



Purdue University

Spring Greenhouse Bedding Plants

Insect, Mite, and Disease Management



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Introduction

Herbaceous ornamental bedding plants for the garden and patio are produced throughout the United States. Common species include geranium, impatiens, petunias, marigolds, begonias and pansies, among many others. In the northern part of the country, these plants are typically grown in greenhouses in late winter, spring and early summer. During production, populations of insects or mites such as whiteflies, aphids, thrips and spider mites may increase enough to damage plants or interfere with their marketability. Fungi, bacteria and viruses periodically infect plants and may lead to significant crop losses. Successful production of these crops requires effective management of insects, mites and diseases.

This publication is designed as a practical guide to managing these problems in spring greenhouse bedding plants. Environmental conditions in the greenhouse promote problems and require solutions different from those of the field. Pesticide labels that allow field use may prohibit greenhouse use, and pesticides allowed on ornamental crops may not be allowed on food crops. This publication is oriented towards spring crops, because the combination of plants, pest species and environments found in the spring leads to problems and management options that differ from those in the fall.

General Insect, Mite and Disease Management Strategies

Several key practices can help minimize potential insect, mite and disease problems in ornamental crops:

1. **Keep pests out.** Inspect all new plants for the presence of insects, mites and symptoms or signs of disease before bringing them into the greenhouse. Isolate or discard contaminated plants, and consider discarding nearby plants which may become infested or infected. Do not bring plants maintained outdoors into the greenhouse. Do not keep "pet plants" in production greenhouses because they can serve as sources of insects, mites and diseases. Consider screening the greenhouse, including ridge vents and exhaust vents, to prevent insects from entering the greenhouse from outside. If feasible, maintain a 2-foot buffer zone free of plants around greenhouse vents and openings.
2. **Keep the greenhouse clean.** Discard all plant debris away from the greenhouse. Regularly inspect plants and discard any with excessively high insect or mite numbers or those with severe disease symptoms. Keep plant and potting medium debris off floors and benches. Keep the greenhouse algae- and weed-free. Hang hoses so nozzles do not touch the ground. Use new pots or flats for each crop. If you must re-use containers, make sure they are thoroughly cleaned of all organic matter and soaked in a commercial greenhouse disinfectant, such as Greenshield®, Physan®, Triathlon®, Zeritol® or a 1:9 dilution of chlorine bleach. To reduce contamination of the potting medium, steam-sterilize mixes containing soil, do not allow soilless mixes to contact non-sterilized soil or surfaces, and tightly close opened bags of growing medium. Eliminate standing water.
3. **Grow healthy plants.** Adjust pH and fertility levels for optimum plant growth. Do not over-fertilize. Maintain a uniform moisture level in the potting medium, avoiding excessive moisture or extended dry periods. Monitor greenhouse temperatures at the plant level and adjust for optimum plant growth.

4. **Keep foliage dry.** Minimize the duration of leaf wetness after irrigation by proper plant spacing, good ventilation and proper timing of irrigation to promote maximum drying. Avoid touching wet or damp foliage. Avoid irrigation in the late afternoon because plants may remain wet longer. Reduce greenhouse humidity by venting and heating early in the morning and at dusk.
5. **Rotate pesticides.** When using pesticides, avoid the repeated use of a single material, the same combination of materials, or pesticides with the same mode of action. Using materials with different modes of action minimizes the potential for development of pest and disease resistance.

Insect and Mite Management

Thrips

Damage: Thrips (primarily the western flower thrips) use their piercing-sucking mouthparts to penetrate plant tissues and withdraw plant fluids. They cause leaves to appear deformed or misshapen (twisted). In addition, their feeding causes leaf stippling, which gives leaves a "silvery" appearance. Black fecal droppings can also be found on leaves. Thrips generally prefer flowers and their feeding causes petals to appear scraped or stippled. This damage is more noticeable on dark-colored flowers. Thrips also transmit Tomato Spotted Wilt and Impatiens Necrotic Spot Viruses (TSWV and INSV), which makes early detection and control extremely important.

Management Strategies:

- Monitor thrips' presence with yellow or blue sticky cards. In general, place one sticky card per 1000 ft² of greenhouse area. Additional cards should be used if numbers are high or if plants highly susceptible to TSWV or INSV are grown. Place the cards 1 to 2 inches above the crop canopy, and replace them once per week. Use a 10x hand lens to count the number of thrips per card. Record the number of thrips trapped on the cards before and after insecticide applications to determine efficacy. To detect migration into the greenhouse, place sticky cards near doors, vents and sidewalls. Immature and adult thrips can also be moni-

tored by blowing into open flowers. This stimulates their movement and makes them easier to see. Shake flowers over white paper and look for thrips crawling on the paper.

- Apply insecticides at 3 to 5 day intervals (i.e. Tuesday and Friday) when thrips numbers are building up. A one-time spray application of an insecticide will not control a thrips problem because some thrips will be in growth stages (such as eggs and pupae) that are unaffected by insecticide applications. After thrips numbers decline, less frequent applications may be needed. After 2 to 3 weeks of using the same material or combination, switch to a product with a different mode of action to reduce the development of resistance. Use high volume sprays to get coverage of all plant parts, including growing points.

Whiteflies

Damage: Whiteflies remove plant fluids with their piercing-sucking mouthparts. They feed primarily on leaves, which may result in plant stunting and leaf distortion. Whiteflies produce a clear, sticky liquid called honeydew. Honeydew serves as a medium for growth of black sooty mold fungi. These unsightly fungi can reduce photosynthesis and crop marketability.

Management Strategies:

- Monitor with yellow sticky cards placed 1 to 2 inches above the plant canopy. Place two sticky cards per 1000 ft². Count the number of whiteflies on the sticky cards with a 10x hand lens. Record the number of whiteflies trapped on the cards before and after insecticide applications to determine efficacy.
- Inspect plants, particularly the undersides of leaves, for eggs, larvae and pupae.
- Apply contact insecticides when whitefly numbers are building up. Be sure to thoroughly cover leaf undersides where most whitefly life stages are located.

Fungus Gnats

Damage: Fungus gnat larvae damage plants by feeding on roots and root hairs and by tunneling into plant stems near the medium surface. This damage can stunt and/or wilt plants. In addition, the larvae can spread fungal root rot and bacterial

soft rot pathogens to plants as they feed. Fungus gnat adults can also carry fungal pathogens on their bodies and distribute the microorganisms as they move between plants.

Management Strategies:

- Monitor fungus gnat adults weekly by placing yellow sticky cards horizontally on rims of flats or pots. Use 1/4-inch slices of potatoes laid horizontally on the growing medium surface to monitor for fungus gnat larvae. Remove after 48 hours and examine slices for the presence of fungus gnat larvae.
- Minimize algae build-up and weed growth under benches and on floors. Algae and weeds provide conditions favorable for fungus gnats.
- Eliminate standing water which serves as a breeding site for fungus gnats.
- Apply appropriate foliar or soil insecticides when adult numbers are building up.

Aphids

Damage: Aphids damage plants by inserting their piercing-sucking mouthparts into plant tissue and removing plant fluids. The insects usually feed on young terminals or the undersurface of leaves. Aphid feeding can cause leaf discoloration and/or leaf distortion (leaves curl downward or upward). Large numbers of aphids can stunt and kill plants. The insects produce a sticky excrement called honeydew as they feed, which can serve as food for sooty mold fungi. This black fungal growth can reduce photosynthesis and crop marketability. In addition, the presence of cast-off aphid skins can also reduce the aesthetic quality of a crop.

Management Strategies:

- Monitor for aphids, cast skins and honeydew by inspecting plants. Be sure to inspect terminal growth and buds and leaf undersides. Sticky cards are not a good means of monitoring because aphids are wingless under most environmental conditions. Winged aphids found on sticky cards can indicate appropriate environmental conditions for the development of the sexual form (winged adults), a high aphid population, or movement into the greenhouse from outside.
- Apply insecticides when aphid numbers are building up. Be sure to thoroughly treat all leaf surfaces and growing points.

Spider Mites

Damage: Spider mites (primarily two-spotted spider mites) remove plant fluids with their piercing-sucking mouthparts. They feed primarily on leaf undersides where they cause mottling or speckling. In addition, spider mites can cause plant stunting. Webbing is visible under heavy infestations. Leaves appear "sand blasted" where heavy feeding has occurred.

Management Strategies:

- Monitor for spider mites by shaking plant leaves over a white sheet of paper and looking for very small mites crawling on the surface.
- Check the underside of plant leaves for spider mites, especially in warm and dry locations in the greenhouse where mite development is favored. Hanging baskets in particular should be closely monitored.
- Apply miticides when mite numbers are building up. Be sure to thoroughly cover all plant parts, especially leaf undersides, where most spider mite life stages are located.

Disease Management

Root Rots, Crown Rots and Damping-off

Damage: Poor seedling stand is an indicator of pre-emergent damping-off. After emergence, seedlings attacked by soil-borne pathogens may be stunted, develop lesions at the soil line, or wilt and collapse. When larger plants become infected with root rot pathogens, aboveground symptoms include poor growth, off-color foliage, wilting and death. Infected roots are usually brown in color, and may be soft and decayed. Some root rot pathogens invade the lower stem as well, causing tan, dry cankers or a soft, dark-brown, watery stem rot.

Management Strategies:

- Follow cultural practices listed under General Insect/Mite and Disease Management Strategies.
- Minimize plant stress. Plants under stress are more susceptible to root rot pathogens.
- Formulations of specific biological control microorganisms antagonistic to root rot fungi can be incorporated into the potting medium or applied as a soil drench at transplanting. These

products are most effective when applied prior to disease occurrence. Some examples of these products include RootShield®, PlantShield® and SoilGard®.

- Use fungicide drench applications to protect plants from infection.
- Accurate diagnosis of specific root rot pathogens is necessary for optimal use of fungicides, since most fungicides are only effective against a select number of fungal pathogens. Contact your state Cooperative Extension Service for assistance in diagnosis.

Botrytis Blight

Damage: Botrytis blight is an ever-present threat to ornamental plants in the greenhouse. The fungus causes a range of symptoms, including spots and blights on leaves or petals, stem cankers, crown rot, wilting and damping-off. Botrytis infections may also cause discoloration and death of flower buds and premature loss of flowers. The fungus is spread by the movement of spores in air currents, in splashing water, and on insects. The fungus commonly invades wounded or senescent tissue, such as fallen flower petals or other fresh plant residues. It can also invade healthy tissue in contact with infected residues. Masses of fuzzy, grayish-brown spores on thin black stalks develop on infected plant tissues under cool, moist, humid, cloudy conditions. The presence of these spores is diagnostic for confirming Botrytis infections.

Management Strategies:

- Reduce the amount of spores in the greenhouse with strict sanitation practices.
- Reduce humidity and promote leaf drying as described in the General Insect/Mite and Disease Management Strategies section.
- Use fungicide sprays as needed. Fungicides may be necessary when conditions are favorable for disease. Avoid repeated use of a single fungicide or fungicides with the same mode of action to minimize the potential for development of resistance.

Powdery Mildew

Damage: Powdery mildew is characterized by the presence of whitish fungal growth on the surfaces of leaves and stems. Infection of young, expanding leaves or shoots can result in severe

distortion. There are many different fungi in the powdery mildew group; some are quite host-specific while others can infect a wide range of plants. The fungi obtain nutrients from host plants by penetrating the outermost layer of plant cells. Powdery mildew spores are easily detached from the hyphae on which they develop and are carried by air currents to surrounding plants. Unlike most fungal diseases, leaf wetness is not required for powdery mildew infection. Disease development is favored by high humidity resulting from dry, sunny days followed by cool, moist nights.

Management Strategies:

- Reduce humidity as described in the General Insect/Mite and Disease Management Strategies section.
- Use fungicide sprays as needed. Fungicides may be necessary when conditions are favorable for disease. Avoid repeated use of a single fungicide or fungicides with the same mode of action to minimize the potential for development of resistance.

Fungal Leaf Spots

Damage: Some plants, such as dusty miller, ageratum, pansy and marigold, are occasionally affected by fungal leaf spot diseases. Symptoms range from tiny discolored specks to larger blotches. The lesions may have red or purple margins depending on the host plant and pathogen involved. Most of these diseases affect only one or a few plant species. Fungal leaf spot pathogens survive on infected plant debris, and are spread by spores carried in air currents or splashing water. Prolonged leaf wetness usually favors fungal leaf spot disease development.

Management Strategies:

- Inspect plants on a regular basis for fungal leaf spot symptoms. Discard symptomatic plants.
- Reduce humidity as described in General Insect/Mite and Disease Management Strategies section.
- Use protectant fungicide sprays if disease continues to spread.

Virus Diseases

Damage: Virus symptoms are often quite striking and distinctive. Chlorotic mottling, ringspots and

line patterns on the foliage or stems may occur. Stunting is commonly observed. The single most important virus in ornamental plant production is Impatiens Necrotic Spot Virus (INSV). New Guinea and common impatiens are often affected, although the virus can infect a wide range of bedding plants, pot crops and weed hosts. Symptoms of INSV on impatiens include dark black or purple lesions on the stems and leaf veins and dark ringspots or blotches on leaves. Infected plants are stunted, and young leaves may be small and misshapen. INSV causes bleached white spots and rings on leaves and stems of snapdragons. INSV is spread by western flower thrips feeding.

Management Strategies:

- Inspect plants regularly for virus symptoms. Test symptomatic plants for virus diseases to have definitive diagnosis of specific virus problems. Samples may be sent to a diagnostic laboratory or commercial virus-testing company, or may be tested in-house using commercially available virus test kits.
- Maintain strict weed control inside the greenhouse as well as around the outside walls.
- Destroy plants showing virus symptoms.
- Manage thrips to minimize the spread of INSV (refer to Thrips section for more information).
- Place plants that are most susceptible to the virus in the center of the greenhouse, away from doors, vents and sidewalls.

Bacterial Diseases

Damage: Bacterial pathogens can cause leaf spots and stem rots on a variety of ornamental plants. Leaf spots are initially watersoaked or greasy in appearance, then turn dry and dark to light brown. In some cases, the leaf tissue surrounding the necrotic spots may be yellow. Bacterial pathogens require films of water to enter plant tissues. Cool, wet conditions favor leaf spots caused by *Pseudomonas* species. Bacterial leaf spot diseases are becoming more common, particularly in plug production where irrigation is often a mist system. Bacterial soft rot of stems is usually associated with wounds from handling or insect feeding. Fungus gnat larvae can spread soft rot bacteria.

Most bacterial diseases of ornamental plants cause little damage. Two important exceptions

are bacterial blight (caused by *Xanthomonas pelargonii*) and southern bacterial wilt (caused by *Ralstonia solanacearum*) which can cause wilt and death of geraniums. Any geranium suspected of having a bacterial disease should be sent to a diagnostic laboratory for confirmation of the disease.

Management Strategies:

- Promote leaf drying as described in the General Insect/Mite and Disease Management Strategies section.
- Destroy infected plants, being careful to avoid contact with other plants. Remove all plant debris.
- Copper compounds may help protect plants from bacterial infection, but they must be used along with a strict sanitation program for effective control.

Know What You're Dealing With!

If you are unsure of your plant problem, consult your local Cooperative Extension office, or call the Purdue University Plant and Pest Diagnostic Laboratory at 765-494-7071.

Table 1.

Insecticides and miticides registered for use on ornamental plants in greenhouses, 2002. Read the pesticide label for specific host information, rates, possible phytotoxicity and resistance management information. Always follow label instructions.*

Insect/Mite Pest	Common Name	Trade Name	REI (hours)
Thrips	Abamectin	Avid	12
	Acephate	Orthene	24
	Azadirachtin	Azatin	4
		Ornazin	12
	<i>Beauveria bassiana</i>	Naturalis, Botaniguard	12
	Chlorpyrifos	Duraguard	24
	Cyfluthrin	Decathlon	12
	Cyfluthrin + Chlorpyrifos	Duraplex	24
	Fenoxycarb	Preclude	12
	Horticultural Oil	Ultrafine Spray Oil	4
	Methiocarb	Mesurool	24
	Spinosad	Conserve	4
Whiteflies	Azadirachtin	Azatin	4
		Ornazin	12
	<i>Beauveria bassiana</i>	Naturalis, Botaniguard	12
	Bifenthrin	Talstar	12
	Cyfluthrin	Decathlon	12
	Cyfluthrin + Chlorpyrifos	Duraplex	24
	Fenoxycarb	Precision, Preclude	12
	Fenpropathrin	Tame	24
	Horticultural oil	Ultrafine Spray Oil	4
	Imidacloprid	Marathon	12
	Kinoprine	Enstar II	12
	Permethrin	Astro	12
	Potassium salts of fatty acids	M-Pede, Insecticidal Soap	12
	Pymetrozine	Endeavor	12
	Pyridaben	Sanmite	12
	Pyriproxyfen	Distance	12
Fungus Gnats	Azadirachtin	Azatin	4
		Ornazin	12
	<i>Bacillus thuringiensis israelensis</i>	Gnatrol	4
	Chlorpyrifos	Duraguard	24
	Cyromazine	Citation	12
	Diflubenzuron	Adept	12
	Fenoxycarb	Precision	12
	Pyriproxyfen	Distance	12
	<i>Steinernema feltiae</i>	Nemasys, Scanmask, Entonem	0
Aphids	Acephate	Orthene	24
	Azadirachtin	Azatin	4
		Ornazin	12
	<i>Beauveria bassiana</i>	Naturalis, Botaniguard	12
	Bifenthrin	Talstar	12
	Chlorpyrifos	Duraguard	24
	Endosulfan	Thiodan, Endosulfan	24
	Fenpropathrin	Tame	24
	Imidacloprid	Marathon	12

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Table 1 continued

	Kinoprene	Enstar II	12
	Permethrin	Astro	12
	Potassium salts of fatty acids	M-Pede, Insecticidal Soap	12
	Pymetrozine	Endeavor	12
Spider Mites	Abamectin	Avid	12
	Bifenazate	Floramite	4
	Bifenthrin	Talstar	12
	Chlorfenapyr	Pylon	12
	Clofentezine	Ovation	12
	Fenpropathrin	Tame	24
	Fenpyroximate	Akari	12
	Hexythiazox	Hexygon	12
	Horticultural oil	Ultrafine Spray Oil	4
	Pyridaben	Sanmite	12
	Potassium salts of fatty acids	M-Pede, Insecticidal Soap	12
* Mention of chemicals on this list does not constitute an endorsement. Omission of any registered chemicals does not imply criticism.			

Table 2.

Fungicides and bactericides registered for use on ornamental plants in greenhouses, 2002. Check labels for specific host information, rates, possible phytotoxicity and resistance management information. Always follow label instructions.*

Disease	Common Name	Trade Name	REI (hrs)
Pythium and Phytophthora root rot, damping-off	Etridiazole	Terrazole, Truban	12
	Etridiazole + Thiophanate-methyl	Banrot	12
	Fosetyl-Al	Aliette	24
	Mefenoxam	Subdue MAXX	0
	Metalaxyl	Subdue II	12
	Propanocarb	Banol	12
Rhizoctonia root rot, damping off	Etridiazole + Thiophanate-methyl	Banrot	12
	Fludioxonil	Medallion	12
	Flutolanil	Contrast	12
	Iprodione	Chipco 26019	12
	PCNB	Defend, Terraclor	12
	Strobilurins	Compass	12
		Heritage	4
	Thiophanate-methyl	Cleary's 3336, Domain, Fungo Flo	12
	Triflumazole	Terraguard	24
Thielaviopsis root rot	Etridiazole + Thiophanate-methyl	Banrot	12
	Fludioxonil	Medallion	12
	Thiophanate-methyl	Cleary's 3336, Domain, Fungo Flo	12
	Triflumazole	Terraguard	24
Botrytis blight	Chlorothalonil	Daconil 2787	48
		Exotherm Termil	12
		PathGuard	12

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	Chlorothalonil + thiophanate-methyl	Spectro	12
	Copper compounds	Kocide 2000 T/N/O	24
		Phyton 27	24
	Copper compound + mancozeb	Junction	24
	Fenhexamid	Decree	4
	Fludioxonil	Medallion	12
	Iprodione	Chipco 26019	12
	Mancozeb	Dithane, Fore, Protect T/O	24
	Maneb	Pentathlon	24
	Potassium bicarbonate	FirstStep, Kaligreen	4
	Strobilurins	Compass	12
		Heritage	4
	Thiophanate-methyl + mancozeb	Zyban	24
	Vinclozolin	Ornalin	12
Powdery mildew	Chlorothalonil	Daconil 2787	48
		PathGuard	12
	Chlorothalonil + thiophanate-methyl	Spectro	12
	Copper compounds	Camelot	12
		Phyton 27	24
	Hydrogen dioxide	Zerotol	0
	Myclobutanil	Systhane	24
	Piperalin	Pipron	12
	Potassium bicarbonate	FirstStep, Kaligreen	4
	Strobilurins	Compass	12
		Cygnus	12
		Heritage	4
	Thiophanate-methyl	Cleary's 3336, Domain, Fungo Flo	12
	Thiophanate-methyl + mancozeb	Zyban	24
	Triadimefon	Strike	12
	Triflumazole	Terraguard	24
Fungal leaf spots	Chlorothalonil	Daconil 2787	48
		Pathguard	12
		Thalonil	48
	Chlorothalonil + thiophanate-methyl	Spectro	12
	Copper compounds	Camelot	12
		Kocide 2000 T/N/O	24
		Phyton 27	24
	Copper compound + mancozeb	Junction	24
	Fludioxonil	Medallion	12
	Iprodione	Chipco 26019	12
	Mancozeb	Dithane, Fore, Protect T/O	24
	Maneb	Pentathlon	24
	Potassium bicarbonate	FirstStep, Kaligreen	4
	Strobilurins	Compass	12
		Cygnus	12
		Heritage	4
	Thiophanate-methyl	Cleary's 3336, Domain, Fungo Flo	12
	Thiophanate-methyl + mancozeb	Zyban	24
Bacterial diseases	Copper compounds	Camelot	12
		Kocide 2000 T/N/O	24
		Phyton 27	24
	Copper compound + mancozeb	Junction	24

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