



AGRONOMIC SPOTLIGHT



MANAGING DOWNTY MILDEW IN CUCUMBERS

- » Downy mildew is one of the most destructive foliar diseases on cucumbers.
- » It causes significant losses in both field and protected culture production systems.
- » Management requires an integration of cultural, resistance, and chemical methods.

SIGNS AND SYMPTOMS

Downy mildew can affect plants of all ages, but in many growing regions it appears late in the season.^{1,2} The infection is mostly restricted to the leaves, but the resulting reduction in photosynthetic area causes stunting of plants, reduced yields, and sunscalding of the fruit following defoliation. Initial symptoms are small chlorotic spots on the upper leaf surface, often developing first on the older, crown leaves (Figure 1). The lesions expand and take on an angular shape as they are bound by the major leaf veins. The infected tissue eventually becomes necrotic (dead) leading to leaf death and defoliation. Gray to purple colored downy mold growth develops on the undersides of leaves (Figure 1).

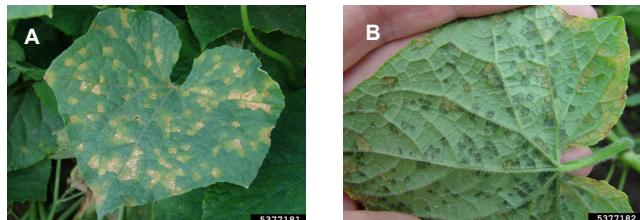


Figure 1. Symptoms of downy mildew on the (A) upper and (B) lower leaf surfaces. Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org.

CONDITIONS

Downy mildew of cucumber is caused by *Pseudoperonospora cubensis*, a member of the water mold group (Oomycota) of fungal-like organisms. The downy mildew pathogen is an obligate parasite that needs living cucurbit plants in order to grow and survive. It does not overwinter on plant debris in most areas. In the U.S., the pathogen overwinters on live cucurbit plants in areas with mild winter climates or plants growing in greenhouse/protected culture environments. The pathogen is disseminated by windblown sporangia that can travel up to 600 miles in 48 hours on air currents.³

For the Eastern and Midwestern production areas, inoculum typically comes from southern Florida and Texas. In these regions, the pathogen arrives first in the more southern locations and makes its way northward, usually arriving in the Midwest and New York in late July, August, or

September.^{4,5} Inoculum from infected, greenhouse-grown plants in the region may result in the disease showing up on field-grown plants earlier than would be expected.^{1,6}

Infection and disease development occurs most rapidly during periods with moderate temperatures (59-68°F) and cool nights. Disease development is slowed by warm (>95°F) temperatures, while periods of fog, rain, and frequent dews are favorable for infection. Symptoms usually develop three to twelve days after infection, depending on the temperature and moisture levels present, with new sporangia formed in a little as four days.²

MANAGEMENT

Adequate management of downy mildew requires an integrated approach to reduce the periods of leaf wetness, avoiding the disease by planting early in the season, the use of disease-resistant varieties, and the application of fungicides. Because the disease does not overwinter in many production areas but is blown in from areas to the south, the occurrence of the disease is not affected by crop rotation or post-harvest sanitation.⁵

Minimizing periods of leaf wetness can lower the incidence and severity of downy mildew. Increasing air flow in the canopy by selecting sites with good air circulation, increasing plant spacing, or by trellising can help foliage dry more quickly.^{1,2} Avoiding overhead irrigation can help keep leaves dry and lower disease levels. In the Eastern and Midwestern parts of the U.S., downy mildew usually arrives later in the growing season. Thus, the disease can be avoided, or impacts on yield reduced by planting early. High disease pressure can significantly impact late season plantings.⁴

In the past, the use of disease resistance was very effective controlling downy mildew in cucumber, and today most commercial varieties have some level of resistance to downy mildew. Even partial resistance can delay the onset of disease, slow the spread within a field, result in less severe symptoms, and reduce yield losses.² A form of downy mildew resistance identified in 1954 has been widely used and mostly eliminated the need for using fungicides to

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manage downy mildew for nearly 50 years.⁷

Since 2004, severe epidemics of downy mildew have occurred on cucumbers in the Eastern and Midwestern parts of the U.S. These epidemics have been caused by new strains of the pathogen that can overcome previously effective forms of resistance.⁴

Improved resistance to downy mildew has recently become available in slicing varieties such as SV3462CS, SV4719CS, and Bristol, and pickling varieties such as Citadel and Peacemaker from Seminis. This intermediate form of resistance should be used along with the application of effective fungicides to help ensure acceptable levels of control in situations of high disease pressure.⁷

Fungicide applications are most effective when used in combination with disease-resistant varieties and other methods of control. High spray pressures (75 psi) and high application volumes (75 gallons of water per acre) are needed to help ensure adequate spray coverage, and applications should be made before rain events, to provide time for treatments to dry.³

Several fungicides are available for controlling downy mildew, including both protectant and eradicant fungicides. Protectants, including chlorothalonil, copper-based compounds, and mancozeb, can be used alone to protect plants from infection early in the season. Once the disease appears, eradicants that penetrate tissue will be needed.⁴

The downy mildew pathogen can develop resistance to fungicides fairly quickly, and products that provided good control only a few years ago are no longer as effective as they once were, including the phosphorus acid fungicides, fungicides containing mefenoxam (Ridomil Gold[®]), and the Qo1/strobilurin group of fungicides (formulations of Quadris[®], Flint[®], Cabrio[®], Pristine[®], and Reason[®]). These fungicides are no longer recommended for the control of downy mildew in most areas.⁴ Fungicides such as Presidio, Previcur[®] Flex, Revus[®], Curzate[®], and Tanos[®], are also less effective than they were, but still provide some control.

As of 2016, the most effective products are those that contain fluopicolide, famoxadone+cymoxanil, cyazofamid, and zoxamide.^{2,3,4} To prevent or delay the development of new resistant strains, it is recommended (or required) that eradicant fungicides be tank-mixed with a protectant fungicide and/or alternated with applications of fungicides that have different modes of action (FRAC groups).

Determining the need and frequency of fungicide applications can be improved by the use of a disease forecast model, such as the one available at the Cucurbit Downy Mildew forecasting website.⁸ This site is part of the

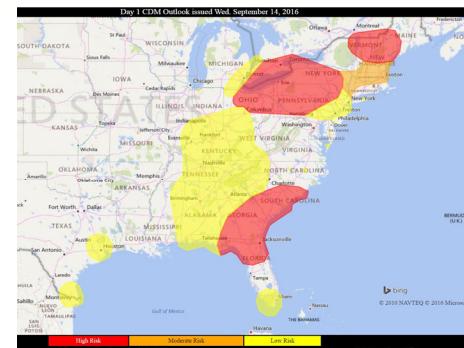


Figure 2. Downy mildew risk prediction map.⁸ IPM-PIPE (Integrated Pest Management Pest Information Platform for Extension and Education) network. The cucurbit downy mildew forecast is based on the presence of the pathogen in or near an area and large-scale weather systems. Growers can subscribe to receive text or email alerts when outbreaks of downy mildew are confirmed in their area.^{2,8}

The forecast is based on an evaluation of the threat of inoculum production in source areas where the disease is present, and the risk of inoculum dispersal and disease development into areas along a projected trajectory of spread from the source areas (Figure 2). These risk evaluations are based on a number of parameters, including the amount of sporulation at the source, the potential for spore survival during transport (based on sunny vs. cloudy conditions), the potential for spore deposition (based on chances of rain), and the favorability of conditions for infection in the local area. The highest risk levels occur when conditions are cloudy with rainfall likely, which favor the survival and deposition of the downy mildew inoculum.

Sources:

¹ Zitter, T.A., Hopkins, D.L., Thomas, C.E. 1996. Compendium of cucurbit diseases. The American Phytopathological Society. St. Paul, MN.

² Colucci, S.J. and Holmes, G.J. 2010. Downy mildew of cucurbits. The Plant Health Instructor. DOI: 10.1094/PHI-I-2010-0825-01.

³ Keinath, A.P. 2015. Cucurbit downy mildew management for 2015. Clemson Cooperative Extension. Horticulture: Plant Pathology. IL 90 - Rev. April 2015.

⁴ Reiners, S. and Seaman, A. 2016. Cornell integrated crop and pest management guidelines for commercial vegetable production.

⁵ Egel, D. S. 2016. Midwest vegetable production guide for commercial growers.

⁶ Hausbeck, M. 2015. Cucumber downy mildew makes an early appearance in Michigan. http://msue.anr.msu.edu/news/cucumber_downy_mildew_makes_an_early_appearance_in_michigan.

⁷ Holmes, G.J., Ojiambo, P.S., Hausbeck, M.K., Quesada-Ocampo, L., and Keinath, A.P. 2015. Resurgence of cucurbit downy mildew in the United States: a watershed event for research and extension. Plant Disease 99:4, 428-441.

⁸ The cucurbit downy mildew forecast homepage. <http://cdm.ipmPIPE.org>.

For additional agronomic information, please contact your local seed representative. Developed in partnership with Technology Development & Agronomy by Monsanto.

Individual results may vary, and performance may vary from location to location and from year to year. The information provided in this communication may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible. ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. The recommendations in this article are based upon information obtained from the cited sources and should be used as a quick reference for information about cucumber downy mildew. The content of this article should not be substituted for the professional opinion of a producer, grower, agronomist, pathologist and similar professional dealing with this specific crop.

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