High humidity control

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Need for humidity control
In the autumn/winter season it is important to control the 'high side' of humidity. At high humidity conditions, the aim is to reduce the humidity and avoid condensation on cold spots. The reasons are well known. Firstly, wetness permits the always present Botrytis spores to germinate and infect the plants. Secondly, high humidity prohibits transpiration, as humid air has not much 'space' for absorbing more water vapour (the Vapour Deficit is low). High humidity, especially in combination with lower light levels in winter is detrimental for plant transpiration. This may lead to insufficient uptake and transport of nutrients and hence a lower plant quality and weaker plant.

Outside air humidity
Air humidity in a greenhouse depends very much on the humidity of the ambient air, and it is therefore worthwhile to consider outside air humidity. High relative humidity (RH) of the ambient air can occur both in the cold and the warm season. When there is fog on cold days, the RH is very high, but at the same time the absolute humidity is very low, because cool air can hold only a small amount of water vapour. On warm days the outside RH can be very high too. This happens when warm air has absorbed a lot of water vapour from the sea surface (and then has cooled down a little bit so that RH increases further). When RH is high at a high temperature, the absolute humidity is high too.
Rain does not necessarily cause a high air humidity: if the water droplets are very cold they act as condensation surfaces and even reduce the absolute humidity. The effect of rain on RH depends on the air temperature.

Greenhouse air humidity
The absolute humidity of the outside air is the starting point of the absolute humidity inside the greenhouse. Transpiring plants increase the absolute humidity of the greenhouse air by adding water vapour. Therefore, in a greenhouse with an active crop the absolute humidity is always higher than outside. The air temperature is usually (although not always) higher inside the greenhouse than outside. Therefore the relative humidity (RH) in the greenhouse can be higher or lower than outside, depending on the temperature. Important is that greenhouse air has a higher absolute humidity, so a higher water vapour content than the outside air.

Ventilation and air movement
Ventilation means exchange of air between inside and outside. Humid (and warm) air from the greenhouse is replaced by dryer (and normally cooler) air from outside. Therefore, ventilation means loss of water vapour (and heat). Ventilation can be used to deliberately dispose excessive water vapour.
Ventilation also improves the air movement. This has an other effect: it stimulates air movement and this stimulates plant transpiration. The air movement effect, combined with the water vapour removal effect, are very effective methods of increasing transpiration on a dull day. Fans for air movement inside the greenhouse can be useful too, as they increase transpiration a bit. They also mix the greenhouse air, thus avoiding the incidence of cold spots. However, air mixing fans do not remove excessive water vapour and are less effective in increasing transpiration than opening vents.

Heating

The effect of heating on humidity is more complicated than the effect of venting. If an enclosure (e.g. a greenhouse) with a constant amount of water vapour is heated, the absolute humidity does not change, but the relative humidity drops (because warm air can contain more water vapour). But a greenhouse with plants does not have a constant amount of water vapour, because the plants add water to the air by transpiration, and also because there can be condensation.

In a greenhouse with an active crop, heating does two things: 1) increasing the air temperature and 2) stimulating the transpiration. (1) Increasing temperature means that the air can contain more water vapour, so the RH drops. (2) Enhanced transpiration means that water is added to the greenhouse air, so RH increases. The overall effect of heating on RH is not easy to predict. If the temperature would be increased very fast, RH would first go down, and later go up when the transpiration increases. Control of humidity with the heating system alone can cause difficulties. Heating must be combined with venting, as will be discussed below.

Humidity control

Humidity can only be controlled properly with a good control computer, a well-calibrated humidity sensor, and automatic ventilation and heating in place. The best way of high humidity control is by ventilation. This has to be combined with heating to maintain the required temperature. When a certain high level of humidity is measured, the ventilation must be triggered to start or to open further. When subsequently a drop in temperature is measured, (extra) heat should be supplied.

Some growers use heating for humidity control: if a certain high level of humidity is measured, the heaters are activated or the heat input is increased. This must be combined with ventilation to remove excessive heat water vapour. It can happen that heating increases the air temperature above the set point for venting. In that case the vents will open automatically, which is good. It is important that the setting are such that the heating and venting don't start to conflict with each other (temperature starts fluctuating, vents open and close, and pipe temperature goes up and down all the time).

Heating is a good method to dry the plants early in the morning, when the temperature has to be increased anyway from the night to the day level (see later article). Increasing the air temperature means that the air can contain more water vapour, so the RH drops. However, heating for humidity control during the day may have unpredictable results, because heating also increases the transpiration (see above).

Under high humidity conditions in winter, especially under low light conditions, a little bit of ventilation combined with heating is recommended to reduce humidity and also to keep the transpiration going. Ventilating conflicts with CO2 enrichment, but on dull winter days it can be the preferred way to go. It may prevent problems such as Botrytis infection and weak plants.

Final notes

Heating stimulates transpiration as discussed above. However, the effect of heating is much smaller than the effect of a bit of sunshine. Only in dull conditions, the effect of heating on plant transpiration is relatively worthwhile.