

# Hop Downy Mildew

## Identification and Management

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Hops are dioecious flowering plants in the Cannabaceae family and are indigenous to the temperate regions of the Northern Hemisphere. The primary use of hop cones is as a flavoring and preservative of beer.

Downy mildew is a serious disease of hop caused by the fungus-like organism *Pseudoperonospora humuli*. Damage is dependent upon cultivar susceptibility and weather conditions

during the growing season, but severe infection can lead to a complete loss in marketable yield.



Hop cones maturing in a Wisconsin hop yard

### Disease cycle

This pathogen overwinters within hop buds and crowns and moves up the plant during the growing season, infecting shoots, leaves, and cones.

### Ideal conditions

Environmental conditions favoring downy mildew include high moisture from rain, dew, and other sources, mild to moderate air temperatures (60–68°F), and high humidity (greater than 80–90%).



Microscopic view of hop downy mildew sporangiophore and lemon-shaped sporangia

Multiple stunted downy mildew spikes showing pale yellow-green leaves in the variety 'Santiam' in early June



## HOP DOWNY MILDEW

### Symptoms and effects Management

Symptoms of downy mildew first appear in the spring as infected shoots, often called “basal spikes.” These spikes are stunted and show chlorotic, yellow-green leaves that are brittle and curl downward. Lesions on the leaves appear angular and water soaked and are confined within leaf veins. Reproductive structures may form as a purple-gray to black downy, fuzzy growth. Infected cones become brown, shriveled, and dried-up.

Hop downy mildew can be managed by integrating cultivar selection, sanitation practices, appropriate harvest timing, and timely applications of fungicides.

Reducing the amount of time foliage is wet can help minimize the disease. Overhead irrigation should be avoided.

There are no hop cultivars that are completely immune to downy mildew. Moderately resistant cultivars include ‘Cascade’, ‘Fuggle’, ‘Perle’, ‘Tettnanger’, and ‘Willamette’. More susceptible cultivars include ‘Cluster’, ‘Galena’, and ‘Nugget’.

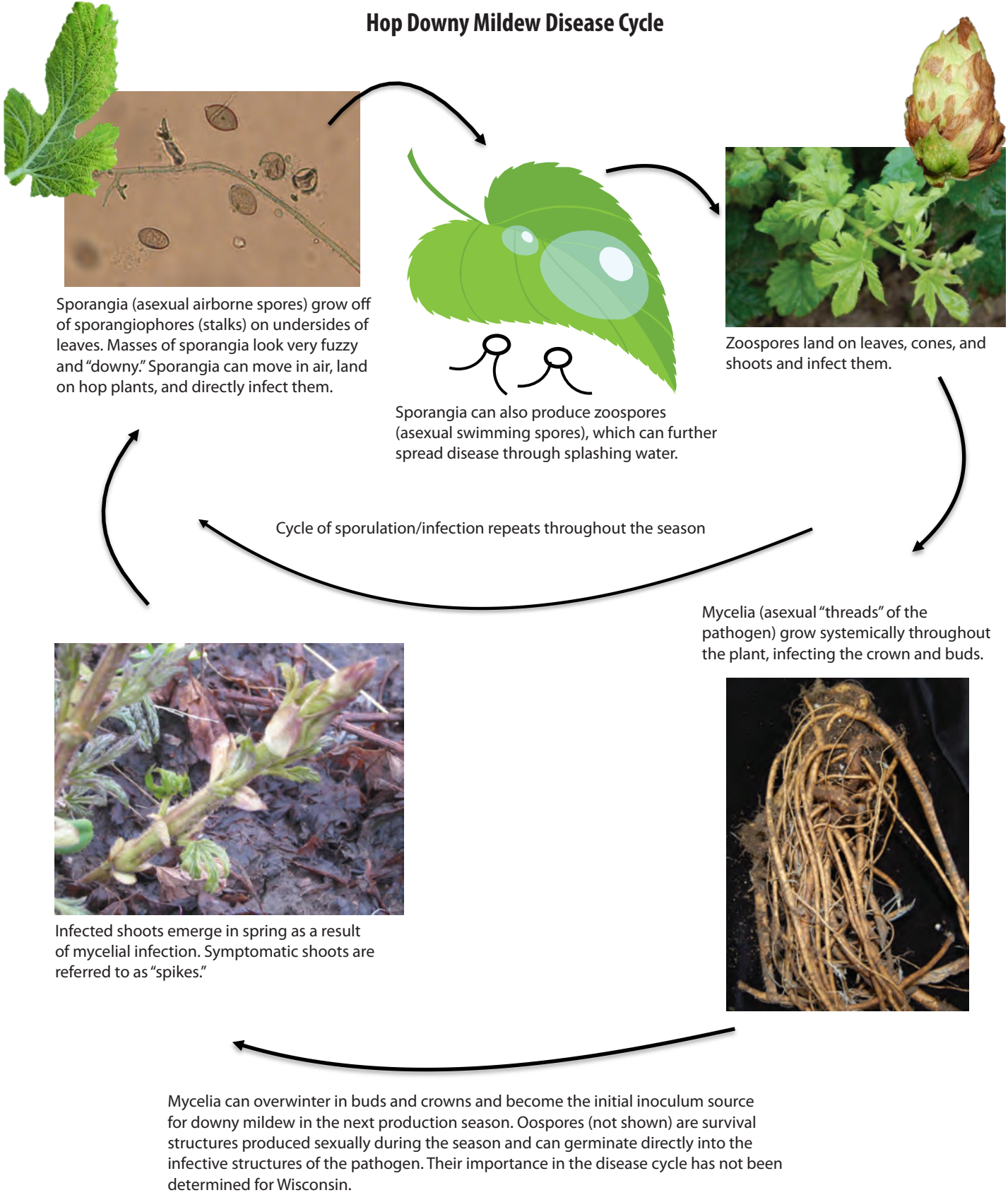
Selecting disease-free rhizome for planting is extremely important for reducing downy mildew within the hop yard. Heavily diseased plants should be removed early and the primary basal spikes eliminated. Stripping the foliage from the bottom of the plant after training can reduce inoculum density and prevent disease spread into the canopy. Fungicides should be applied prior to or soon after infection, and forecasting systems are in development to aid in fungicide timing decisions.



Leaf undersides showing typical gray-black sporulation (above) and angular, water soaked lesions (right).



### Hop Downy Mildew Disease Cycle



Sporangia (asexual airborne spores) grow off of sporangiophores (stalks) on undersides of leaves. Masses of sporangia look very fuzzy and "downy." Sporangia can move in air, land on hop plants, and directly infect them.

Sporangia can also produce zoospores (asexual swimming spores), which can further spread disease through splashing water.

Zoospores land on leaves, cones, and shoots and infect them.

Cycle of sporulation/infection repeats throughout the season

Mycelia (asexual "threads" of the pathogen) grow systemically throughout the plant, infecting the crown and buds.

Infected shoots emerge in spring as a result of mycelial infection. Symptomatic shoots are referred to as "spikes."

Mycelia can overwinter in buds and crowns and become the initial inoculum source for downy mildew in the next production season. Oospores (not shown) are survival structures produced sexually during the season and can germinate directly into the infective structures of the pathogen. Their importance in the disease cycle has not been determined for Wisconsin.



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