

Downy Mildew of Hop

Pseudoperonospora humuli

QUICK FACTS ABOUT DOWNY MILDEW

- Downy mildew is the most notable disease of hop production in Michigan.
- Caused by a fungus-like organism called *Pseudoperonospora humuli*
- Can cause significant yield and quality losses or even crown death
- Mild temperatures (60-70°F) and regular rainfall provides ideal growth conditions for the fungus.
- Growers need to scout consistently, purchase disease-free plant material, select less susceptible cultivars and utilize a protectant fungicide management strategy to limit severe infections.

DISEASE CYCLE

The causal agent of downy mildew, *Pseudoperonospora humuli*, overwinters in dormant buds or crowns and may move into the basal spikes as shoots expand in the spring. Infected crowns may produce uninfected shoots as well. The pathogen produces copious spores on the underside of infected leaves which infect new tissue through the stomata. Buds, growing points, cones and leaves are all susceptible to infection. Leaf infections produce a second source of spores which can infect all parts of the plant but typically this leaf sporulation desiccates under dry conditions. Infections occurring on the terminal growing point become systemic and can also produce spores, further contributing to the spread of infection. Once the fungus has become systemic, it grows down the plant toward the crown and can persist in the buds and crown for a prolonged period. The fungus can also produce a resting spore and overwinter but it is unclear how substantially these resting spores contribute to infection and how readily they are produced under Michigan conditions.

Infection is favored by mild to warm temperatures (60-70 °F) when free moisture is present for 1.5 hours, leaf infection can also occur at temperatures as low as 41 °F when wetness persists for 24 hours or longer.

SCOUTING

Scouting and monitoring for downy mildew is a critical step in determining if intervention is warranted, what level of intervention is warranted, and whether or not previous management practices have been effective. Scouting for downy mildew involves monitoring the crop for signs and symptoms of disease. Growers should keep records of their scouting, including maps of their fields, a record of sampling and disease pressure, as well as the control measures utilized. Scouting for downy mildew should begin as soon as plants begin to grow and should continue until the crop is dormant.

Section your farm off into manageable portions based on location, size and variety and scout these areas separately. It is more practical to deal with blocks that are 10 acres or smaller and that contain plants of the same variety, age and spacing.



A. Stunted downy mildew infected spike with sporulation. B. Downy mildew infected bine with cupped leaves failing to climb the string. C. Downy mildew sporulating on the underside of a leaf. Photo credit: Erin Lizotte, Michigan State University.

diagonally across the yard when scouting to ensure you view plants from both the edge and inner portion of the block. Change the path you walk each time you scout to inspect new areas. Reexamine hotspots where you have historically encountered high downy mildew pressure. Weekly scouting is recommended.

MANAGEMENT

Unfortunately, even when we follow best management practices, downy mildew can take us by surprise due to high disease pressure, poor fungicide timing, suboptimal spray coverage, fungicide wash-off due to rain, cultivar susceptibility or a combination of factors. In addition, fungicide resistance may play a role in some cases.

Cultural control

It takes a multipronged approach to manage for downy mildew. Growers should utilize a protectant fungicide management strategy to mitigate the risks of early and severe infections but can also utilize cultural practices to reduce disease. Keep in mind that varieties vary widely in their susceptibility to downy mildew and select the more tolerant varieties when possible (see table). Clean planting materials should be used when establishing new hop yards since this disease is readily spread via nursery stock. Growers should consider purchasing a few plants from prospective nurseries and have them tested for downy mildew before committing to a large numbers of plants, particularly if the grower hasn't worked with the nursery before.

To minimize disease spread, it is also recommended that growers pull all basal foliage during spring pruning. Spring pruning should be performed as late as possible and all green materials should be removed from the hopyard and covered up or burned. Early harvest can also minimize cone infection when infection pressure is high.

If disease is already present in the yard, diseased shoots on the string should be removed by hand and healthy shoots retrained in their place. Remove superfluous basal foliage and lower leaves to promote air movement in the canopy and to reduce the duration of wetting periods. If there is a cover crop, it should be mowed close to the ground. If yards have no cover crop, cultivation can help to dry the soil and minimize humidity. Keep nitrogen applications moderate.

Chemical control

Apply fungicide treatments on a protectant basis as soon as vines emerge in the spring regardless of the presence or

absence of visible symptoms of downy. Applications should continue season long on a 7-10 day reapplication interval until harvest. The time between applications may stretch longer when the weather is dry and if hopyards don't have active infections. Several periods in the season are particularly critical for disease control: immediately before and after training; when lateral branches begin to develop; bloom; and cone development. Covering young, developing bracts before cones close up is critical to protecting against downy mildew when conditions for disease are favorable. Getting adequate coverage on undersides of bracts where infection occurs becomes increasingly difficult as cones mature. If needed, growers should be prepared to apply post-infection treatments. Refer to the current list of registered fungicides at www.hops.msu.edu for more information.

Organic

Organic growers have fewer options and will need to focus on keeping tissue protected, selecting downy mildew tolerant varieties and following cultural practices to limit downy infection. Copper-based products are the mainstay of downy mildew management in organic hopyards and offer 5-7 days of protection but no post-infection activity. The pre-harvest intervals for copper formulations vary, refer to the label. Additional organic products are available, for a complete list refer to the current hop pesticide guide at www.hops.msu.edu.

DOWNY vs. POWDERY

Growers are cautioned from confusing downy with powdery mildew of hop, they are separate pathogens. Powdery mildew is caused by *Podosphaera macularis*, and is not as prevalent in Michigan as the downy mildew pathogen in Michigan at this time. Downy mildew and powdery mildew are controlled by different classes of fungicides, making the determination between these two pathogens critical to proper management.

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Powdery mildew on hop, cause by Podosphaera macularis. Phot credit David Gent, USDA-ARS.