

College of Food, Agricultural, and Environmental Sciences, Department of Plant Pathology

# Hop Downy Mildew

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Downy mildew is the most wide spread and destructive disease of hops (*Humulus lupulus*) in the Midwest and Northeastern United States. Downy mildew is caused by the fungal-like pathogen *Pseudoperonospora humuli* and is most severe during wet weather and mild temperatures. The disease is systemic and can cause significant yield and quality losses annually

## Disease Development and Symptoms

The downy mildew pathogen survives the winter in dormant buds, crowns or plant debris in the soil and can move systemically into the basal spikes in the spring. Diseased spikes are stunted, pale green and brittle (**Figure 1**). On the upper side of the leaves angular chlorotic (yellow) spots (**Figure 2A**) form and these spots eventually turn brown and have a crusty appearance. Dark purple to black colored spores (sporangia) are produced on the underside of leaves (**Figure 2B and 2C**) during wet or foggy weather and when temperatures are between 60-70 °F. Spores are wind dispersed and can initiate new infections on new leaves, aerial spikes (**Figure 2D**), flowers, and cones. On the upper side of the leaves angular chlorotic (yellow) spots form and these spots eventually turn brown and have a crusty appearance. Infected flower clusters shrivel, turn brown and dry out. Cones begin to turn brownish grey at the base of the bracteoles.

## Hop Downy Mildew Management

Hop downy mildew is best managed by integrating resistant varieties, cultural practices, and chemical control.

### Variety selection

Selecting cultivars that are highly or moderately resistant to downy mildew is the ideal method for controlling hops downy mildew. Backyard and organic growers are strongly encouraged to plant resistant cultivars in order to reduce or eliminate the need for fungicide applications. There are many public hop cultivars that are resistant or moderately resistant to downy mildew (Table 1). However, some of the more popular cultivars grown in the Midwest including 'Cascade', 'Chinook', 'Nugget', and 'Galena' are susceptible to downy mildew. Purchase rhizomes or starter plants from a reputable propagator or nursery that uses best propagation, sanitation and other integrated disease management strategies.



**Figure 1.** Downy mildew symptoms on basal spikes. Image on the left courtesy of Erica Goodman, Goodmanor Farm.



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Table 1. Cultivars with resistance to downy mildew.

<b>Resistance</b>	Hall Gold, Hall Magnum, Hall Tradition, New Port, Perle, Spalter
<b>Moderate resistance</b>	Columbia, Fuggle, Sterling, Teamaker, U.S. Tettnanger, Wilamette
<b>Low resistance</b>	Olympic, Saazar, Saazar 36

**Cultural practices**

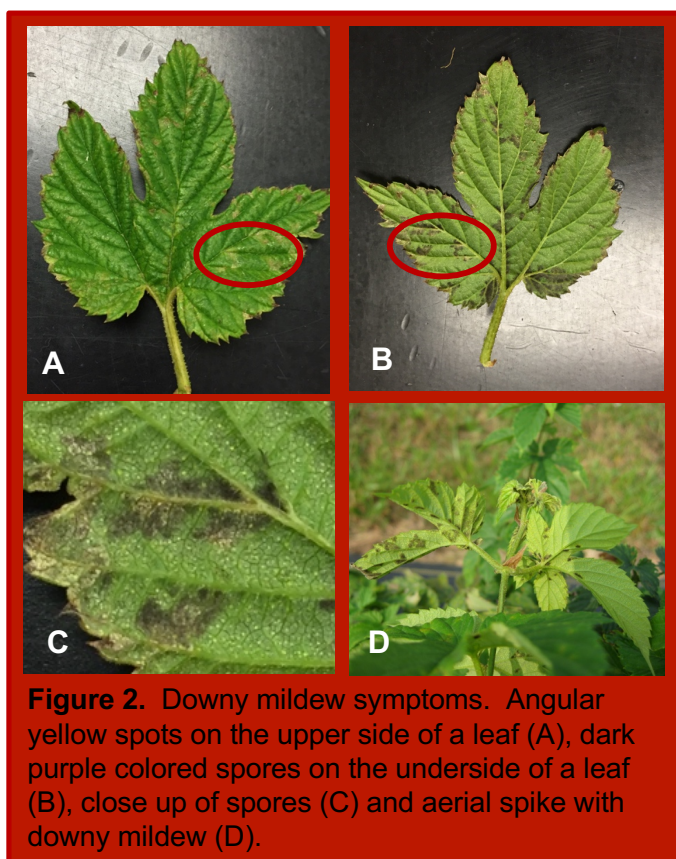
In the spring, basal foliage should be cut off of the crown, removed from the hop yard and destroyed. Basal tissue can also be burned back before training to kill infected spikes and reduce the spread of spores. Bines should be trained early to prevent them from coming into contact with the soil and diseased aerial spikes should be removed and destroyed. Remove lower leaves (up to 4 ft), suckers and weeds beginning in early spring and continuing throughout the season to promote air movement through the canopy and reduce humidity within the canopy. If cones were not harvested (i.e. first year hops), bines and leaves should be removed and destroyed after a hard frost. Composting diseased plant tissue is not recommended unless proper composting techniques are used.

**Chemical and biological control**

The season long application of fungicides is the primary method to manage hop downy mildew in susceptible and some moderately resistant cultivars. Begin applications as soon as basal foliage appears in the spring and continue on a 7-to 10-day schedule throughout the season. The time between applications can be extended to 14 days when the weather is hot and dry, however the time between applications should not extend past 14 days. Critical periods in the

season for managing downy mildew include immediately before and after training and burr and cone development. Post-harvest fungicide applications may also be needed, especially if warm and wet weather persists into the fall.

Commercial growers can consult the Ohio Hop Disease Management Guide (Plant Pathology Series No. 155) for current fungicide recommendations and spray schedules. Backyard and organic growers have few options for controlling downy mildew using fungicides or biocontrol products. Copper-based products can be applied early in the season to prevent infections but are not effective once infections occur. Additional organic products including Actinovate AG, Regalia (extract of *Reynoutria sachalinensi*) and Sonata are labeled for use on hops but the efficacy of these products in Ohio is not known.



**Figure 2.** Downy mildew symptoms. Angular yellow spots on the upper side of a leaf (A), dark purple colored spores on the underside of a leaf (B), close up of spores (C) and aerial spike with downy mildew (D).