



DOWNY MILDEW CONTROL IN CUCURBITS

CURRENT TOPIC

By **George Kuepper**
NCAT Agriculture Specialist
March 2003

Downy mildew, caused by the fungal organism *Pseudoperonospora cubensis*, is most destructive to cucumber and cantaloupe, though all cucurbits are susceptible. Symptoms first appear as pale green areas on the upper leaf surfaces. These change to yellow angular spots. A fine white-to-grayish downy growth soon appears on the lower leaf surface. Infected leaves generally die but may remain erect while the edges of the leaf blades curl inward. Usually, the leaves near the center of a hill or row are infected first. The infected area spreads outward, causing defoliation, stunted growth, and poor fruit development. The entire plant may eventually be killed (1, 2).

The fungus is easily carried by wind currents, rain splash, farm implements, or the hands and clothes of farm workers. It is favored by cool to moderately warm temperatures, but tolerates hot days, although long periods of dry hot weather can stifle the spread of the disease (3). Unlike powdery mildew, it requires humidity to flourish. Therefore, downy mildew is most aggressive when heavy dews, fog, and frequent rains occur (1, 2).

Downy mildew does not overwinter beyond Mexico and the southernmost tier of U.S. states, where it survives on cultivated and wild cucurbit plants. Spores are blown northward each season as favorable seasonal conditions advance. As a result, the disease is most common on late summer plantings and is infrequently seen on spring cucurbits (4).

Monitoring

Keeping abreast of when, and how severely, downy mildew is occurring in your area can help you determine the proper time to treat it. The North American Plant Disease Forecast Center is an online forecasting network that tracks outbreaks of downy mildew from March through the end of the growing season. Data is posted twice weekly. Growers can use the website to identify areas where an outbreak is reported, as well as spore movement in that area. The site also offers information on control measures, photos, and more. Because the website relies on growers and others to report the outbreaks, it isn't comprehensive or foolproof. It is, however, a useful monitoring tool. The website is located at <<http://www.ces.ncsu.edu/depts/pp/cucurbit/>>.

Resistant Varieties

One of the principal means of managing downy mildew in cantaloupe and cucumber is the use of genetically resistant cultivars. Resistance has not been developed in other cucurbits, though some squash varieties like Super Select and Zucchini Select are considered to be tolerant (5), as are cucumber varieties like Poinsett and Galaxie (6). The Virginia Extension publication *Downy Mildew of Cucurbits* (3) identifies other resistant cucumber cultivars. Growers are advised to contact Coopera-

ATTRA is the national sustainable agriculture information service, operated by the National Center for Appropriate Technology through a grant from the Rural Business-Cooperative Service, U.S. Department of Agriculture. These organizations do not recommend or endorse products, companies, or individuals. NCAT has offices in Fayetteville, Arkansas (P.O. Box 3657, Fayetteville, AR 72702), Butte, Montana, and Davis, California.



tive Extension and local seed suppliers for assistance in selecting resistant varieties that also perform well in their location.

Cultural Controls

Because this disease is carried to most fields on light winds, cultural practices like crop rotation and sanitation have a limited effect on the incidence of downy mildew. Still, there are several things that growers can do to suppress the disease. Growing vigorous plants, capable of withstanding or repelling disease onslaughts, is the first step. This involves careful irrigation and soil fertility management. ATTRA's publications on soil management and related matters include *Sustainable Soil Management*, *Manures for Organic Crop Production*, *Alternative Soil Amendments*, and *Sources of Organic Fertilizers and Amendments*.

Good soil fertility management can often be backed up with foliar fertilization, which some growers believe can assist in pest resistance. For additional information see the ATTRA publication *Foliar Fertilization*.

Further cultural considerations include selecting growing sites with good air drainage, full sunlight, and low humidity. Using drip irrigation, or scheduling overhead irrigation to avoid excessive leaf wetness, will also reduce disease incidence. When detected early, disease spread might be slowed somewhat by removing and destroying infected plants, and by taking care not to transport the disease by hand or on infected tools and equipment.

Alternative Pesticides

Along with resistant varieties, fungicides are considered the principal means of downy mildew control in cucurbits. There are several alternatives to synthetic fungicides. Be certain to use all pesticides, synthetic or natural, according to label instructions.

Copper

Copper-based fungicides have traditionally been recommended for suppressing downy mildew in organic production systems. Caution is advised, however, as copper can be phytotoxic to cucurbits. Crop damage appears to be most common during periods of cool wet weather—precisely the conditions in which downy mildew thrives (7). As a result, it is suggested that the most dilute application recommended for each product be followed (5).

The use of copper fungicides in organic production is somewhat controversial. Copper is a *regulated* material in organic production. Though an essential plant nutrient in small amounts, fungicidal levels of copper are directly toxic to some beneficial organisms such as earthworms and several soil microbes such as blue-green algae—an important nitrogen-fixer in many soils. Excessive use can also result in the buildup to toxic (crop-damaging) levels in the soil—particularly in climates where little to no leaching occurs. Thus, growers who use these sprays frequently must monitor soil copper levels through regular soil testing.

Neem Oil

Neem oil is a botanical pesticide derived from the tree species *Azadirachta indica*. It is a multi-purpose insecticide, miticide, and fungicide labeled for control of both downy and powdery mildews on cucurbits (8).

Neem products, once considered largely benign to beneficial insects, have demonstrated some negative impacts. Washington State research has found neem to be toxic to ladybeetles, especially in their early larval stages (9). Being an oil formulation, neem can also harm bees and should be applied when they are not active in the field (10). Therefore, while neem oil is suitable for organic production, it should not be used without clear need and plenty of caution.

For information on and sources of Trilogy 90EC™, a formulation of neem oil, contact Certis USA, LLC (11).

Biofungicides

Serenade™, a relatively new fungicide based on the biocontrol agent *Bacillus subtilis*, is available in a wettable powder formulation that can be used for downy mildew control on vegetables (12). According to its manufacturer, Serenade turns on the plant's natural immune system. It is also said to:

"...stop plant pathogen spores from germinating, disrupt the germ tubes and mycelial growth and inhibit attachment of the plant pathogen to the leaf by producing a zone of inhibition restricting the growth of...disease causing pathogens" (13).

For sources of the product, contact the manufacturer, AgraQuest Inc. (14).

Peroxides

Organic growers and others in alternative agriculture have often mentioned hydrogen peroxide (H₂O₂) as a disease preventive for crops (15). While documentation on the use of food- and/or pharmacy-grade peroxide in managing plant diseases is sketchy, BioSafe Systems has recently released a peroxigen formulation under the name of OxiDate™, which is labeled as a broad-spectrum bactericide and fungicide. Downy and powdery mildews of cucurbits are among the diseases it is said to control. Among the listed benefits are biodegradability, little to no phytotoxicity, and the ability to kill fungal spores on contact (16).

Although the Organic Materials Review Institute (OMRI) had previously approved OxiDate for organic production, it removed the product from its listing in spring 2002 because of non-compliance with federal regulations. If reformulated, it may be approved again in the future. Contact BioSafe Systems (17) for additional details.

Bicarbonates

In 1998, Church & Dwight Co. (18)—the manufacturer of Arm & Hammer Baking Soda™—received EPA registration for Armicarb 100™, a potassium bicarbonate formulation, for use against downy and powdery mildews, botrytis, and alternaria leaf-spot (19). This product is the direct result of research done at Cornell and funded by Church & Dwight. Armicarb 100 is now available from Helena Chemical Company (20) and Agri-Turf Supplies (21). Similar products are FirstStep™ by the Cleary Chemical Corp. (22), Kaligreen™ by Monterey Chemical (23), and Remedy™ by Bonide Products Inc. (24). For additional information on the use of bicarbonates in plant disease management, request ATTRA's *Use of Baking Soda as a Fungicide*.

Compost Tea

Though still somewhat experimental, compost teas have proved successful in managing a number of plant diseases. For details, please request the ATTRA publication *Notes on Compost Teas*.

References

1. Motes, Jim et al. 1986. Cucurbit Production and Pest Management. Circular E-853. Cooperative Extension, Oklahoma State University, Stillwater, OK. 40 p.
2. Bernhardt, Elizabeth et al. 1988. Cucurbit Diseases: A Practical Guide for Seedsmen, Growers & Agricultural Advisors. Petoseed Co., Saticoy, CA. 48 p.
3. Hansen, Mary Ann. 2000. Downy Mildew of Cucurbits. Publication Number 450-707. Virginia Cooperative Extension. <<http://www.ext.vt.edu/pubs/plantdiseasefs/450-707/450-707.html>>.
4. McDaniel, M.C. No date. Control Diseases of Cucurbits. Cooperative Extension, University of Arkansas, Fayetteville, AR. 6 p.
5. Ellis, Barbara W. and Fern Marshall Bradley. 1992. The Organic Gardener's Handbook of Natural Insect and Disease Control. Rodale Press, Emmaus, PA. 534 p.
6. Kucharek, Tom. No date. Downy Mildew of Cucurbits. University of Florida Cooperative Extension Service. <<http://edis.ifas.ufl.edu/VH006>>.
7. Cowall, Matt and May Hausbeck. 1995. Copper fungicide disease control options. Vegetable Update. Cornell Cooperative Extension of Oswego County, NY. July 25. p. 11.
8. Meister, Richard et al. (editors). 1999. The All-Crop, Quick Reference Insect and Disease Control Guide. Meister Publishing Co., Willoughby, OH. p. 58.
9. Banken, Julie and John Stark. 1998. Multiple routes of pesticide exposure and the risk of pesticides to biological controls: A study of neem and the seven-spotted lady beetle (Coleoptera: Coccinellidae). Journal of Economic Entomology. Vol. 91, No. 1. p. 1-6.
10. Anon. 1999. 1999 Main Catalog. Peaceful Valley Farm Supply, Grass Valley, CA. p. 91.
11. Certis USA
LLC 9145 Guilford Rd.
Ste. 175
Columbia, MD 21046
Tel: 800-847-5620
Fax: 301-604-7015
<http://www.thermotrilogy.com/>
12. Fravel, Deborah. 1999. Commercial Biocontrol Products for Use Against Soilborne Crop Diseases. January 1. <<http://www.barc.usda.gov/psi/bpdl/bpdlprod/bioprod.html>>.

13. AgraQuest website. No date. < www.agraquest.com/agrochemical/professional-products/rhapsody.php>.
14. AgraQuest, Inc.
1530 Drew Ave.
Davis, CA 95616-1272
Tel: 530-750-0150
Fax: 530-750-0153
E-mail: info@agraquest.com
<http://www.agraquest.com>
15. For example, market gardeners Ward Sinclair and Cass Peterson made claims for successful disease control using hydrogen peroxide on tomatoes and peaches. These claims are cited in: Hofstetter, Bob. 1993. Homemade pesticides. The New Farm. February. p. 14-16.
16. BioSafe Systems. No Date. OxiDate Product Literature. BioSafe Systems, Glastonbury, CT.
17. BioSafe Systems
36 Commerce St.
Glastonbury, CT 06033
Tel: 888-273-3088
Fax: 860-657-3388
E-mail: info@biosafesystems.com
<http://www.biosafesystems.com>
18. Church & Dwight Co., Inc.
469 N. Harrison St.
Princeton, NJ 08543-5297
Tel: 609-683-5900
19. Anon. 1998. EPA approves reduced-risk fungicide. The Grower. December. p. 8.
20. Helena Chemical Co.
Tel: 901-748-3200
<http://www.helenachemical.com/products/Pages/products.aspx>
21. Agri-Turf Supplies Inc.
2257 Las Positas Rd.
Santa Barbara, CA 93105
Tel: 800-922-9634
Fax: 805-569-0073
E-mail: info@rosecare.com
<http://store.yahoo.com/rosecare1/pea20.html>
22. Cleary Chemical Corp.
178 Ridge Road
Dayton, NJ 08810
Tel: 800-524-1662
<http://www.clearychemical.com>

23. Monterey Chemical Co.
P.O. Box 35000
Fresno, CA 93745-5000
Tel: 559-499-2100
Fax: 559-499-1015
E-mail: info@montereychemical.com
<http://www.montereychemical.com>
24. Bonide Products Inc.
6301 Sutliff Rd.
Oriskany, NY 13424
Tel: 315-736-8231
Fax: 315-736-7582
E-mail: customerservice@bonide.com
<http://www.bonideproducts.com/>

Additional Resources

What do Organic Gardeners do about Mildew?
Irish Organic Farmers and Growers Association

http://www.organicmattersmag.com/features/what_do_organic_gardeners_do_about-mildew.htm

Explains mildew types, resistant varieties, and control measures.

Downy Mildew of Cucurbits
University of Illinois Extension

<http://urbanext.illinois.edu/hortanswers/detailproblem.cfm?PathogenID=135>

Provides a good overview of downy mildew, including information on symptoms, disease cycle, and control.

By **George Kuepper**
NCAT Agriculture Specialist

Edited by **Richard Earles**
Formatted by **Cynthia Arnold**

March 2003

The electronic version of **Downy Mildew Control in Cucurbits** is located at:

HTML

<http://www.attra.ncat.org/attra-pub/downymildew.html>

PDF

<http://www.attra.ncat.org/attra-pub/PDF/downymil.pdf>

CT111