EXPECT AND PREPARE FOR DOWNY MILDEW IN BASIL

Margaret Tuttle McGrath
Department of Plant Pathology and Plant-Microbe Biology, Cornell University
Long Island Horticultural Research and Extension Center
3059 Sound Avenue, Riverhead, NY 11901; mtm3@cornell.edu

An earlier version of this article was prepared with Andy Wyenandt and Jim Simon
(Plant Biology & Pathology, Rutgers University) and posted at
http://www.growingproduce.com/americanvegetablegrower/?storyid=3310

PLEASE Report Observations of Basil Downy Mildew in the USA.
Monitoring program success depends on participation.

Downy mildew of basil is a new, destructive disease that appears to be here to stay. It was first reported in south FL in October 2007. In 2008 downy mildew was confirmed in both field- and greenhouse-grown basil crops, as well as home gardens, in many states: NC, PA, NJ, NY, MA, NC, KS, and MO. Likely it occurred elsewhere but was not recognized. Growers generally did not realize their basil had a disease because the most noticeable symptom on affected plants was yellowing resembling a nutritional deficiency. The downy-appearing sporulation of the pathogen only develops on lower leaf surfaces. And, since downy mildew of basil is so new in the USA, few knew about it. Complete crop loss occurred for some growers because leaves with any injury are unmarketable. This disease was also reported in Canada in 2008 and in greenhouse-grown basil in Argentina in February 2008. In 2009 basil downy mildew was found in the western USA, and early in 2011 it was reported in Hawaii for the first time as well as in FL as usual.

Reports of downy mildew began a few years earlier in Europe, where the disease is now considered endemic. It was observed in greenhouses in Switzerland in 2001, Italy in 2003, and Belgium plus France in 2004. Basil downy mildew has also been detected recently for the first time in Israel, New Zealand, Iran and several African countries: Cameroon in 2007, South Africa in 2005, plus Benin and Tanzania.

So where did this new scourge come from? Prior to all these recent outbreaks, basil downy mildew had only been reported in Uganda and that was in 1933. One possibility is that a more aggressive pathogen strain evolved in Uganda that is responsible for the recent outbreaks. The pathogen (Peronospora belbahrii) can be seed-borne, as well as dispersed via its air-borne spores. Unknowingly distributing contaminated seed is a plausible way that it has been spread long distances between geographically-separated areas, including in to the USA. Basil growers may recall with frustration a similar situation years ago with another new disease: Fusarium wilt. In just a few years, as the cause of this wilt was being identified, the pathogen became endemic most likely as the result of marketing of contaminated seed. It also is possible that spread of the basil downy mildew pathogen occurred through marketing of infected, basil leaves that were asymptomatic during shipment. Basil in the US has become the leading culinary herb and is available year round. An estimated 20% of the total basil sold is imported from other countries. The pathogen found in FL has been shown to be genetically the same as that in Switzerland (100% homology in their genetic sequences). Once downy mildew has begun to develop in one crop, the pathogen can readily spread via the easily wind-dispersed spores that it produces abundantly. This is likely the main way it has spread throughout the eastern USA every summer since 2008, similar to its well-known relative, the cucurbit downy mildew fungus.
A monitoring program was started in 2009 to obtain information on where basil downy mildew occurs and to try to determine whether the pathogen could move northward through the eastern USA, now that it is considered established in FL, as occurs with the cucurbit downy mildew pathogen, and whether a monitoring program can assist growers to be prepared for downy mildew occurrence in their basil crop. Each year a spreadsheet accessible by anyone has been set-up in Google Docs. These pages are at:

For 2011: https://spreadsheets.google.com/ccc?key=tphmBim45_9rRh31XfV70eA&hl=en#
For 2010: http://spreadsheets.google.com/ccc?key=tpjIzTOV96rlFTVvYXl3w&hl=en
For 2009: http://spreadsheets.google.com/ccc?key=pwvp1mHxmowsEd8Sdi4coNQ

In 2009, 49 reports of downy mildew were logged from 17 states, plus Canada. Most were made by growers and home gardeners. Eight reports were of downy mildew in greenhouses or high tunnels plus one of potted plants indoors. In 2010, 63 reports were logged from 24 states. Many more occurrences have been acknowledged but not logged. Another monitoring activity has been sentinel plots with basil conducted as an add-on to the ipmPIPE cucurbit downy mildew monitoring program. In 2009, downy mildew was observed in sentinel plots in seven of the 14 states with these plots. There were other reports of downy mildew in these states logged in the web-based monitoring spreadsheet. There were two states with no reports of downy mildew in plots or elsewhere. Thus occurrence of downy mildew in the sentinel plots often reflected disease occurrence in a state.

Figures. Yellowing of the upper surface of affected basil leaves often occurs in sections of the leaf delineated by veins because the downy mildew pathogen cannot grow past major veins in leaves. Purplish gray spores of the downy mildew pathogen only develop on the lower surface of leaves. Sporulation coincides with yellowing on the opposite side of the leaf. These are the same leaves.

Success of the monitoring program depends on reports from anyone growing basil; therefore everyone is encouraged to enter observations. Information is needed about the planting and how the diagnosis was made. Reports are also valuable of locations where downy mildew is not found on basil. Monitoring will assist with determining whether seed is becoming a less important source, as expected with the pathogen’s ability to be seed-borne becoming well known, and whether movement of the pathogen via its wind-dispersed spores can be predicted based on knowledge of where downy mildew is occurring and forecasts of wind trajectories plus
weather, as is done now for cucurbit downy mildew. Even before a forecasting system like that for cucurbit downy mildew can be developed, growers and gardeners alike will be able to look at reports in the spreadsheet to see if basil downy mildew has been observed near by.

Downy mildew also was observed recently on ornamental plants related to basil, in particular coleus and salvia. These plants all belong to the Lamiaceae family, which includes basils (*Ocimum* spp.), mints (*Menta* spp.), sages (*Salvia* spp.) and other culinary herbs. Fortunately, the coleus and basil downy mildew pathogens have now been demonstrated to be genetically different; therefore, these ornamental plants are no longer considered potential alternative hosts. However, there are many ornamental types of basils that are also hosts to the pathogen affecting basil grown for use as an herb.

The first step in preparing for basil downy mildew is learning the symptoms. See figures on previous page. Additional photographs are posted at:

http://www.longislandhort.cornell.edu/vegpath/photos/downymildew_basil.htm
http://vegetablemdonline.ppath.cornell.edu/NewsArticles/BasilDowny.html

Next become familiar with the monitoring web page to be ready to use it after planting. Finally develop a management plan.

Using seed not infested with the basil downy mildew pathogen, selecting a less susceptible variety, and applying fungicides are the primary management practices for downy mildew. A seed testing procedure is being developed. Minimizing leaf wetness and reducing humidity to obtain conditions unfavorable for disease development may suppress downy mildew, especially in greenhouses.

Variety evaluations are being conducted to determine if there are inherent differences among varieties and species of basil. Research conducted in New Jersey in 2009 by Wyenandt and Simon revealed that commonly grown sweet basil (*Ocimum basilicum*) is more susceptible than the some of the other exotic and ornamental basils such as *Ocimum citriodorum* and *Ocimum americanum*. Sweet basil varieties ‘Aroma 2’, ‘Genovese’, ‘Martina’, ‘Italian Large Leaf’, ‘Magical Michael’, ‘Nufar’, ‘Opal Purple Variegated’, ‘Poppy Joe’s’, ‘Queenette’, and ‘Superbo’ had the most symptoms. Fewer were found on ‘Red Leaf’ and ‘Red Rubin’. Similar low severity of downy mildew was observed in each of the lemon and lime basil varieties tested including: ‘Lemon’, ‘Lemon Mrs. Burns’, ‘Sweet Dani Lemon Basil’, and ‘Lime’. No symptoms were found on leaves of ‘Spice’, ‘Blue Spice’, and ‘Blue Spice Fil’. In an evaluation conducted on Long Island in 2009, ‘Cinnamon’, ‘Queenette’ (Thai basil), and ‘Red Rubin’ were less severely affected than ‘Superbo’. These trials have demonstrated that all the sweet basils tested are very susceptible. Similar results have been obtained in trials conducted in Illinois and Florida. Fewer symptoms were observed only on those basils that are different from sweet basil being distinct in visual appearance, aroma and flavor, and which have quite limited markets. The challenge in breeding for resistance to basil downy mildew is to develop improved resistant varieties that still look, taste, grow and pack-out as a traditional high quality sweet basil. Without resistant sweet basil varieties, growers will need to rely on alternative strategies to control this disease.

Applying fungicides frequently and starting before first symptoms are considered necessary to control downy mildew effectively. Few fungicides are currently labeled for this new disease. Actinovate AG, Trilogy, and OxiDate are OMRI-listed fungicides labeled for use on herbs and for suppressing foliar diseases including downy mildew. OxiDate is labeled for use outdoors and in greenhouses. The Actinovate and Trilogy labels do not have a statement prohibiting use in greenhouses. OxiDate has limited residual activity and thus if used should be combined with or followed by another product. There are three phosphorous acid fungicides that have downy mildew under herbs on the current label: ProPhyt, Fosphite and K-Phite. This
chemistry was documented to be effective in fungicide evaluation experiments. Greenhouse use is not prohibited. Quadris is labeled for use on basil but not specifically for downy mildew; it also has been shown to be effective for this downy mildew. In states like NY where the target disease is required to be specified on the label, Quadris cannot be used without an approved FIFRA 2(ee) recommendation, which the applicator must possess when using (the one for NY can be downloaded at http://magritte.psur.cornell.edu/pims/current/). Greenhouse use is not permitted with Quadris. Other fungicides, that are considered more effective than those currently available, are expected to be labeled for basil downy mildew in the future as a result of work by the IR-4 program, which has identified this as a top priority and is supporting fungicide evaluations.

To determine when to initiate a fungicide program and also when it is warranted to consider harvesting early to avoid losses to downy mildew, growers should not only routinely check the on-line spreadsheet to determine when downy mildew is occurring on basil nearby, but also regularly inspect their crop for symptoms. The cucurbit downy mildew forecasting web site (http://cdm.ipmpipe.org) might be useful for predicting when conditions are favorable for basil downy mildew since both pathogens likely have similar requirements for successful wind dispersal long distances (e.g. overcast skies) and subsequent infection (e.g. wet leaves or high humidity). Summer is not a time to forget about this disease: unlike most other downy mildew pathogens, e.g. the ones affecting lettuce and cruciferous crops, which stop developing in summer, the basil downy mildew pathogen seems to develop best under moderate to warm temperatures while also tolerating cool temperatures. Don’t forget to report occurrence of downy mildew as soon as possible at the monitoring page or via e-mail to mtm3@cornell.edu.

Practices that minimize leaf wetness and reduce humidity can contribute to control. These include planting where there is full sunlight and good air movement with rows parallel to the prevailing wind direction, maximizing plant spacing, and using drip irrigation. Humidity can be lowered in greenhouses by using circulating fans and lights and by increasing temperature. Observations of downy mildew occurrence in field and greenhouse basil plantings suggest that environmental conditions might significantly affect severity of downy mildew.

Basil crops should be disked under or otherwise destroyed as soon as possible after last harvest, or when abandoned because of disease, to eliminate this source of inoculum for other plantings. A sunny day is the best time to physically destroy an affected crop because the disturbed spores will be killed by UV radiation.

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.