GROWERTALKS

Features

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Better Mist Management

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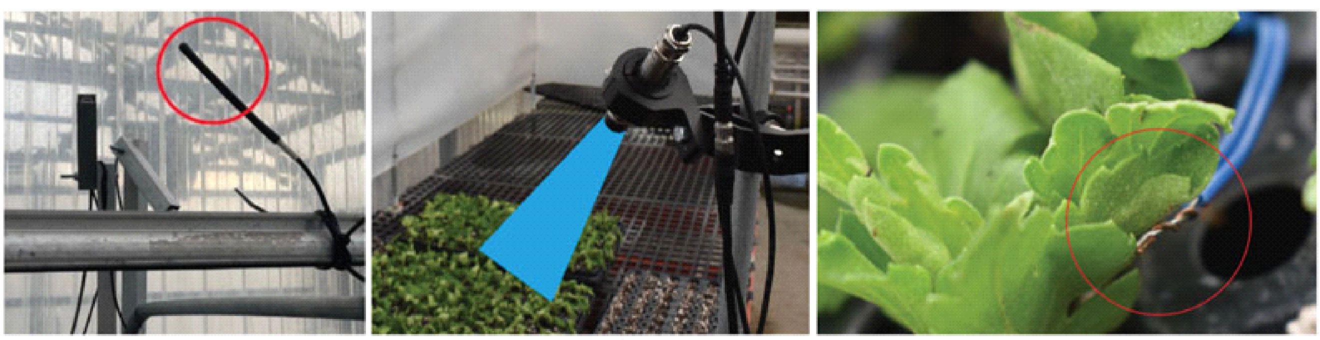
Maintaining an optimum temperature of your cuttings and root substrate (typically around 72 to 74F/21 to 23C) greatly improves rooting time. Most growers focus on air temperature and humidity, but the temperature of the leaf and substrate surface is also a key indicator for plant growth. When leaves become too warm, cuttings lose moisture faster than water can be replaced through mist. When leaves and substrate stay too cool, photosynthesis and rooting slow down.

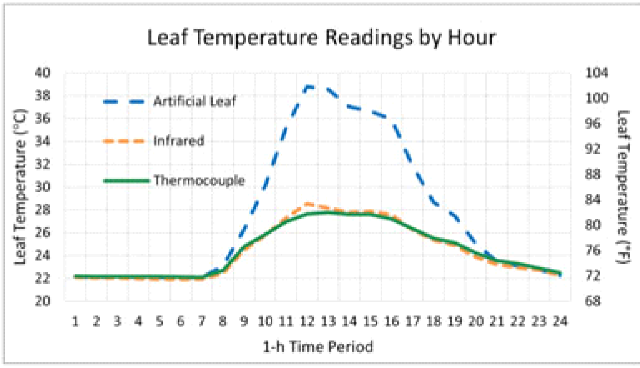
In this article, we explain why infrared (IR) sensors are an effective and affordable way to measure leaf and soil surface temperature in propagation greenhouses in order to fine-tune climate and irrigation management.

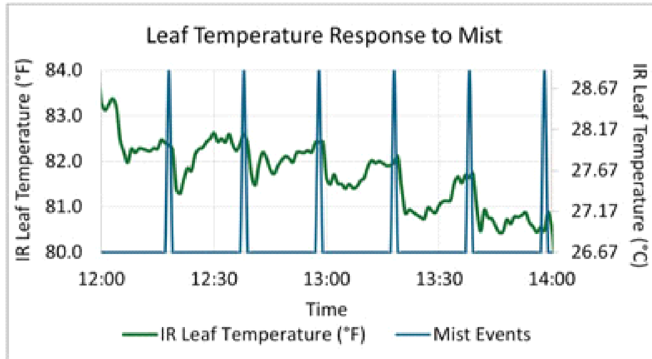


Left: Leaf temperature sensors, including (from left to right) an Artificial Leaf sensor (which is a thermistor above the mist zone exposed to sunlight), an IR sensor (which measures infrared thermal radiation emitted from the leaf and substrate surface) and a thin-wire Thermocouple (which is a sensor placed on or inside the leaf surface).

Center: Comparison of temperature readings from three different sensor types over the course of a day in a mist greenhouse, averaged from seven days.

Right: A graph showing the effect of six mist events (every 20 minutes, indicated by blue spikes) on leaf temperature measured with an IR sensor. The leaf temperature drops immediately after a mist event because the mist droplets on leaf surfaces evaporate, thereby cooling the leaf, humidifying the air and reducing water loss from the cutting.





Tools for testing

To help schedule misting, many greenhouses use an “Artificial Leaf” sensor (Figure 1, left), which is a dark-colored thermistor exposed to sunlight that’s mounted above the mist line or irrigation boom. These sensors are meant to represent the temperature of a plant leaf.

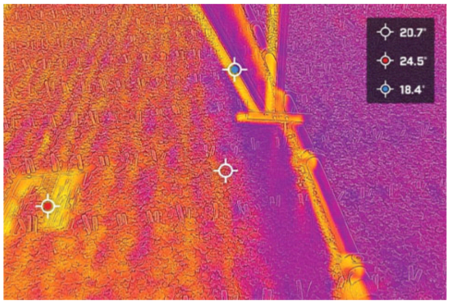
Leaf temperature is used to calculate vapor pressure deficit (VPD). High VPD (warm leaves in combination with warm and dry air) causes cuttings to dry quickly. Many growers program their irrigation booms based on accumulated VPD to signal when the crop needs misting (more frequent mist is applied when VPD accumulates quickly because leaf and air temperatures are high, and air relative humidity is low).

We tested the accuracy of Artificial Leaf and IR sensors (Figure 1, middle) against a research standard (a thin-wire thermocouple placed on the lower leaf surface) when chrysanthemum cuttings were propagated in a greenhouse. Thermocouples are highly accurate research tools, but are impractical in commercial greenhouses because they need to be moved to new leaves every week as the crop grows.

We found that the Artificial Leaf overestimates the temperature of cuttings under mist during the daytime. In sunny conditions, the sensor often reads 4 to 20F (2 to 11C) higher than actual leaf temperature (Figure 2). Because the Artificial Leaf is mounted above the mist line and stays dry, it doesn’t experience the cooling that occurs when mist evaporates from a real leaf. Using an Artificial Leaf for VPD control of booms would therefore overestimate the amount of mist needed during the sunny peak of the day.

IR sensors measure temperature without touching the plants, and we found they track the thermocouple readings very closely throughout the day and night. When misting occurred, the IR sensors immediately detected a drop in leaf temperature of several degrees, reflecting the effect of evaporative cooling (Figure 3). In contrast, the Artificial Leaf remained warm because it was above the mist zone.

We connected IR sensors to environmental control systems in seven commercial propagation greenhouses from Florida to Michigan. They performed consistently under different environments and lighting systems, including both LED and HPS supplemental lighting fixtures. At a cost of less than $400 for the IR sensor we tested (Omega OS151-LT/OS211-LT), this technology proved to be an affordable, practical and reliable solution. Measured leaf temperature varied widely depending on greenhouse design, lighting and irrigation strategy. For example, leaves in greenhouses using HPS lighting or floor heating were an average 2 to 5F (1 to 3C) warmer than the surrounding air because of the energy absorbed from the lamps or floor.



Accurate leaf temperature data can help growers improve mist control. When leaf temperature is available in real time, the timing and frequency of misting can be adjusted based on climate conditions. This allows the system to apply water based on VPD, rather than relying solely on a time clock. Basing misting frequency on climate can reduce unnecessary misting, reduce leaching and runoff, and minimize the risk of disease from excessive moisture.

Thermal infrared image showing the evaporative cooling effect following a mist irrigation event from an overhead boom (center) in a commercial greenhouse. The boom is passing from right (mist-irrigated) to left (not yet irrigated) over trays of unrooted cuttings in a greenhouse. Misted leaves on the right are blue (cool) because of immediate evaporative cooling.

IR sensors are relatively easy to install on many modern environmental control systems, adding the ability to read data and use those values to adjust irrigation or shading. They should be mounted so that the sensor has a clear view of the crop canopy and isn't directly hit by mist droplets. The lens should be kept clean to prevent water spots or dust from affecting accuracy.

With a sneak peek into the future, IR cameras are another way to measure and visualize leaf surface temperature. Our future research aims to map greenhouse zones using IR cameras in order to identify wet and dry spots (cool and warm areas) in greenhouses (Figure 4). **GT**

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