECTS and RELATED ORGANISMS

**Figure 1.** Moth fly adult or drainfly. The adults are ½- to ¾-inch long, and have long antennae and "fuzzy" wings. They are found in areas with decaying organic matter.

**Figure 2.** Moth fly larva. Larvae feed on decaying organic matter. Note the breathing tubes on the hind end (left) of the larva.

**Figure 3.** Moth fly pupa in the growing medium.

**Figure 4.** Tarnished plant bug, *Lygus lineolaris*, adult feeding on flower parts.

**Figure 5.** Four-lined plant bug, *Poecilocapsus lineatus*, adult feeding on a leaf.

**Figure 6.** Plant injury caused by four-lined plant bug feeding. This insect produces toxic saliva, resulting in leaf spotting.
OTHER INSECTS and RELATED ORGANISMS

Figure 7. Plant bug nymphs on a flower.

Figure 8. Close-up of eriophyid mites. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 9. Spittlebug nymph on a carnation just beneath the flower bud. Nymphs of these sucking insects produce a frothy material which completely covers them.

Figure 10. Norfolk Island pine Eriococcus infestation. The white, waxy females resemble mealybugs.

Figure 11. Broad mite, *Polyphagotarsonemus latus*, damage to transvaal daisy. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 12. Broad mite damage to New Guinea impatiens. (Photo: Raymond A. Cloyd, University of Illinois)
OTHER INSECTS and RELATED ORGANISMS

**Figure 13.** Beetle larva (white grub) in growing medium.

**Figure 14.** Black vine weevil, *Otiorhynchus sulcatus*. From left to right: egg, larva, pupa, and adult.

**Figure 15.** Garden symphylans are common in decaying organic matter.

**Figure 16.** Springtail with springing device (furcula) extended. Some springtail species may be mistaken for thrips.

**Figure 17.** Sowbugs and pillbugs (which roll themselves into a ball) can be minor pests in greenhouses.

**Figure 18.** Slugs feeding on foliage.
OTHER INSECTS and RELATED ORGANISMS

Figure 19. Slug injury to lupine leaf. Slugs make irregular holes in leaves and leave shiny slime trails on plants.

Figure 20. Slugs feeding on transvaal daisy leaf. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 21. Slug damage to poinsettia. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 22. Tarsonemid mite. Two common species are the cyclamen mite, Steneotarsonemus pallidus, and broad mite. These are very tiny mites, less than 0.3 mm.

Figure 23. Group of bulb mites on lily. (Photo: Raymond A. Cloyd, University of Illinois)

Figure 24. Close-up of bulb mite. (Photo: Mark Ascerno, University of Minnesota)
OTHER INSECTS and RELATED ORGANISMS

Figure 25. Rotting tissue on Easter lily associated with bulb mite infestation (Photo: Mark Ascerno, University of Minnesota)

Figure 26. Eriophyid mite infestation on yucca. Note the white "fuzzy" areas on leaf. These are mites and cast skins.

Figure 27. Magnified view of eriophyid mites on yucca leaf. These tiny worm-like mites can only be seen with a microscope. (Photo: Marilyn Steiner, New South Wales Agriculture)

Figure 28. Seed from Oxalis spp., just above tip of thumb. This weed can disperse red seeds throughout a greenhouse. These seeds are often mistaken for insect eggs or nymphs.
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