e-GRO Edible Alert

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Powdery Mildew Management 101

Though powdery mildew does not lead to total crop death in the way that many viral, bacterial, & other fungal pathogens often do, growers need to manage this disease. This article covers powdery mildew basics and tips for managing the disease in greenhouse-grown food crops.

"Powdery mildew" is the common name that we use to refer to a group of fungi that cause disease and similar symptoms and signs across a wide range of crops. If your crops are displaying a coating of white, dusty-looking growth on the upper leaf surface, chances are – you've got powdery mildew!

Overview & Life Cycle. Powdery mildew-causing fungi belong to the Ascomycete family; this family is also referred to as the "sac fungi." Some of the more commonly known plant diseases caused by members of this fungal family impact landscape ornamentals (ex. Dutch elm disease and "black knot") and apples (ex. apple scab), but powdery mildew-causing fungi have a very broad range of potential hosts.

Despite affecting a wide range of plant taxa and sharing signs and symptoms from plant to plant, powdery mildew fungi are generally very host-specific. That is to say – the chances of powdery mildew on lettuce infecting and causing disease on tomatoes in the same greenhouse are incredibly slim.

Powdery mildew fungi have relatively straight-forward means of reproducing. Survival structures formed at the end of the previous growing season (chasmothecia) persist on infected debris over the winter. They then produce ascospores at the

Fig. 1. Powdery mildew can infect a wide variety of greenhouse-grown food crops, including cucumber (*Cucumis sativus*; pictured above). Lower, mature leaves, such as the ones shown here, are often the first to exhibit signs of powdery mildew. Thus, scouting for this disease should begin in the lower canopy of any crop.

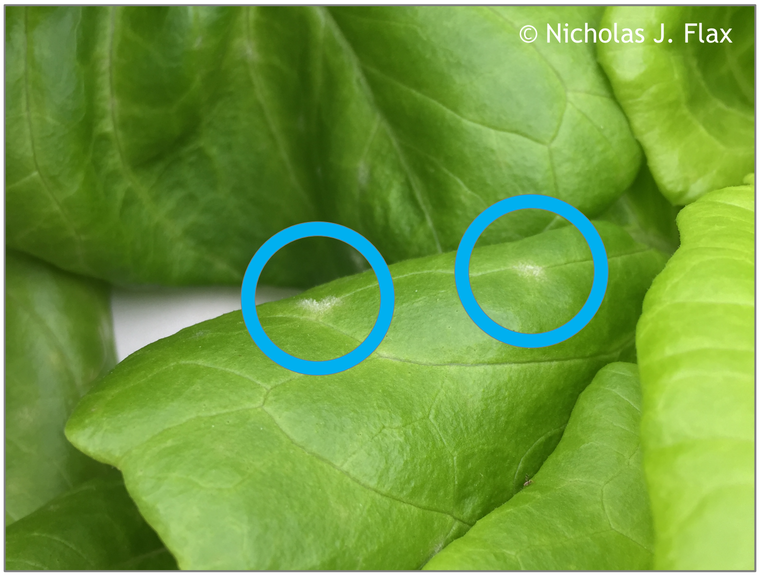

Fig. 2. Early detection of powdery mildew on high-value crops such as hydroponically grown butterhead lettuce (*Lactuca sativa* 'Rex'; above) is essential. Careful and frequent scouting is key to managing this disease early, especially on leafy crops (lettuce, greens, culinary herbs) under warm, humid conditions.

Overview & Life Cycle (cont). beginning of the growing season, which provide the primary source of infection in a given year. Once infection occurs, these fungi reproduce rapidly in infected tissue via asexual spores called conidia. These conidia are disseminated by wind and, in some cases, can be spread from plant to plant by insect pests (ex. wooly aphids).

Unlike fungi such as botrytis (aka "gray mold"), which need free-water to grow, powdery mildew spores germinate well under high humidity conditions. Optimum temperature for spore germination varies from species to species, but moderate to warm greenhouse temperatures provide ideal conditions for most powdery mildews.

*****Quick Review*****

Signs = Physical evidence of pathogen presence (ex. spore-producing structures)

Symptoms = Physiological indication of disease (ex. chlorosis, necrosis, etc.)

Signs, Symptoms, & Impact. Powdery mildew is most easily recognized by its signs. The white, powder-like growth that can be observed on the upper leaves of infected plants are hyphae (analogous to fungal "roots") and conidia.

Symptoms, on the other hand, are often less apparent and can take considerably longer to manifest than signs. Common symptoms include chlorosis of infected tissues, reduced yield of fruit, and overall slowed growth.

Though total crop death is virtually never observed, even when powdery mildew pressure is very high, this disease can significantly impact greenhouse food crop producers. Reduction in fruit yield of crops such as tomato, cucumber, and peppers can result from heavy powdery mildew infestation. Additionally, tolerance for disease signs and symptoms on leafy crops like herbs and greens are very low and can result in unsalable crops if infected at harvest.

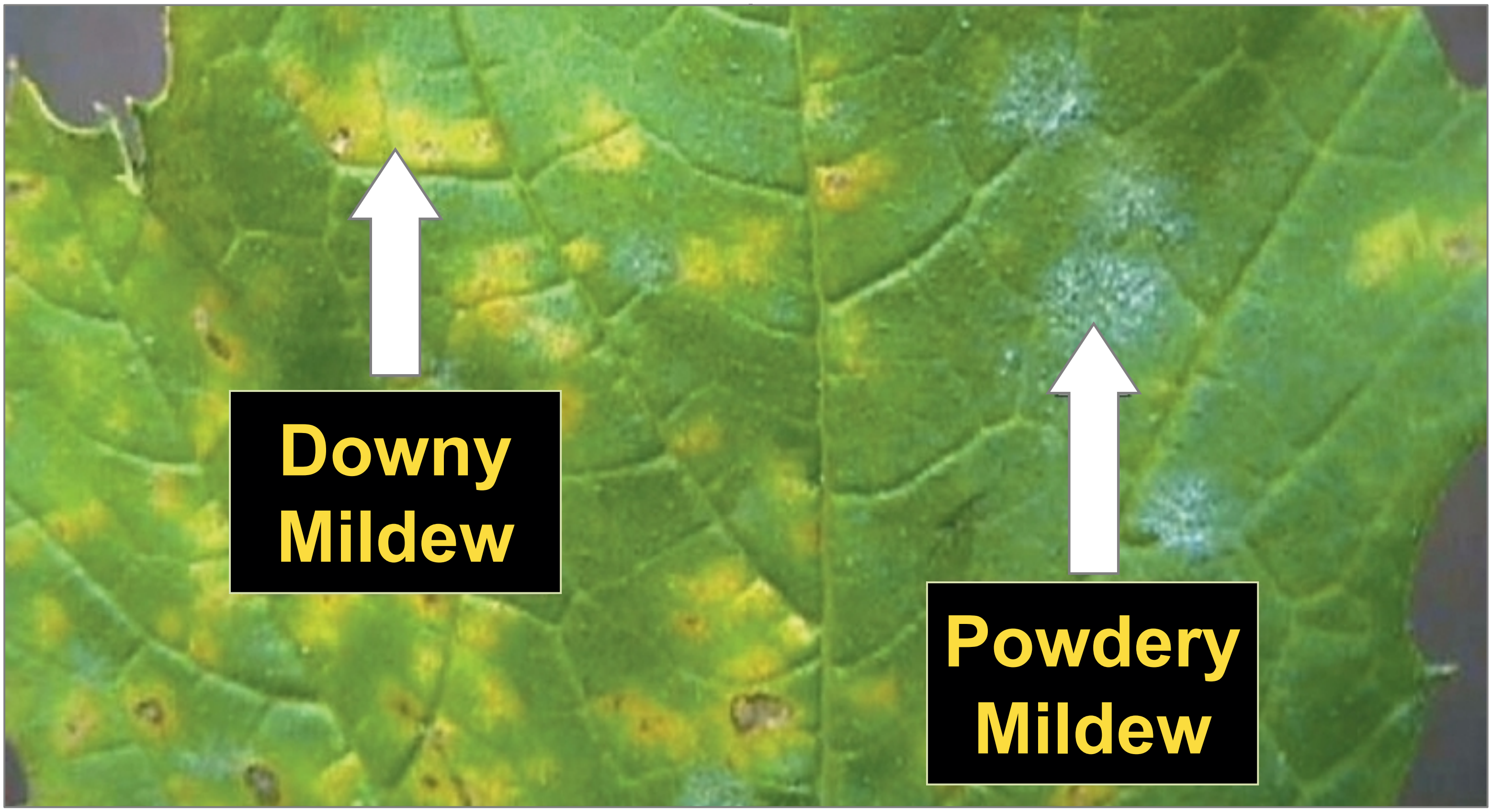

Fig. 3. Powdery and downy mildews have similar names, but their symptoms, signs, and the way they affect crops are notably different. The image above (courtesy of David B. Langston, University of Georgia [via Bugwood.org]) offers a great, side-by-side illustration of the two pathogens on a cucumber (*Cucumis sativus*) leaf. Classic powdery mildew signs (white hyphae and conidia) are present on the upper leaf surface on the righthand side, while characteristic downy mildew symptoms (splotchy, interveinal chlorosis) can be observed on the left. Signs of downy mildew (sporulating structures) can be observed on the undersides of leaves during advanced stages if the disease.

Downy vs. Powdery Mildew. Due to similar common names, powdery and downy mildew are sometimes confused with one another. However, the life cycles and ways the diseases impact plant health are quite different. Downey mildew is caused by members of the Oomycetes family – a group of devastating plant-pathogenic organisms referred to as "water molds." Common genera of downy mildew-causing pathogens in food crops include: *Bremia* (lettuce), *Pseudoperonospora* (cucurbits), *Plasmopara* (grapes), and *Sclerospora* (cereal crops). These pathogens, much like powdery mildew, proliferate under humid conditions, but prefer cooler temperatures than most powdery mildews.

Typical symptoms of downy mildew (splotchy foliar chlorosis) are often observed before or in parallel with presentation of signs. In contrast to powdery mildew, whose signs are more indicative of infection than a major problem, downy mildew signs are often the harbinger of total crop collapse. Downy mildew cannot be managed retroactively, and judicious monitoring of environmental and crop cultural parameters is essential to preventing infection. Chemical controls are available to help curb downy mildew but are only effective if application is timed properly and good coverage is achieved. In contrast, powdery mildew can be managed retroactively once signs are present and plants can make a full (or nearly full) recovery using a variety of strategies.

Management. Preventing powdery mildew spores from entering a greenhouse is basically impossible. Once airborne, no commercial pest screening is fine enough to physically exclude spores and installing HEPA filters at air intakes would be an incredibly cost-prohibitive means to curb the disease. As a result, managing crop cultural and environmental parameters, and/or using chemical and biological agents are the most effective options.

Reducing humidity in your greenhouse environment is the first step to managing powdery mildew. If your floors are porous or absorbent (ex. dirt or gravel), consider renovating with concrete or another non-porous material. Adjusting irrigation intervals in drain-to-waste vine crop production systems to minimize leachate on floors is another way to reduce relative humidity. For hydroponically grown leafy crops, be sure to cover any nutrient solution cisterns or reservoirs, and repair leaks diligently to reduce evaporation of water on floors. Increasing airflow with horizontal air flow (HAF) fans is another effective method for curbing powdery mildew. Finally, programming dehumidification cycles into your greenhouse environment controller and venting excess humidity throughout the day can be an effective strategy to reduce humidity if your controller has the capacity.

If the aforementioned strategies are not enough to create suboptimal conditions for powdery mildew, use of chemical or biological controls may be necessary. If conventional chemistries are your weapon of choice, be sure to review the label in detail. Factors such as pre-harvest interval may affect your ability to maintain harvest flexibility when applied. If your production model demands the use of "soft chemistries" or biological controls, there are many effective products on the market today. Potassium bicarbonate is a common active ingredient in "soft" powdery mildew control products, that discourages the disease by making the leaf surface inhospitable to ungerminated fungal spores. Microbial-based biocontrol products can similarly curb the disease preventively by colonizing the leaf surface and outcompeting germinating fungal spores, or by coating the leaf surface with naturally produced compounds that discourage spore growth. Remember to always check the label and confirm whether chemical or bio-controls are labeled for your intended crop.

Summary. Managing powdery mildew in greenhouse-grown food crops is critical to maximizing profits. If disease pressure is not managed appropriately, yield of fruit-bearing crops can decrease, and leafy crops may become unsalable. Reduce relative humidity, increase airflow, and employ chemical or biological controls if necessary.

Fig. 4. Increasing airflow in your production environment is an effective way to reduce powdery mildew pressure. Whether the number of horizontal air flow (HAF) fans or total air movement is increased, both are meaningful steps to reduce disease.

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