

## DISEASE MANAGEMENT

Know the diseases to which your crop is prone	Recognize disease symptoms	Know the conditions that cause a disease to develop	Management
<b>Foliar and stem diseases</b>			
Anthracnose	Anthracnose is a catch-all term for leaf spot or stem canker symptoms caused by several different fungal species. Affected tissue dies. Colletotrichum forms masses of pinkish-orange spores within the lesions or stem cankers. Black whisker-like structures can sometimes be seen within the lesions.	Warm, moist conditions with high humidity favor disease development.	Minimize leaf wetness duration through environmental modification and cultural practices such as irrigation and plant spacing. Preventive fungicide applications may help to reduce new infections and spread. Pathogen populations of Colletotrichum species resistant to thiophanate-methyl have been found. Common hosts include cyclamen, osteospermum, begonia and pansy.
Botrytis leaf blight (gray mold)	Symptoms vary with host and tissue invaded. Leaf spots; bud rot; flower blight; cutting rot; stem canker; stem and crown rot; proliferation of fluffy, brown/gray fungal mycelium containing spores; damping-off.	High humidity, greater than 85%; poor air circulation; 70°F-77°F optimum temperature for spore germination. Spores must have free moisture to germinate. Old flowers and decaying vegetation are sources of spores. Rapidly colonizes wounded tissue.	Keep relative humidity below 85%. Do not allow leaves to stay wet for more than 6 hours. Provide good air circulation around plants. Remove infected plants. Strict sanitation to remove spent flowers and old leaves. Fungicides alone will not control Botrytis. Many susceptible hosts including geranium, cyclamen, poinsettia and rose.
Downy mildew	White/purple/gray fuzz (spores) on undersides of leaves. Yellowish or pale green mottling on upper leaf surface. On garden impatiens, yellow stippling similar to spider mite injury. Downward curling of leaves. Emerging leaves may be small or discolored. Can become systemic in plants resulting in stunting or distorted new growth. Leaf drop is often one of the first symptoms observed on coleus.	Favored by high humidity, long durations of leaf wetness, and cool weather (60°F-74°F during the day). Can survive in plant debris in soil. Spores are spread by splashing water and air currents. Increasingly detected during warm months and in warmer regions.	Immediately discard infected plants and adjacent plants. All remaining plants on premises should be treated with a fungicide. Fungicides are used to prevent spread to non-infected plants and to new growth when symptoms first appear. Apply fungicides frequently with good coverage. Fungicides will not cure an already infected plant. Keep relative humidity below 80-85%. Do not reuse pots from diseased plants. There are many downy mildew species and most are only capable of infecting one or a few closely-related host plants. Common hosts include coleus, snapdragon, alyssum and many perennials.
Fungal leaf spot diseases (Alternaria, Cercospora, Septoria, Phyllosticta)	Round to irregular leaf spots, often with a colorful border (red/purple/brown). Center of lesions becomes tan with age. Size of lesions increase over time. Fruiting bodies (appear as black dots) may be present within the lesions.	Prolonged leaf wetness, high humidity, and warm temperatures favor most fungal leaf spot diseases.	Minimize leaf wetness. Scout frequently. Apply fungicides. Common hosts include pansy, geranium, impatiens, zinnia, dianthus and many perennials.
Myrothecium leaf spot and crown rot	Circular, zonate leaf spots initially appear brown or water-soaked and eventually turn brown or light tan. Infection sites often at leaf margins and tips. Diagnostic symptom is the presence of raised, dark green-to-black masses of spores surrounded by a fringe of white fungal tissue. Spores typically produced in a circular pattern on leaf tissue.	Warm, moist, humid conditions favor infection and disease development. Wounds are quickly colonized by this soil-borne fungus.	Remove and discard infected plants. Highly susceptible crops should be carefully scouted or fungicides applied on a preventive basis. Remove plant debris between crops and disinfest benches. Common hosts include pansy, New Guinea impatiens, syngonium and perennials.
Powdery mildew	Fluffy white patches generally on upper leaf surface, turning gray with age. On succulents the leaf infections appear scab-like. Can also infect stems and flower petals when severe.	Favored by warm days and cool, damp nights. Free water inhibits spore germination. This fungus can infect at low relative humidity.	Must be detected early, as this disease can spread quickly. Susceptible crops should be treated with a fungicide prior to development of powdery mildew. Increase air movement and reduce humidity. Common hosts include verbena, gerbera, petunia, rosemary and rose.
Rust	Yellow, orange or brown spore masses or pustules form on the underside of the leaves and erupt through the leaf tissue. On geranium, the pustules form in a ring pattern.	Infect under mild, moist conditions. Spores easily spread in air currents.	Minimize the time foliage stays wet. Discard infected plants as soon as they are detected. Provide good air circulation and don't crowd plants. Fungicides applied at the first sign of infection can help prevent serious damage. Common hosts include geranium, snapdragon, aster and fuchsia.

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Bacterial leaf spot ( <i>Pseudomonas</i> sp. and <i>Xanthomonas</i> sp.)	Small, round, water-soaked lesions develop on underside of leaves. On top surface of leaves, lesions may be surrounded by a purple or yellow halo. Lesions often vein-delimited. Lesions are initially yellow or light green, quickly progressing to dark brown or black (lesions may turn tan with age if conditions become dry). Lesions may rapidly enlarge and entire leaf will rot. Infection may follow the petiole down to the crown.	Warm temperatures, high humidity and wet leaf surfaces. Splashing water spreads bacteria and allows infection of new leaves. Reducing nitrogen may reduce disease caused by <i>Pseudomonas</i> . Insects (fungus gnats, shore flies and leafminers) and greenhouse workers may move bacteria around.	Discard infected plants and leaves showing symptoms. Surface disinfect clipping shears, tools and benches between plantings. Monitor humidity; reduce free moisture on leaves. Bactericides may help reduce spread but are generally not very effective. Preventive fungicide applications may mask symptoms and still not control disease. Irrigate when leaves can dry quickly. Drip or ebb-and-flow irrigation will help to control some leaf spot diseases. Common hosts include gerbera, reiger begonia, zinnia, geranium, vinca, English ivy and poinsettia.
Viruses: Impatiens necrotic spot virus (INSV) and Tomato spotted wilt virus (TSWV)	Symptoms vary with host. Yellow or necrotic spots on stems or leaves. Leaf mosaic; black leaf spots; black ring spots; line patterns; overall yellowing; stunting.	Transmission from infected to healthy plants via thrips. Introduction into the greenhouse via infected plants or insect vector.	Careful monitoring and management of thrips population. Inspection and isolation of new plant materials. Purchase plant material certified virus free. Weed management. Avoid carrying over stock plants unless tested free of viruses. Common hosts include many ornamental plants.
Viruses: Hosta Virus X (HVX), Tobacco rattle virus (TRV)	Symptoms highly variable depending on cultivar. With HVX major leaf veins may take on a feathered appearance at the edges, resulting in a “bleeding” appearance. Extreme symptoms include severe necrosis and death of leaves. TRV causes expanding necrotic lesions on hosta that look similar to fungal leaf spots.	No evidence HVX is transmitted by insects. TRV can be transmitted by root feeding nematodes. Vegetative propagation most important means of spread for both viruses.	Some reported differences in hosta cultivar susceptibility. Tiara series, ‘Blue Cadet’ and ‘Honeybells’ are highly susceptible. Purchase virus-indexed plants from a reputable source. Sanitize tools often, and avoid mixing lots from different sources. HVX only infects hosta. TRV has many perennial hosts including hosta.
Foliar nematodes	Pattern of damage is dictated by the pattern of major leaf veins (i.e., stripes, patchwork). Nematodes enter leaf cells through wounds or natural openings. Plant tissue initially turns yellow and eventually brown and necrotic. Symptoms often not visible until nematode population becomes quite large.	Spread by vegetative propagation, splashing water, plant-to-plant contact, worker movement and tools.	Exclusion is the most effective method of management. Inspect plant materials before introduction. Separate dormant materials until new growth has emerged and can be inspected for symptoms. Maintaining a 3-foot distance between nursery blocks will minimize spread. Plants confirmed with foliar nematodes should be promptly discarded. Chemical control is highly variable with limited effectiveness. Common hosts include many herbaceous and woody perennials. Buddleja and anemone are common hosts.
<b>Root and crown diseases</b>			
Pythium root rot	Damping off. Attacks root tips. Lower leaves yellow and wilt. Poor growth. Nutrient deficiencies. Brown, limp roots – outer cortex sloughs off. Plant may die. Plant wilts during warm, sunny days even with adequate moisture. Uneven height or coloration within a crop.	Generally cool, wet growing substrate, but depends on <i>Pythium</i> species present. <i>P. aphanidermatum</i> can be found at high temperatures. Over fertilization can predispose plants to infection.	Pathogen-free growing substrate. Sterilized flats. Plant when substrate and air temperatures are favorable for rapid emergence. Good drainage, careful irrigation and sanitation. Make sure cell packs are evenly filled. Common hosts include geranium, chrysanthemum, calibrachoa and poinsettia.
Phytophthora root and crown rot	Infects roots and may move into crown and stems; stunting of leaves and plant; leaves turn yellow, wilt and may drop prematurely; plant may die; roots turn dark and rot and outer cortex sloughs off; may also be present with <i>Pythium</i> .	High growing substrate moisture greater than 70%; generally cool temperatures (59°F-74°F); wet substrate and over fertilization generally predisposes plants. Wide host range.	Good drainage and water management. Use pathogen-free growing substrate, plants, water and equipment. Common hosts include gerbera, poinsettia, pansy, African violet, lavender and annual vinca.
Thielaviopsis root rot	Yellowing, stunted growth; signs of nutritional deficiencies; root decay; wilting; roots develop black lesions along the roots as well as black root tips.	Moist, cooler (55°F-61°F) growing substrate favors disease. Weakened/stressed plants are more susceptible. Wide host range. Can be spread by fungus gnats.	Use new or sterilized containers. Grow plant at substrate pH most favorable for the crop. Good sanitation. Discard infected plants. Use preventive fungicide applications for highly susceptible crops. Avoid stressing plants. Common hosts include pansy, petunia, calibrachoa, annual vinca and verbena.

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Rhizoctonia crown rot	Damping off; infection starts at crown and moves up stem; constriction of stem; stem becomes soft; plant may wilt; rotted crown may have a shredded, dry-appearance; roots sometimes affected. Brown, irregular-shaped spots can develop on leaves and stems. Aerial web blight can develop when the fungus grows from the growing substrate surface into the plant canopy. Web-like strands of mycelium can sometimes be observed stretching between the substrate and the infected plant parts. Fungus grows in a radial pattern so that infected areas look like a circle or semi-circle on dead plants.	Use drier substrate, but still wet (~40% water-holding capacity). Humid and warmer conditions. Wide host range. Web-like strands of the fungus can be seen when humidity is high.	Discard infected plants (all plants in a flat). Apply fungicides to protect still healthy plants. Avoid placing plants directly on the ground. Irrigate plants only when substrate and plants will dry quickly. Increase air circulation to reduce humidity. Clean pots and production facility surfaces of soil and crop debris, followed by application of a disinfectant on all surfaces. Use pathogen-free growing substrates. Good drainage. Careful irrigation. Common hosts include garden and New Guinea impatiens, chrysanthemum and poinsettia.
Fusarium wilt	Lower leaves yellow and dry; can be followed by rapid wilting of the entire plant. Infected plants wilt under moisture stress. On some hosts, when affected stems are cut open, the vascular system appears dark. Yellowing and stunting of older plants. Symptoms often expressed at time of flowering.	High air and substrate temperatures (75 °F-86°F); infected plants may appear symptom-less at substrate temperatures less than 68°F. Can be spread by infected but healthy-looking cuttings; fungus may be present on seed coats. Drought or flowering stress can result in rapid and severe symptoms. Can be spread by fungus gnats.	Infected plants nearly always die. Remove plant debris and disinfest between crops. Avoid reusing trays and pots; use fungicides preventively. Common hosts include cyclamen, chrysanthemum, dianthus, lisianthus and osteospermum.
Myrothecium crown rot	Stems rot at the soil line, leaf petioles collapse. Diagnostic symptom is the presence of raised, dark green-to-black masses of spores surrounded by a fringe of white fungal tissue. Spores typically produced in a circular pattern on the leaf tissue.	Warm, moist, humid conditions favor infection and disease development. Wounds are quickly colonized by this soil-borne fungus.	Remove and discard infected plants. Highly susceptible crops should be carefully scouted, or fungicides applied on a preventive basis. Remove plant debris between crops and disinfest benches. Common hosts include pansy, New Guinea impatiens and syngonium.
Bacterial soft rot (Pectobacterium=Erwinia)	Watery decay of plant tissue at the soil line. Foul odor. Collapse of plant (meltdown).	Requires high humidity to infect. Bacterium is ubiquitous in environment. Increased irrigation increases severity of the disease. Excessive nitrogen increases disease on calla lily.	Immediately discard infected plants. Porous substrates have been reported to decrease disease on calla lily. Copper dips are effective for about 6 weeks. Treat poinsettia stock plants with copper prior to taking cuttings. Avoid water logging substrate. Provide shading. Common hosts include calla lily, cyclamen, primula, poinsettia and bulb crops.
Sclerotinia blight (white mold)	Water-soaked spots on the stems and leaves become covered in a white cottony mass of fungal mycelium. As infection progresses, the plant becomes soft and slimy. Hard black structures called sclerotia develop within the fungal mass. May also cause dry lesions that girdle the stem. Sclerotia form within the stem.	Spread is primarily by airborne ascospores. High substrate moisture, high humidity and cool temperatures (50 °F-75 °F) favor disease development.	Difficult, if not impossible, to control once infection has occurred. Many susceptible hosts including marigold, zinnia, lobelia and petunia.