

Managing Basil Downy Mildew in the Greenhouse

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Basil is the most important herb crop and downy mildew its most important disease for both field and greenhouse grown crops, with potential to render a crop completely unmarketable. Fortunately, progress has been made in managing this disease since 2008 when basil downy mildew was first detected in the U.S. Most important for greenhouse production are resistant varieties and environmental manipulation. Growers have reported successfully managing downy mildew with these approaches alone or combined. Recently released varieties have exhibited a high level of suppression. Cultural practices recommended to manipulate the environment are based on knowledge about conditions favorable for infection and disease development. These include fans to keep leaves moving to prevent water deposition, dehumidification of air and heat to keep relative humidity in the plant canopy below 85%, and lighting at night to prevent spore production. Additionally, there are several fungicides that can be used on greenhouse crops. Pathogen-free seed is another important management practice especially during winter. Details about management are below the image.

2014 was arguably the worst year for downy mildew of basil in the USA. It began in the spring with several occurrences in greenhouses. This suggested there was a higher incidence of contaminated seed than previous years. Seed appeared to be the only possible source in greenhouses where basil was not grown year round because this pathogen cannot survive long when basil is no longer present: its spores are short-lived, it cannot survive in dead plant debris, and it has no other known host plant. During spring 2014 affected plants were found for retail sale in garden centers, not only on Long Island, but elsewhere in the northeast, as far south as Tennessee, and also in Canada. There were more reports of basil downy mildew in the USA made to a web-based monitoring page in 2014 than previous years. Most were outdoor occurrences reported by gardeners. There were 284 reports from 35 states plus the District of Columbia, compared to 49 – 75 reports per year in 2009 – 2013. Most occurrences during summer are likely the result of wind-dispersed spores from other affected plants. Downy mildew has developed on outdoor-grown basil starting during mid-summer every year on Long Island since 2008.

Management practices:

1. Start with pathogen-free seed. Eurofins STA Laboratories in Colorado now tests basil seed for *Peronospora* spp (<http://www.eurofinsus.com/stalabs/products-services-seed-health.html>). It is sufficient to test only at the genus level with this pathogen since it is the only species of *Peronospora* that would be associated with basil seed.

Seed companies are starting to steam treat basil seed. High Mowing Organic Seeds offers steam treatment. Basil seed is not amenable to hot-water treatment because while in water the seed produces a gelatinous exudate, which makes the seed challenging to handle.

2. Select resistant varieties. Fortunately there are now varieties with a high level of resistance. Researchers at Rutgers identified an excellent source of resistance. Rutgers Devotion DMR, Rutgers Obsession DMR, Rutgers Passion DMR, and Rutgers Thunderstruck DMR are the first Rutgers varieties released. Amazel and Prospera are other new highly-suppressive resistant varieties that have different resistance genes. These six exhibited good to excellent suppression in [evaluations conducted at Cornell](#) recently in contrast with Eleonora, the first

commercially available resistant variety. Amazel is only available as cuttings because it does not produce viable seeds. Prospera Compact DMR is a new variety especially suitable for pot production. Emma and Everleaf (aka Basil Pesto Party and M4828Z when evaluated at Cornell) have moderate resistance providing limited suppression. To ensure acceptable control of downy mildew, especially when growing varieties with intermediate resistance, it is important to use other management practices, in particular making the environment unfavorable for disease development and/or applying fungicides. Using an integrated approach to management ensures success in the event of a new pathogen strain being present that can overcome plant resistance.

3. Avoid favorable conditions for disease development. The basil downy mildew pathogen needs leaves to be wet or humidity of at least 85% in the plant canopy to be able to infect. Practices to keep humidity low include base watering, wide plant spacing, dehumidifying air, circulating fans, lights, and increasing temperature. Base heating is an especially effective method to reduce humidity. Set up sensors in the plant canopy to monitor humidity to ensure implementing practices are sufficient.

4. Fan the crop. Fanning is a practice developed and being used in Israel for basil grown in protected culture. It entails directing greenhouse fans toward plants so that leaves move. This prevents water depositing on leaves when humidity is high. Wet leaf tissue is favorable for infection. Fanning is especially important at night.

5. Turn lights on during night. Illuminating either leaf surface of plants growing under protected conditions during nighttime was shown to effectively suppress downy mildew in basil by inhibiting spore production through a study conducted in Israel. Light was supplied in high tunnel-like structures with 20W Day Light fluorescent bulbs each equipped with a white metal reflector (30 cm diameter), with one bulb per meter row. Spores formed on leaf tissue shaded by other leaves, thus this procedure is most effective when plants are small. Initial experiments were done with illumination throughout night. Recent research has revealed light exposure is most important during the first 6 hours of night, and the pathogen needs at least 7 hours of darkness. Red light was shown to be the most inhibitory under laboratory conditions.

6. Apply fungicides. The importance of fungicides in a management program for downy mildew depends on whether highly resistant varieties are being grown and whether the greenhouse environment can be successfully manipulated to be unfavorable for disease development. When managing downy mildew with fungicides, a preventive program with conventional fungicides is considered necessary to achieve effective control based on results from replicated fungicide evaluations on field-grown susceptible varieties: downy mildew was not controlled effectively when applications were started after symptoms were seen and with organic fungicides. Ranman (cyazofamid; FRAC code 21) and Revus (mandipropamid; FRAC 40) have targeted activity for downy mildew and other oomycete pathogens. Their use is permitted in greenhouses. There are several phosphorous acid (phosphonate) fungicides labeled for this disease, including ProPhyt, Fosphite, Fungi-Phite, Rampart, pHorsephite, and K-Phite. These are suggested used at low label rate tank-mixed with Ranman and Revus, which are recommended used in alternation for resistance management.

Heritage SC (azoxystrobin; FRAC 11), Micora (mandipropamid; FRAC 40), Segovis (oxathiapiprolin; FRAC 50, previously U15), and Subdue MAXX (mefenoxam; FRAC 4) are additional fungicides that can be used in greenhouse-grown plants for retail sale to consumers. It is important to use a fungicide resistance management program including alternation among as many chemistries based on FRAC code as possible. Heritage can be applied once to plants at each production stage, plug and finish. It must be applied in alternation with another fungicide. Micora and Segovis also can be applied at most twice to a crop. Micora can only be used in an enclosed greenhouse with permanent floor. Segovis can also be used in outdoor nurseries. Subdue MAXX can be applied once to foliage and must be tank-mixed with another fungicide

labeled for this use and applied at full label rate. Phosphorous acid fungicides can be tank-mixed with any of these greenhouse fungicides. Micora, Segovis, and Subdue MAXX can only be applied to foliage of plants for retail sale as transplants; they are not permitted used on plants to be marketed as fresh herbs in grocery stores.

Basil downy mildew has proven difficult to manage with fungicides approved for organic production. This is partly due to the fact there is no tolerance for any amount of disease on leafy herb crops for fresh consumption or for retail sale. Additionally, it is difficult to deliver spray material to the underside of leaves where the pathogen typically infects and produces spores. Most organic fungicides are contact materials. None of the products tested in fungicide evaluations have provided commercially-acceptable level of control. A fogger is expected to improve coverage over a boom sprayer.

There is no tolerance for downy mildew on basil for retail sale. Very few gardeners are going to apply fungicides to basil, and the products they can use have limited activity. Downy mildew can develop very quickly. I have seen at garden centers basil plants that were very healthy-appearing with some downy mildew sporulation and no leaf yellowing, but just three days later leaves on the plants not sold were yellowing and covered with spores on the underside.

7. Monitor plants for symptoms. Yellow leaf tissue in bands delimited by large veins is distinctive for downy mildew. It is important to examine the underside of leaves for the pathogen's spores because there are other causes of leaf yellowing and spores can be present without yellowing. Photographs are posted at:
<http://blogs.cornell.edu/livegpath/gallery/basil/downy-mildew/>

8. Heat treat affected plants. If symptoms are found early, it might be possible to save some plants by subjecting plants to heat and then taking steps to improve the management program. High temperature is detrimental to the pathogen. Maximum temperatures for infection, colonization, and spore production are 80 – 88 F. Research conducted in growth chambers demonstrated that temperatures up to 113 F kill spores and mycelium of the pathogen in affected plants, with length of effective exposure decreasing with higher temperature range, least being 6 - 9 hours at 104 – 113 F. Subsequently solar heating has been used to cure plants in Israel by closing greenhouse vents or using a transparent IR polyethylene sheet covering during sunny days. It is recommended done at first sign of downy mildew and over 3 consecutive days with 3 – 4 hours exposure. It necessitates routine monitoring to ensure temperature reaches effective range while not rising high enough to kill plants. If temperature does not go about 95 F, treating for a fourth day is recommended.

9. Promptly destroy unmarketable affected plants. Affected plants should be carefully bagged (after turning off fans) and thrown out to minimize opportunity for spores to spread to other plantings.

More information about this disease plus images and links to monitoring pages are [on line](https://www.vegetables.cornell.edu/pest-management/disease-factsheets/basil-downy-mildew/) at <https://www.vegetables.cornell.edu/pest-management/disease-factsheets/basil-downy-mildew/>.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.

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