Martin-Gatton
College of Agriculture, Food and Environment
Cooperative Extension Service

Plant Pathology Fact Sheet **PPFS-GH-01**

Managing Greenhouse & High Tunnel Environmental Conditions to Reduce Plant Diseases

Nicole Gauthier
Plant Pathology Extension Specialist

Philip Konopka
County Extension Agent

Cheryl Kaiser
Plant Pathology Extension Support

Managing plant diseases in greenhouses and high tunnels is essential for the production of high-quality, marketable products. Unfortunately, the warm, humid environment in these structures can also provide ideal conditions for pathogens to infect, cause disease, and spread (Figure 1). While challenging, it is possible to manage greenhouse and high tunnel environments to simultaneously encourage plant growth and discourage disease development.

Relative Humidity & Temperature Management

Moisture and temperature are the primary drivers of disease development. They often work together to create conditions that are conducive to infection and disease spread.

Relative humidity (RH) is a measure of the amount of water vapor present in the air in relation to the maximum amount of water vapor the air can hold; it is expressed as a percentage.

Understanding the correlation between temperature and humidity can help growers manage greenhouse/high tunnel environments to reduce the risk of plant diseases. Given the same amount of moisture in the air (Figure 2):

- Warm air has the capacity to hold more moisture, so relative humidity goes down as temperatures warm.
- Cool air has less capacity to hold moisture, so relative humidity goes up as temperatures cool.

Excess water vapor in the air is released as dew or fog.

High relative humidity promotes development of many leaf, flower, and fruit diseases, including downy mildew and Botrytis gray mold. Maintaining daytime relative humidity levels below 70% is often low enough to inhibit disease. However, when humidity rises above 70%, especially for long periods, fungal disease incidence can increase. Bacterial and oomycete (water mold) diseases typically increase when relative humidity reaches 85% and above.

Not only does air temperature impact all aspects of plant development, but it also influences pathogen infection and disease progression. Unfortunately, temperatures ideal for plant growth can also be ideal for pathogens. However, proper management of relative humidity can help mitigate temperature effects.

Figure 1. Warm, humid conditions in greenhouses and high tunnels increase the risk of plant diseases, such as Botrytis gray mold. Pathogens that multiply on diseased tissues serve as sources of infectious material for further disease spread.

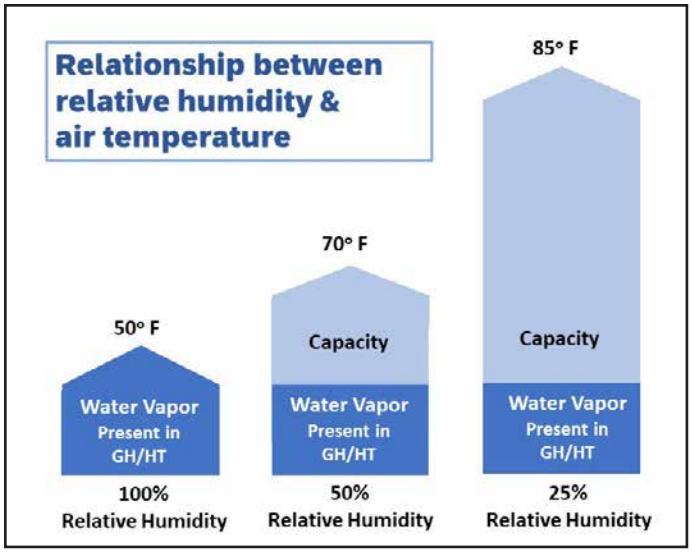

Figure 2. Relative humidity and air temperature are interconnected; as air temperature warms, the air has a greater capacity to hold moisture (water vapor). Understanding this relationship helps growers manage environmental conditions within greenhouse and high tunnel structures to minimize plant diseases.

The following practices help manage humidity and temperature.

Improve Air Circulation

Fans and/or air flow systems should operate continuously during periods of high humidity, which often occur during cool nights or during cloudy or rainy days. Exhaust fans can be used to circulate air in greenhouses and high tunnels when sides are closed.

Figure 3. When excess water vapor in the air is released, it can result in condensation on high tunnel sidewalls. Note the inset showing a close-up of condensation.

Heat and Vent

Exchange air in greenhouses and high tunnels with outdoor air to reduce internal relative humidity. This can be accomplished in heated greenhouses and high tunnels, as explained below.

Heated greenhouses

In winter, warmer daytime air traps moisture in structures, which is then released as condensation, dew, or fog as the air cools in the evening/night (Figure 3). This condensation can be reduced significantly with late afternoon ventilation, in which fans exhaust warm, moist air from the greenhouse, replacing it with cooler outdoor air. When this fresh air is heated, it becomes much drier and less favorable for disease development.

High tunnels

As with greenhouses, winter and spring conditions in high tunnels are conducive to increased internal humidity. High tunnels typically lack fans, so ventilation is manipulated by opening sidewalls and/or endwalls (Figure 4). For new construction, choose a site with good air flow to facilitate ventilation. Prevailing winds should dictate orientation of vents.

Figure 4. Ventilating high tunnel (**A**) and greenhouse (**B**) structures is important to reducing internal relative humidity. High humidity encourages the development of many diseases, such as downy mildew and leaf mold.

Increase Plant Spacing

Closely spaced plants with overlapping crop canopies can create microclimates with higher relative humidity than the surrounding air. Crowded plantings are typically the first sites for disease development. Plant spacings should allow for air movement during all stages of growth. Wider spacing enables plant tissues to dry more quickly and helps to maximize spray coverage if fungicides are required.

The following situations can also contribute to high humidity and reduced airflow in crop canopies:

- Hanging baskets placed overhead, which reduce normal water evaporation (Figure 5).
- Bushy or suckered plants with insufficient spacing, especially if plants are not pruned regularly.
- Determinate tomatoes with suckers and old leaves (up to first bunch of fruit) that have not been removed.
- Lack of trellising for vining crops.

For specific recommendations on vegetable spacing, see *Vegetable Production Guide for Commercial Growers* (ID-36).

Monitor Air Temperature

Continuous monitoring of indoor temperatures is essential to maintaining optimal conditions for plant growth. Temperatures outside the normal range for healthy plant growth can stress plants, making them more susceptible to disease. Plants can also become stressed when rapid temperature fluctuations occur in structures. Consult a local county Extension agent for optimal temperatures for specific greenhouse or high tunnel crops.

Water Management

Water management plays a critical role in the greenhouse environment and can directly impact disease incidence. As water evaporates from benches, floors, and potting media, the air becomes more humid. As discussed earlier, high relative humidities are conducive to infections by plant pathogens. In addition, many pathogens require “free water” (which can include relative humidity) to infect and reproduce. Wet tissues are often at risk for foliar or fruit diseases, and overly wet growing media favors the development of damping-off and root rot diseases. Additionally, many pathogens are spread from plant to plant by splashing water or flooded soil.

The following practices can aid in management of moisture in greenhouse and high tunnel systems.

Avoid Wetting Foliage

- Whenever possible, opt for drip irrigation instead of overhead irrigation to keep plant surfaces dry.
- If overhead irrigation is the only option, water early so foliage dries quickly.

Water Only as Needed

- Monitor plants closely and water judiciously, but only as needed. Variations in light levels, temperature, and humidity affect water requirements. For example, plants require less water during periods of cloudy weather. Also, plants arranged beneath overhead hanging baskets (Figure 5) dry more slowly than those exposed to bright light or full sun.
- Group plants with similar water requirements together to help avoid overwatering.

Figure 5. Monitor plant water needs and irrigate accordingly. Variations in growing conditions affect plant water requirements. For example, plants produced under hanging baskets may remain excessively wet.

Avoid Standing Water

Water that collects or puddles under benches or in walkways (FIGURE 6) increases relative humidity. Standing water also encourages growth of weeds and volunteer plants, which can harbor plant pathogens. Gravel, concrete, or woven landscape fabric covering dirt walkways reduces splash, but gravel and landscape fabric can hold moisture and contribute to humidity issues.

FIGURE 6. PUDDLING WATER ON GREENHOUSE AND HIGH TUNNEL FLOORS INCREASES RELATIVE HUMIDITY.

ADDITIONAL RESOURCES

- Burley and Dark Tobacco Production Guide (ID-160)
https://publications.ca.uky.edu/sites/publications.ca.uky.edu/files/ID160.pdf
- Greenhouse & High Tunnel Crops (Plant Pathology Extension Publications)
https://plantpathology.ca.uky.edu/extension/publications#GreenhouseCrops
- Herbaceous Ornamentals (Plant Pathology Extension Publications)
https://plantpathology.ca.uky.edu/extension/publications#HERBACEOUSORNAMENTALS
- Greenhouse Resources (Center for Crop Diversification)
https://ccd.uky.edu/resources/systems/greenhouse
- High Tunnel Resources (Center for Crop Diversification)
https://ccd.uky.edu/resources/systems/hightunnel
- High Tunnel Webinar Series (Center for Crop Diversification)
https://ccd.uky.edu/training
- Vegetable Production Guide for Commercial Growers (ID-36)
https://publications.ca.uky.edu/files/ID36.pdf
- What is Humidity? (NOAA)
https://scijinks.gov/what-is-humidity/

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