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FACT SHEET

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Managing Downy Mildew in Organic and Conventional Vine Crops

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Downy mildew can be a serious disease on any vine crop, but may be especially devastating to cucumbers where the appearance of initial symptoms and complete defoliation may be separated by only a few days.

Symptoms

Downy mildew causes a variety of symptoms depending on cucurbit type. On cucumber, water-soaked lesions on the underside of the leaf are often observed first. Yellow, irregularly shaped lesions confined by the small leaf veins appear soon after on the top of the leaf. These lesions then turn brown and may drop out of the leaf. The "checkerboard" arrangement of lesions is characteristic of cucumber downy mildew. Symptoms normally appear 4–12 days after infection. On cantaloupe, the somewhat angular lesions tend to have a yellow halo around them. On watermelon, the spots may or may not be angular, normally turning brown or black with the leaf developing an upward curl. On pumpkins and winter squash, the symptoms may resemble powdery mildew, causing a yellow spotting that tends to brown out. As the lesions age, they usually become necrotic on all types of cucurbits and

Figure 1. Initial downy mildew symptoms on cucumber

Figure 2. Advanced downy mildew symptoms on cucumber

Figure 3. Downy mildew symptoms on cantaloupe

Figure 4. Downy mildew symptoms on watermelon

the leaves often senesce. This dieback is normally first noticed on the oldest leaves near the center of the plant.

Regardless of the variability in appearance of the leaf lesions among the different cucurbits, the one similarity and diagnostic sign is the presence of purplish-gray sporangia on the bottom side of the leaf within the lesions. These are most readily observed when conditions are cool and moist, with or without the aid of a hand lens. They may also appear when an infected leaf is placed in a closed plastic bag with a damp paper towel for 12–24 hours. The leaves are the only portion of the plant directly affected by downy mildew, though the resulting loss in leaf surface can cause loss of yield, misshapen fruit, and sunscald.

Causal Organism

Downy mildew is caused by *Pseudoperonospora cubensis*, an oomycete pathogen more closely related to water molds such as Phytophthora than to true fungi. There are multiple pathotypes of *P. cubensis*; watermelons, pumpkins, and squash are incompatible with several pathotypes, while cucumbers and cantaloupe are susceptible to them all. There are also several strains within each pathotype, to which various cultivars of each type of cucurbit show varying degrees of susceptibility. *P. cubensis* can survive and sporulate only on green (living) tissue of the host, and therefore cannot naturally overwinter north of Mexico or the southernmost extremes of the United States.

Figure 5. Downy mildew symptoms on pumpkin

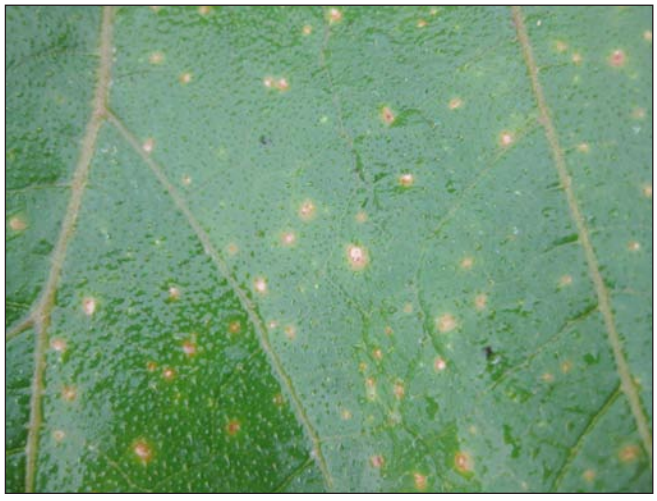

Figure 6. Close-up of downy mildew on pumpkin

Figure 7. Purplish-gray sporangia on the bottom side of a cucumber leaf

Sporangia are the reproductive structures and also spread the disease on wind currents. Sporangia are produced on the undersides of the leaves when conditions are humid and nighttime temperatures are between 55 and 75 degrees F. The transport and survival of these sporangia are highly dependent on weather conditions. Cloudiness is especially important as direct sunlight or excessive UV light can cause the sporangia to desiccate. Rainfall can also wash the sporangia out of the air if it occurs before the sporangia travel much of a distance from source area, or it may help to deposit them in production fields. Upon deposition of the sporangia on a leaf surface, the absence of free moisture on the leaf may prevent infection, though only 2–6 hours of free moisture are required. Likewise, temperatures outside of the acceptable range for infection (41–82 degrees F) may also inhibit infection.

For many years, downy mildew was not reported in Ohio cucurbit fields until late August or September, being dependent on remnants of hurricanes to carry the spores northward. Presence of the disease was often considered inconsequential as many crops were considered mature, and the loss of leaf surface at that point did little to reduce the yield of crops such as pumpkins. For late cucumber or melon plantings, fungicides could be applied for control measures. More recently, cucurbit downy mildew has been reported as early as late June, possibly due to overwintering of the disease in greenhouses in northern North America or use of transplants produced in the southern United States or northern greenhouses. New strains of downy mildew have also developed that are resistant to commonly used fungicides, and have overcome the genetic resistance of some cultivars. These midseason infections have resulted in heavy yield losses where preventive measures have not been taken.

Management

Cultural Practices

The same cultural control measures are suggested as part of an IPM effort whether a crop is conventional or organic, in that they may help to reduce or delay the chances of an initial infection.

1. Despite some strains of downy mildew overcoming currently available genetic resistance, the use of disease-resistant or tolerant cultivars is still highly recommended as some degree of resistance remains. A list of these can be found at the North Carolina State University Cucurbit Breeding web site at http://cuke.hort.ncsu.edu/cucurbit/cuke/cukemain.html.
2. Select growing sites with good air drainage, full sunlight, and low humidity.
3. Avoid overhead irrigation to prevent leaf wetness.
4. Insure adequate, but not excessive fertility.
5. Monitor the crop frequently, and make use of the North American Plant Disease Forecast Center at http://www.ces.ncsu.edu/depts/pp/cucurbit to monitor reports of downy mildew throughout the country. Local updates are also available on VegNet (http://www.ag.ohio-state.edu/~vegnet/).
6. If early in a downy mildew epidemic, removal of infected plants may help to slow the spread of the disease. When doing this, make sure not to spread the disease by hand or infested equipment.

Chemical Control

For conventional growers, it is suggested that protectant fungicides be applied on a 7–10 day schedule upon emergence of the seedling or transplanting. When downy mildew is detected in the area, a curative-type fungicide should be added to the spray mixture

and the spray schedule should be shortened to 5–7 days. Consult the *Ohio Vegetable Production Guide* (OSU Extension Bulletin 672) for recommendations and make sure to rotate fungicides with different modes of action.

For organic growers, there are several alternative fungicides labeled for cucurbit downy mildew, including copper-based fungicides. Growers should be cautious in applying copper, as it can be phytotoxic to cucurbits, and high levels in soil are toxic to earthworms and other beneficial organisms. Phytotoxicity is most common during cool, moist conditions, which are also the most favorable for downy mildew. A list of the other alternative fungicides can be found at the National Sustainable Agriculture Information Services "Downy Mildew in Cucurbits" web page at http://attra.ncat.org/attra-pub/downymildew.html#ref4. Make sure to check with OMRI http://www.omri.org and your organic certifier to determine if the suggested products are currently considered acceptable for organic production.

Resources

"Downy Mildew in Cucurbits," National Sustainable Agriculture Information Service, http://attra.ncat.org/attra-pub/downymildew.html#ref4

North Carolina State University Cucurbit Breeding Program, http://cuke.hort.ncsu.edu/cucurbit/cuke/cukemain.html

"Cucurbit Downy Mildew Forecast Home," North American Plant Disease Forecast Center, http://www.ces.ncsu.edu/depts/pp/cucurbit

"Update on Managing Downy Mildew in Cucurbits," Vegetable MD Online, Cornell University, http://vegetablemdonline.ppath.cornell.edu/NewsArticles/Cuc_Downy.htm

"Cucurbit Downy Mildew Caused by Pseudoperonospora cubensis," Extension Collaborative Wiki, http://collaborate.extension.org/wiki/Cucurbit_Downy_Mildew_Caused_by_Pseudoperonospora_cubensis

Acknowledgments

All photos by Sally A. Miller.