

KEEPING THOSE DRATTED DISEASES OUT OF YOUR GREENHOUSE CROPS

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BLACK ROOT ROT. One of the most persistent problems in the greenhouse industry is black root rot, caused by *Thielaviopsis basicola*. This fungus can become established in greenhouses and return on crop after crop, year after year. It is primarily encountered on pansy, viola, vinca, petunia, and calibrachoa. Some other annuals and perennials are susceptible as well (e.g. bacopa last year). In the past, fuchsia and poinsettia were often troubled by black root rot.

Symptoms. The main aboveground symptom is stunting, and this may be accompanied by yellowing or purpling of the foliage. It is easy to mistake black root rot for a nutritional problem. The root systems are also stunted, and if rinsed carefully the browning caused by accumulation of fungus structures (resting spores) may be visible: the roots are not softened, the way they are with Pythium root rot. Check incoming plugs for root health.

Management of Black Root Rot. Fungus gnats may play a major role in moving *Thielaviopsis* from pot to pot or up from the greenhouse floor into the crop, so keeping them managed is important for disease control. Biocontrols are helpful against fungus gnats, but are not especially valuable against the *Thielaviopsis*. Cultural controls can help: keep pH low to discourage the fungus (disease is greatest at pH 6.2 and higher), avoid poorly drained soil mix or cooler than desirable temperatures. Chemical control is achieved with thiophanate-methyl (3336, 6672, etc. in FRAC 1), rotated with fludioxonil (Medallion, FRAC 12), triflumizole (e.g. Terraguard, FRAC 3) and polyoxin-D (e.g. Affirm, FRAC 19). Sanitation is another key weapon against *Thielaviopsis*: if reusing packs and pots, they must be cleaned thoroughly to remove organic debris. Jets of water to remove debris followed by treatment in a disinfectant is desirable. Either a spray of 27% hydrogen dioxide (2.5 fl oz/gal) or a dip for 10 min. in 5.25% sodium hypochlorite (12.8 fl oz/gal) is effective for killing *T. basicola* chlamydospores.

PYTHIUM ROOT ROT is different from *Thielaviopsis* root rot in almost every way except that the pathogens both like wet soil conditions—and roots. The different *Pythium* species that cause disease are not even true fungi: they are ‘water molds’, also known as oomycetes, more closely related to algae than to fungi. Their life cycle is tied to wetness, because they produce a swimming spore called a zoospore. The different species have different temperature preferences, so different species will plague your crops in spring than in summer. *Pythium aphanidermatum*, troubling crops in the summer, is perhaps hardest to control.

Symptoms. When *Pythium* attacks, plants look small, sickly, and wilted. Upon inspection, the root system is not full and white: the outer cortex of the root is discolored gray or brown, soft-rotted, and often pulls away as a wilted plant is lifted from the soil. Symptoms sometimes extend up from the root system into the lower stem to create “black leg”. Most crops are susceptible to *Pythium* root rot under highly disease-favorable conditions, but some crops are notorious for the problem: geraniums, snapdragons, Easter lilies, mums and poinsettias lead the list. Periodically, New Guinea impatiens are stunted and wilted by *Pythium cryptoirregulare*, which causes streaking in roots and a black discoloration of the vascular system extending up into the stem.

Management. *Pythium* produces oospores that allow it to survive well in plant debris, so greenhouse sanitation is important to keep problems with root rot from cycling year after year. Well-drained mixes and adequate soil temperature favor the crop and discourage the pathogen. Fewer chemical fungicides work against *Pythium* than against *Phytophthora* (which is, for example, more susceptible to strobilurins than is *Pythium*). The most reliable *Pythium* controls include etridiazole (found in

Truban, Terrazole, Banrot, FRAC 14), cyazofamid (Segway, FRAC 21), and phosphorous acids (Alude, Aliette, Jetphite, etc FRAC 33). Mefenoxam (SubdueMAXX) is helpful within a rotation, but strains of *Pythium* with resistance are well established in the greenhouse industry so it should be used with awareness of this situation. Many growers today use biocontrols as protectants against *Pythium*, which are helpful if applied early in the life of the crop and used in conjunction with good sanitation and cultural practices. Biocontrols based on *Bacillus* spp. (Cease, Triathlon BA, Companion, etc), *Trichoderma* spp. (Asperello, RootShield, etc.) and *Streptomyces* spp. (Mycostop, Actinovate, etc.) all have competitive effects against *Pythium* species.

POWDERY MILDEWS generally move in towards the latter part of the spring season. Powdery mildews are a group of fungi that are host-specialized, and prolific spore producers. They do well under normal greenhouse growing conditions, thriving on high humidity rather than excessive wetness (always keep humidity below 85%RH). Hydrangeas, roses, zinnias, gerberas, begonias, pansies, rosemary and petunias are among the crops where powdery mildew might be expected.

Symptoms. Plants infected by powdery mildew may show isolated white colonies or be completely coated in white. Sometimes crops have harder-to-diagnose symptoms, such as the scabby spots seen on kalanchoes and sedums. Last year the most troublesome losses were seen in calibrachos: flower symptoms reduced quality on crops where foliage symptoms were minor and overlooked. Flowers had a gray cast, and a shortened lifespan, lowering the visual quality of hanging baskets. Powdery mildew is the perfect disease to scout for: unless you see it, you do not need to treat for it—unless your experience has taught you that it is an annual problem for a particular crop.

Management. Because of their prolific sporulation, powdery mildews should be managed with careful attention to FRAC groups: as with downy mildew and *Botrytis cinerea*, resistant populations can be created by poor deployment of fungicides. Biocontrols (e.g. Cease, Actinovate, Triathlon BA) can be used in alternation with chemical fungicides. Many FRAC groups are available for rotation, including: Group 11 (strobilurins such as Compass, Pageant), FRAC 3 (DMIs such as Terraguard), FRAC 5 (piperidin, Pipron), FRAC 19 (polyoxin D, such as Affirm) and FRAC NC (bicarbonates, such as Milstop; plus oils; plus *Reynoutria sachalinensis* extract, Regalia). There are also a number of relatively new combination fungicides on the market that work well against powdery mildews. FRAC 9 + 12: Palladium (cyprodinil + fludioxonil); FRAC 11 + 3: Trigo (trifloxystrobin + triadimefon, previously found as Strike Plus) and Fame + T (fluoxastrobin + tebuconazole); FRAC 11 + 7: Orchestra (pyraclostrobin + fluxapyroxad) and Mural (azoxystrobin + benzovindiflupyr).

BACTERIAL LEAF SPOTS CAUSED BY XANTHOMONAS SPECIES. As impatiens have become more risky due to downy mildew, begonias have become more popular. Although *Begonia semperflorens*, the standard bedding plant, has very low susceptibility to *Xanthomonas axonopodis* pv. *begoniae*, other types of begonias, also popular, are much less resistant. Be especially vigilant with Rieger begonias, Rex begonias, NonStops and *Begonia boliviensis* hybrids. Similarly, *Xanthomonas campestris* pv. *campestris* is problematic on ornamental cabbage and kale as well as other members of the cabbage family. Other *Xanthomonas* diseases (with different pathogens) affect geraniums, poinsettias, peonies, roses and ornamental peppers.

Symptoms. *Xanthomonas* leaf spots may be round or angular, and infected areas sometimes are chlorotic. In begonias, lightly infected plants of some cultivars may show only a few round leaf spots, but highly susceptible cultivars will collapse during warm weather garden conditions. Bacterial diseases can be spread by overhead irrigation, insects or handling. Bacterial blight (called black rot) in ornamental crucifers may be particularly troublesome because it can be seedborne,

Management. Watch for symptoms and discard infected plants. The remainder may be treated with a copper fungicide. *Bacillus subtilis* (e.g. Cease) or *Bacillus amyloliquefaciens* (e.g. TriathlonBA)

applications also inhibit bacteria. Culture-indexing programs help to protect geraniums against their bacterial blight.

DOWNY MILDEWS have been particularly evident on impatiens, coleus, sunflower, rudbeckia, lamium, veronica, foxglove, basil, rose, and Oriental poppy in recent years. Basil DM is spread on seed so vigilance is needed: consider purchasing steam-treated seed (Enza). Keep humidity down. For basil, phos acids, mandipropamid (Revus) and cyazofamid (Ranman) have greenhouse uses in most states. Late blight of tomato is similar to a downy mildew and spreads similarly fast. For recognition of tomato diseases see 'Tomato MD', a 'Plant Health' app from APS.

Symptoms. Downy mildews cause pale or brown spots on foliage. On the undersurface of leaves sporulation is evident as fluffy patches on white, violet or gray opposite the spots. On some plants the entire leaf is chlorotic (purplish or yellowed) and the undersurface is coated with sporulation.

Management. Cultural control for DM is primarily keeping humidity down in the greenhouse. Downy mildew fungicides for ornamentals include mefenoxam (SubdueMAXX), phosphorous acids (e.g. Alude), mancozeb (e.g. Protect T/O), cyazofamid (e.g. Segway), dimethomorph (e.g. StatureSC, Micora), strobilurin-containing materials (e.g. Compass, Cygnus, Disarm, Heritage, Insignia, Orvego, Pageant, Orkestra, Mural), oxathiapiprolin (Segovis) and fluopicolide (Adorn). Note that SubdueMAXX and Adorn both must be tank mixed with another fungicide effective against downy mildew for spray applications.

IMPATIENS NECROTIC SPOT VIRUS (INSV) and **TOMATO SPOTTED WILT VIRUS (TSWV)** will be problematic as long as Western flower thrips is problematic. Symptoms of TSWV were seen in osteospermum, impatiens, begonias, Senettis, Montauk daisies and other crops recently. INSV has been seen in torenia, impatiens and begonia as well as digitalis.

Symptoms. Symptoms of TSWV and INSV cannot be distinguished, and don't need to be. Symptoms are also different on each plant, and on different cultivars, or plants of different ages. Round white to round black spots, browning along veins or at the base of petioles, blackening of parts of leaves, browning of stem sections, ring spots in yellow or brown, and yellow mottling are all seen commonly. Weeds may carry the virus but be symptomless: one more reason to keep them out of the greenhouse.

Management. Remember that vegetables and herbs including tomato, pepper and basil are also susceptible: keep them separate from the flower crops grown from cuttings if possible. Constant monitoring for thrips populations and for virus-like symptoms is important during the spring, when rising temperatures lead to rising thrips populations that vector the viruses.

For **complete pest management information** (NY State): *Cornell Guide for the Integrated Management of Greenhouse Crops and Herbaceous Ornamentals*. 2017-18 available soon. Diseases/insects/weeds. Order from The Cornell Store: <https://store.cornell.edu/c-875-pmep-guidelines.aspx>

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2/14/2017