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## Downy Mildews of Ornamental Plants



Downy mildew diseases pose an increasing problem in the horticultural industry causing serious losses in many floricultural and greenhouse crops. In recent years, new Downy mildew diseases have been discovered on Coleus, basil, and garden Impatiens. Downy mildews present a challenge to growers both because the disease can be present but not obvious; and because they are difficult to control with fungicides once established. The pathogens are very different from Powdery Mildews- they attack different plants under very different environmental conditions, and are controlled by different classes of fungicides. Downy Mildew diseases are caused by a group of fungus-like organisms: they are not true fungi, and are similar to *Pythium* and *Phytophthora* species. Most of the Downy mildew fungi are host specific and infect only one plant family. Pathogens include species of *Peronospora*, *Bremia*, *Plasmopara*, and *Basidiophora*. Downy mildews infect almost all ornamental plants, as well as, some indoor plants. Greenhouse crops reported to have Downy mildew diseases include snapdragon, *Salvia*, alyssum, pansy, rose, rosemary, *Primula*, *Osteospermum*, *Impatiens wallerana*, coleus, statice *Verbena*, ornamental cabbage, basil, and *Cineraria*. Perennial hosts include *Aster*, *Buddleia*, *Coreopsis*, *Geranium* (not *Pelargonium*), *Geum*, *Gerbera*, *Lamium*, *Delphinium*, Rose, *Veronica* and *Viola*.

Symptoms of Downy mildew start as yellow to light green, irregular leaf lesions which can become purple to dark brown and be delimited by leaf veins. Under humid conditions, the fungus sporulates on leaf undersides, producing white, tan, gray or purple, downy growth. Downy mildews reproduce through special structures called sporangia that develop on leaf undersides. Air currents and splashing water dislodge these sporangia which then infect nearby healthy plants. Symptoms will vary along with the host plant and Downy mildew pathogens vary in aggressiveness. As the disease progresses, lower leaves can wither and fall off. The fungus grows both locally and systemically and it can escape notice until conditions are right for sporulation. Systemic symptoms can include stunting, leaf distortion and epinasty, shortened internodes, and a decrease in the quantity and quality of flower production. Some Downy mildews start from contaminated seed or from weed hosts around the production area. Some downy mildews produce long

lasting survival spores (Oospores) that can persist in the soil indefinitely. These diseases thrive under the cool, wet conditions of spring and fall. Downy mildews need wet leaves and high relative humidity (greater than 85 %) to cause disease; under these conditions, disease can occur very rapidly and is difficult to control.

**Downy mildew of Coleus, *Peronospora lamii***, was first detected in New York and Louisiana in 2005; by 2006 it was present throughout the United States. Symptoms include brown, irregular lesions on leaves, leaf drop, and stunting of seedlings. Because the lesions are irregular, infection can cause the leaves to twist and distort before dropping. In cool, wet, humid conditions sporangia may be visible to the naked eye as a downy gray to purplish growth on leaf undersides. Sometimes Downy mildew infection is obvious and sometimes it can go unnoticed until environmental conditions favor disease development. Under the right conditions, disease spread is very rapid. It is important that coleus plants not be carried to the next production season. Growers should resist the temptation to save their favorite cultivars or to harbor 'pet plants' in production greenhouses. It is also not advisable to use coleus in outdoor flower beds near greenhouses. Coleus plants may arrive at a greenhouse in apparent good health that harbor the pathogen. All new shipments should be carefully inspected and kept in a separate area for observation, if possible. Both seed and vegetatively propagated types of coleus are susceptible. Although all coleus are susceptible to Downy mildew, cultivars vary in their reactions.

**Downy mildew of basil, *Peronospora behlrahi***, was first reported in Uganda in 1930. The disease did not attract international attention until it recently appeared in several new locations; Italy (2004), France (2005) South Africa (2006), Iran (2007) United States, in Florida (2007) and Argentina (2008). During 2008 and 2009, the disease occurred throughout the east coast in epidemic proportions both in the field and in greenhouses. Considerable economic losses occurred in Massachusetts during that time and it is expected that basil downy mildew will be a major disease of basil in the US in the foreseeable future. Although the downy mildew pathogen has been detected in basil seed; air-borne dissemination from infected plants is more likely. Infected leaves develop diffuse yellowing on the top of the leaf but distinctly vein-bounded patches on the bottom. When spores are produced, a characteristic gray, fuzzy growth on the underside of the leaves is evident. Symptoms of downy mildew on basil can easily be mistaken for a nutritional deficiency. The fuzzy growth of spores on the underside of the leaf looks as if soil had been splashed onto the leaf under-surface. Commonly-grown sweet basil (*Ocimum basilicum*) cultivars such as 'Poppy Joe' and 'Nufar' are the most susceptible to downy mildew. The least susceptible basil types included the lemon and spice types such as *O. x citriodorum* and *O. americanum* cultivars, 'Lemon Std', 'Lemon', 'Lime', 'Spice', 'Blue Spice' and 'Blue Spice Fil'.

**Downy mildew of Impatiens, *Plasmopara obduscens***, has been reported sporadically since 2004 but it wasn't until 2011 that widespread outbreaks were observed in landscapes in Massachusetts. Symptoms on *Impatiens walleriana*

typically start with a few leaves that appear slightly chlorotic or stippled, and become completely yellow over time. Some varieties will have subtle gray markings on the upper leaf surface. A white, downy-like growth may be present on the underside of primarily yellow leaves, but can also be found on the underside of green leaves. As the disease progresses, premature leaf drop results in bare, leafless stems. Although the airborne spores remain viable for just a short time, *Plasmopara* produces a second spore type (a resting spore known as an Oospore) within the affected plant tissues. These resting spores are released into the soil as the diseased material decomposes and are likely to survive for extended periods. Research has shown no evidence of seed-borne transmission. Young plants, seedling cotyledons, and immature plant tissues are most susceptible to infection; leaf symptoms are often first observed on the younger growth. Plants infected at an early stage of development may show marked reductions in growth and leaf expansion. All varieties and intraspecific hybrids of *Impatiens walleriana* are susceptible to impatiens downy mildew, including both vegetative- and seed-produced *I. walleriana*. There are no significant differences in susceptibility among varieties.

A few species of wild impatiens are also hosts of this disease, but there are no other known hosts. New Guinea impatiens (*Impatiens hawkerii*) is highly tolerant to this downy mildew.

## **Impatiens and Coleus\*\* Downy Mildew Prevention and Management\***

**A. PREVENTIVE PROGRAM** — Use when downy mildew has not been seen this year on your premises or in the landscape nearby, and your supplier has not experienced a disease outbreak.

**1. First and last application:**

SubdueMAXX (1.0 oz/100 gal) + Adorn (2.0 oz/100 gal) drench  
Treat soon after plants received unless propagator has treated just before shipment.

**2. Two weeks later:**

A strobilurin (Compass O or Disarm or Fenstop or Heritage or Insignia or Pageant) spray, using high label rate + mancozeb (e.g. Protect DF at 1-2 lb/100 gal) as a tank mix

**3. Two weeks later:**

Segway (2.1 fl oz/100 gal) spray

**4. Two weeks later:**

Stature SC (6.12 fl oz/100 gal) spray

**5. Repeat # 2, 3, 4 at two-week intervals, as needed. Add mancozeb (Protect etc) to any treatment if desired for Alternaria leaf spot control**

**Last application, shortly before shipment:** SubdueMAXX + Adorn drench, as in #1

**B. MANAGEMENT PROGRAM** — Use when downy mildew has been found on Impatiens on your premises or nearby, or your supplier has had a disease outbreak.

**1. First and last application:**

SubdueMAXX (1.0 oz/100 gal) + Adorn (2.0 oz/100 gal) drench  
Treat soon after plants received unless propagator has treated just before shipment.

**2. One week later:**

A strobilurin (Compass O or Disarm or Fenstop or Heritage or Insignia or Pageant) spray, using high label rate + mancozeb (e.g. Protect DF at 1-2 lb/100 gal) as a tank mix

**3. One week later:**

Segway (3.5 fl oz/100 gal) spray + mancozeb (as above)

**4. One week later:**

Stature SC (12.25 fl oz/100 gal) + mancozeb spray (as above)

**5. Repeat # 2, 3, 4 as needed.**

**Last application, shortly before shipment:** SubdueMAXX + Adorn as in #1

*\* Program developed by M. Hausbeck (Michigan State University) and M. Daughtrey (Cornell University) based on experimental data of M. Hausbeck (cucurbit and coleus downy mildew); M. Daughtrey (coleus and impatiens downy mildew); and C. Warfield, Ball Horticultural Company (impatiens downy mildew). Follow all label instructions and note warnings; local restrictions may apply. Product names are given for information purposes only and are not an endorsement, nor is any criticism implied of products not mentioned.*

*\*\* Fungicide program for Basil Downy mildew differs because different fungicides are registered on herb plants. Registered fungicides are few in number, vary by field or greenhouse use as well as transplant or direct market consumption.*

**Downy Mildew Disease Management:** The first tactic in disease management is prevention. Growers should provide the required cultural conditions for healthy plant growth and development. Preventing the introduction of downy mildew pathogens into the greenhouse is of primary importance. Plants should only be purchased from reputable and trusted sources and should be thoroughly inspected before their introduction into production areas. Cultural management practices for Downy mildew diseases consist of managing relative humidity in the greenhouse,

strict sanitation, and preventive fungicide applications. It is critical to keep relative humidity below 85 % to decrease sporulation on infected plants and stop germination of spores on healthy plants. This can be done by venting and heating, which fills the greenhouse with warm, drier air. The use of fans in greenhouses improves horizontal air flow and prevents cold spots where condensation develops from occurring. The density of the plant canopy should be reduced by spacing plants to allow for maximum air circulation and sunlight availability. Greenhouses should be scouted regularly for the first symptoms of the disease to achieve effective control with fungicide applications. Diseased plants, infected debris, and soil should be promptly removed and destroyed. Fungicides should be applied preventively for maximum efficacy. The highest levels of control are obtained when fungicides are applied preventively. The fungicides Adorn, Fenstop, Heritage, Orvego, Pageant, Protect, Stature, Segway and Vital all provided very good to excellent control of impatiens downy mildew when applied as foliar sprays prior to infection. Many products which give excellent control preventively result in less or no control when used as curatives; once sporulation occurs control is difficult to impossible. The use of fungicides to control downy mildew diseases has become more difficult because of the development of fungicide resistant strains of downy mildew pathogens and concurrent loss of effectiveness. Most products with systemic activity are subject to an anti-resistance strategy. These measures include: beginning a regular spray program with a protectant fungicide, limiting the number of applications of particular fungicides applied per season, rotating fungicide applications among FRAC groups (modes of action), applying systemic chemicals in combination with a protectant like mancozeb, and applying mixtures of fungicides.

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