HUMIDITY CONTROL

Words by Elly Nederhoff : Crophouse Ltd

Greenhouse climate control with a dedicated computer seems easy: the grower choses the desired levels or set points, and the computer steers the heating, venting, fans, screens, and so on.

But it is not easy to choose settings that are both good for crop production and energy-efficient. Temperature and humidity settings combined govern the heating and venting, and these two factors can be at odds. It is important to realise that *every degree higher temperature* or *percent lower humidity* in the set points costs energy (we are talking winter conditions). Note that there are various ways to describe humidity, including absolute and relative humidity, VD, VPD (vapour pressure deficit) and dewpoint. In this article we use relative humidity (RH), because everyone is familiar with it, and it works well enough for our purposes. Other units such as dewpoint and VPD can be technically better, but are a bit complicated.

Greenhouse air humidity

Air humidity in a greenhouse is a dynamic balance. The base is the amount of water vapour in the outside air. On top of that comes water vapour added by plant transpiration. Subtracted from it, is water vapour disappearing due to ventilation and condensation. Humidity control is aimed at avoiding extremes: in winter avoiding high humidity that would cause fungal diseases, in summer avoiding low humidity that would cause plant stress. From an energy perspective, we are interested in winter conditions only. In a planted heated greenhouse in cold conditions, the absolute and relative humidity are much higher inside than outside. Therefore venting, which is air exchange with outside air, has a dehumidifying effect. But venting is also loss of energy (warmth and water vapour), so heating is needed to maintain the required temperature. A bit of venting is necessary for avoiding high humidity in winter, but excessive venting is waste of energy.

> “Every degree higher temperature or percent lower humidity in the set points costs energy

Humidity and fungal diseases

When choosing the setpoints for air humidity in the winter, most growers set the RH at a safe low level to reduce the risk of fungal diseases. This prompts simultaneous heating and venting, which costs a lot of energy: every percent lower RH costs more money. The first way to save energy is by choosing a setpoint not too low. As disease prevention remains paramount, the question is, what RH setpoint is safe in winter?

First some background. Spores of fungal diseases such as grey mould (*Botrytis*) often hang around in a greenhouse waiting for the right conditions. The right condition is a thin layer of water on a plant part (leaf, stem, flower or fruit) to let the fungal spores germinate. If the plant part remains wet for some hours, the hyphen from the germinated spores can penetrate the plant. Once inside the plant, the fungus is not depending on air humidity anymore. Thus, fungal diseases can be prevented by drying the plants in time, to give spores not enough time to infect a plant.

> Cold spots are the first to get wet from condensation, and this is where diseases start

Condensation

Plant wetness can be for various reasons: spraying, fogging, condensation. Spraying must be done when the plants have a chance to dry. Condensation occurs when the RH is very high and there is a cold surface with a temperature below the dewpoint. This can be a cold glass roof or cold plant part. Leaves can be cold, but particularly solid parts such as fruit can be cold early in the morning. This is when the heating system or the sun warms up the plants, but the fruit with their bigger mass take longer to warm up. As fruit lag behind in temperature they get below the dewpoint and become wet from condensation.

Cold spots

Nearly all greenhouses have cold spots, be it a corner with inadequate heating or broken windows, or spots deeper in the plants that get little sunshine and air movement. These places are the first to get wet from condensation, and this is where diseases start. A series of temperature measurements can show if the temperature is uniform or if there are serious temperature differences. Temperature uniformity can be established by improving the heating lay-out, repairing broken glass, increasing air movement, or opening dense foliage. This will reduce the risks of condensation and thus diseases.

The next step is avoiding too high air humidity. If a greenhouse has no cold spots at all, the RH setpoint can be set high, in theory close to 100% (but that is unrealistic). In contrast, if there are large temperature differences, the grower must maintain a safety margin and keep the RH under 85% or 80% or even lower. Such a low setpoint means that a lot of energy is used for heating combined with venting. Therefore, identifying and resolving cold spots will significantly improve energy efficiency while keeping diseases in check.

Other effects of humidity

Humidity control in winter is important for maintaining plant health, but also for influencing transpiration, which takes care of nutrient uptake and transport. Humidity also affects for instance pollination in fruit crops, leaf stretching, plant shape and the general vulnerability of the plants. Humidity control can be improved by using more refined measurements. More on humidity and its control in a following article.