Plant Doctor

Greenhouse Basil Downy Mildew

MISSISSIPPI STATE UNIVERSITY EXTENSION

Greenhouse Basil Downy Mildew

Most common seasons

Late fall, winter and early spring.

Weather

A number of days with rains and high humidity, especially originating from the Gulf of Mexico. Temperatures between 53°F and 77°F.

Basil types affected

Especially bad on sweet basil. Colored types and other species are not so susceptible.

Quick symptoms

Chlorotic (yellow) area in center (mid-rib) of leaf. May develop fuzzy gray growth on underside of leaves. In very conducive situations, fuzzy growth may be on upper leaf surface, as well.

Figure 1. Young basil plant with a downy mildew infection. Note the yellow (chlorotic) blotches on the leaves and the black mycelia on the underside of the leaf seen on the opposite side of the plant.

A Very Short History of the Pathogen *(Peronospora belbahrii)*

Downy mildews are members of the water mold group. Other well known water mold plant pathogens are *Pythium* and *Phytophthora*. Pathogens in this group thrive in wet or moist environments, and the plant-pathogenic members develop resistance to chemicals used for their control.

Basil downy mildew was first noticed on a significant commercial basis in Switzerland in 2001. In 2003, it was found in Italy. By 2004, it was found in most Italian growing regions and in France. The disease was in several African countries in 2005. By 2008, it was found in at least nine U.S. states. It is considered established in Florida.

The rapid spread of basil downy mildew is due to two key characteristics:

- Its spores can move many miles on winds.
- It is seed-borne.

Another key point that is crucial to the spread of basil downy mildew is that *it is very difficult to manage and control*.

Life Cycle of Basil Downy Mildew

Seeds

Movement of the pathogen between continents is probably a result of the unintentional distribution of contaminated seeds. Basil plants grown from known infected seeds were systemically and latently infected (plants did not express symptoms), so contaminated seeds were harvested from these plants.

Recently, seed companies have started to decontaminate their seeds by steaming.

Symptoms

The first symptom is a slight chlorosis (yellowing), usually in the central area of the leaf around the mid-rib. Further disease development produces dark-colored (gray) "thread-like" structures similar to fungal hyphae, on the lower side of the leaf (**Figure 1**). They may take on a "fuzzy" appearance (**Figures 2 and 3**). In very conducive conditions, the dark hyphal-like threads may emerge on the upper side of the leaf. These dark, "fuzzy" threads produce spores.

Environmental Conditions

The pathogen requires at least 6 hours of leaf wetness after pathogen exposure to become established and at least 12 hours for severe infections to develop. Spore production requires very high humidity for some hours after symptoms develop. Leaf wetness for 24 hours after symptom development results in prolific sporulation and rapid spread of the disease.

Optimum pathogen growth occurs at 68°F—not much warmer than the energy-saving winter temperature settings used in many greenhouses. No apparent pathogen growth occurs at or below 53°F or above 77°F.

Figure 2. The upper and lower sides of sweet basil cv 'Nufar' infected with downy mildew. Note the chlorotic areas on the upper side of the leaf (left), which relate to mycelial growth on the lower side of the leaf (right).

Figure 3. Sweet basil plant (cv. 'Nufar') infected with downy mildew. Note the yellow or chlorotic splotches on the upper side of the leaves. The dark-colored mycelia will grow from the chlorotic areas on the underside of the leaf—and on the top of the leaf if the environment is very conducive.

Spores are easily moved on wind currents. They apparently can travel many miles. Growth in warmer temperatures will suppress expression of the dark mycelia threads on the lower side of the leaf, but chlorotic patterns will still be present (**Figure 4**).

Observed Patterns in the Greenhouse

Early symptoms of the disease (leaves with a chlorotic central area) will appear in a patchy pattern in areas of the greenhouse where temperatures and relative humidity are highest and air movement is lowest. This is usually in the central part of the greenhouse and in the middle of benches.

Figure 4. Sweet basil infected with downy mildew growing in 80–95°F temperatures. The chlorotic splotches are visible (above), but the mycelia is not expressed (below).

Management

Basil downy mildew is a tough disease. The precisely timed steps below have resulted in successful production of healthy Mississippi greenhouse-grown basil plants. *Missing a spray by as little as a day or two can ruin the crop.*

Seeds

- Try to find a disease-free seed source. Ask your vendor if they steam their seeds and what other precautions they may take.
- Their precautions may include a molecular based test of each seed lot.

Host resistance

- Sweet basil (*Ocimum basilicum*) is more susceptible than exotic, spice, and ornamental basils (*Ocimum citriodorum* and *Ocimum americanum*). In general, the less it looks and tastes like conventional sweet basil, the safer you will be.
- Basils said to be less susceptible:
  - Lemon basil ('Lemon', 'Lemon Mrs. Burns', 'Sweet Dani Lemon Basil')
  - Thai basil ('Queenette')
  - Red types (including 'Red Leaf' and 'Red Rubin')
  - Lime basil ('Lime')
- Basil breeders believe they have identified some resistance and are hopeful for some improved sweet basil cultivars in the future.

Watering

- *Do not overhead water*.
  - Overhead water wets the leaves. In winter, we experience extended periods of overcast days and high humidity coming from the Gulf of Mexico. The leaves rarely dry, and the combination of leaf wetness and high humidity is conducive to disease development.
  - Water by drip irrigation or from a tray. Make sure the trays drain after watering.

Air

- Greenhouse ventilation is very important. The target is less than 85 percent humidity and constant air circulation.
  - Automatic controllers should be set it to ventilate the greenhouse during the night. The more air changes you can afford, the better.
  - Ventilate the greenhouse in the late afternoon, starting about 3–3:30 in the winter. Heat the air. Exhaust the air by opening all the vents and running all fans. Close the vents. Repeat at least three to five times.
- Make sure that you have internal circulation fans going one direction on one side of the greenhouse and the other direction on the other side.
  - Make sure that the internal circulation fans work.

Temperature

- If you can afford it, set the temperature to 68°F or warmer.
- If you cannot, you might try heat mats. If warm enough, they might create a warm local temperature and avoid much of the problem. No test data is available.

Light

- For this to work, the temperature must be at least 60°F.
- Light, especially red light, suppresses the formation of spores of basil downy mildew, but not the hyphal-like, fuzzy growth. Stopping spore production will suppress disease spread.
- The more intense the light, the better.
- Space lamps about every 3.5 feet. A reflector may be used. Do not allow more than 7 hours of dark. Tested lamps are below:
  - 20W daylight (6400K) fluorescent bulbs (Leelite, China)
  - Approximately 40W cool white fluorescent light
  - 40W incandescent bulbs (Osram Sylvania, Indiana, USA)
  - 20W daylight (6400K) fluorescent lamp
- As the plants grow, the leaves will start to shade one another. Shaded leaves will start to produce spores. Direct light on the leaves is required for this to work.

Fungicides

- Fungicides labeled for use against this disease are listed at the end of this section. *However:*
  - Conventional fungicides are expensive.
  - You must constantly rotate their modes of action (FRAC code). You should use at least three different modes of action in rotation, which results in the investment of a significant amount of money in fungicides.
  - Studies indicate that conventional fungicide use is no more effective, and probably less effective, than the following program:
- *Suggested program*, **:* Employ all possible management techniques discussed earlier. Scout your basil at least once a day, looking for early symptom development. If early symptoms are found, bag the symptomatic plants on the spot and remove them from the greenhouse vicinity. Increase spray frequency when temperatures are conducive and humidity is high.
  - Use a phosphanate fungicide such as K-PHITE 7LP (other phosphates listed below). Apply lower rate at 7- to 28-day intervals. Do not apply at intervals less than 3 days. Intervals are shortened with increased environmental or disease pressure. Usually intervals of 1 week to 5 days are needed when days are overcast and humidity is high (those days when the Gulf of Mexico air sweats on the concrete), but intervals up to 2 weeks have worked under less conducive environmental conditions. Label rates for K-Phite 7LP are 1–4 quarts in a minimum of 10 gallons/A.
  - Spray or fog a tank mix of CEASE + MilStop at 3- to 5-day intervals. Make sure to cover the undersides of leaves. Suggested rates:
    - Conventional sprayer: 4–6 qt CEASE + 1.25-1.5 lb MilStop/100 gal spray volume
    - Low-volume fogger: 26–38.4 fl oz CEASE + 4–5 oz MilStop/3–4 L fogger tank volume per 10,000 ft^2
    - Both Cease and Milstop are ORMI listed.
- Following are fungicides labeled for downy mildew of basil that are permitted in greenhouses:
  - Phosphonates:
    - Use specifically allowed in greenhouses: Fosphite, K-Phite 7LP, Rampart
    - Use not forbidden in greenhouses: Fungi-Phite, ProPhyt
  - Conventional types of fungicides. Rotate the use of these products using the FRAC code as a guide:
    - Use specifically allowed in greenhouses: Ranman (FRAC code 21)
    - Use not forbidden in greenhouses: Revus (FRAC code 40)

- Organic listing of some type:
  - Use specifically allowed in greenhouses: Actinovate (*Streptomyces lydicus*), MilStop (potassium bicarbonate), and Regalia (extract of *Reynoutria sachalinensis*)
  - Use not forbidden in greenhouses: Double Nickle (*Bacillus amyloliquefaciens*)
  - On planting, you might drench the soil with Actinovate, Double Nickle, or Root Shield Plus WP. This may or may not help, primarily by suppressing soil-borne pathogens and making a stronger, less susceptible seedling.

*This program is based on the author's experience in cooperation with some greenhouse basil producers in Mississippi. Other programs may work, as well.
**The label is the law. This is a guide, and specific label instructions may differ. Always read and follow label instructions. The information given here is for educational purposes only. References to commercial products, trade names, or suppliers are made with the understanding that no endorsement is implied and that no discrimination against other products or suppliers is intended.

For More Information

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Greenhouse-grown basil plants.

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By **Dr. Alan Henn**, Extension Professor, Entomology and Plant Pathology.