The best way to measure humidity

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There are various types of humidity sensors available, two of which are commonly used in greenhouses. Most reliable and most suitable for the rough greenhouse conditions is the wet- and dry bulb instrument. This article explains why it is worthwhile to go for this more expensive humidity sensor, and how it should be used and maintained.

What to measure
Humidity can be expressed in various ways: as relative humidity (RH in %), absolute humidity (in g/m^3), moisture deficit or vapour deficit (also in g/m^3), vapour pressure (VP in kPa or Pa), vapour pressure deficit (VPD also in kPa or Pa), and dew point (in °C). See previously article in this series for details. For sophisticated greenhouse control we are interested in two aspects of humidity: RH and VPD. RH (or alternatively dew point) is used for disease control, while VPD is the best indicator for transpiration control. In fact it does not matter which form of humidity is measured, because it is possible to compute all the different forms of humidity from one humidity measurement, provided also the temperature is known. Therefore it is very important to measure air humidity and temperature accurately.

Different sensors
At present two types of sensors with different measuring principles are commonly used in greenhouses: number one is the dry and wet-bulb instrument or psychrometer, and the second is the electronic humidity sensor or capacitive sensor. Other principles, like the hair-hygrometer, have been used in the greenhouse sector, whereas some new measuring principles are employed in other areas and are being tested for suitability in greenhouses. We will only consider the two current type of humidity meters.

Electronic (capacitive) sensor
Electronic sensors, mostly capacitive sensors, are usually relatively cheap, and easy to install and maintain. They produce a signal that is converted in the computer to RH or another humidity reading. Some of the cheap sensors easily become unreliable, in particular at high humidity levels. They are usually good when new, but they quickly deteriorate under the rough conditions in the greenhouse like changing humidity and spraying. Make sure you select a sensor that is recommended by a reputable greenhouse supply company for use in greenhouses.

Dry and wet bulb instrument
A simple and yet ingenious method to determine air humidity is with an instrument that contains two thermometers, also called bulbs: one measures the normal air temperature, the other is continuously wet and measures the wet-bulb temperature. The schematic drawing shows the principle. (This is of an older type of Priva sensor, with thanks to Priva). In this drawing #1 and # 2 are the dry and wet-bulb thermometers, respectively. The wet-bulb (#2) is covered by a wick (black in the drawing) that is hanging in a small reservoir with clean water (#3).
The wick sucks water and keeps the wet-bulb continuously wet. A built-in fan (#4) maintains a constant air flow along the two bulbs. The air flow absorbs water from the wick, which cools the wet-bulb. The dryer the air flow is, the more water will be absorbed from the wick, and the more the temperature of the wet-bulb will drop. Under rather dry conditions, the wet-bulb is a few degrees cooler than the dry-bulb. Under humid conditions, the dry and wet-bulb are almost the same. Under 100 % RH in the greenhouse air, the dry and wet bulb should be exactly equal.

The two signals, the one from the dry-bulb thermometer and the one from the wet-bulb thermometer are transferred to the greenhouse control computer. Here the signals can be converted to any form of air humidity reading, either relative air humidity, absolute air humidity, vapour pressure deficit or dew point of the air. Normally, however, only one form of humidity is displayed by the computer, usually RH.

Maintenance

Disadvantages of this sensor are the higher price and the need for frequent maintenance. First of all the bottle must be kept filled with clean water. Topping-up can be needed once a week during dry weather, or once in a few weeks when it is humid. It is good to check them every week. It also depends on the size of the reservoir. The water must be absolutely clean, and the reservoir itself must be cleaned when needed. When the wick is either filthy by algae or fatty due to greasy fingers, it needs to be replaced carefully. Whenever the wick fails to absorb water, the wet-bulb becomes a dry-bulb, and the temperature difference between the two bulbs will be zero, thus the calculated RH will be 100%. This means that the control computer will kick the heating and venting into action, while it is not needed at all.

The way to test this instrument is based on this principle: remove the wick, and make sure that both bulbs are clean and dry. Then the RH reading must be 100% or at least very close to 100%, which means that the dry and wet bulb measure the same temperature. If that is not the case, you better ask your supplier for service or replacement.

Place to measure humidity

As the dry and wet-bulb instrument is rather expensive, some growers have only one such instrument and use it to control several compartments. This is not good practice: each compartment that is controlled needs its own sensor. If this reading is used for humidity control, it is very important the sensor is placed at a good spot. In most greenhouses there is a huge variability in temperature and humidity, both in vertical and horizontal directions. Make sure that the measuring spot is characteristic for the whole greenhouse, and not too close to a heater, heating pipe, fan, wall etc. Also the bulbs must be shielded from sun shine. You can choose to hang it either at crop height, and also move it when the crop grows. It is better thought to have it always at the same height. Good positioning, as well as good maintenance of the sensors, can make an enormous difference in the costs and the effectiveness of the humidity control.

Dry and wet bulb instrument

1. Dry-bulb (thermometer for normal air temperature)
2. Wet-bulb (thermometer for wet air)
3. Reservoir with water for wet bulb
4. Fan