

Controlling high humidity

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This time of the year the air humidity in the greenhouse can be high at times, which can promote the outbreak of fungal diseases such as Botrytis. Also, too much moisture in the air can restrict the transpiration. These are two good reasons to avoid too high humidity. This can be achieved by concurrent heating and venting, which obviously costs a lot of energy. Understanding the background can help choosing good set points for humidity control.

Fungal diseases

Billions of spores of Botrytis and other fungal diseases are floating in the air waiting for the ideal conditions. The ideal conditions for them are wet leaves, because water allows spores to germinate and the sugars in the leaves supports fungal growth. Leaves can get wet through condensation. Avoiding condensation can prevent the outbreak of fungal diseases.

Theoretically it is possible to measure condensation on leaves, but realistically that does not work very well. Moreover, if condensation is detected it is already too late. It is better to look for an early warning that condensation is about to occur. The early warning is high air humidity, either high relative humidity (RH expressed in %) or dewpoint (dewpoint is expressed in degrees celcius, see previous article). If the dewpoint comes close to the air temperature, there is the risk of condensation. Most greenhouse control computers do not use dewpoint, but use RH. In theory one needs to steer clear from 100% RH. In practice this is not good enough for avoiding condensation. It is necessary to have a safety margin, and to restrict the RH to a considerably lower level.

What is a safe RH set point?

The question is what level of RH is safe for avoiding fungal diseases? There is no simple answer. It depends on the temperature distribution. If the temperature distribution is very even, that means that the temperature is very similar at all locations of the greenhouse (but this is hypothetical), the safe RH level is around 95-97%. If the temperature is very uneven, and if some spots are a few degrees colder than other spots, the safe RH level is very much lower than 100%, e.g. 80%. Two examples will demonstrate this. When the computer indicates a temperature of 20 °C and RH of 90 %, the dewpoint is 18.3 °C (see **Table**). This means that condensation will occur on spots that are 18.3 °C or colder. If there are no spots of 18.3 °C or colder, it is safe to control the RH at a maximum of 90%.

If there is a spot as cold as 16.4 °C (while air temperature measured by the sensor says it is 20 °C), we can determine which humidity level will cause condensation on this spot. The table shows that at temperature 20 °C the dewpoint is 16.4 °C at RH is 80 %. So leaves of 16.4 °C will get wet when RH is 80% (at 20 °C). So in a greenhouse with such large temperature differences (16.4 °C versus 20 °C), the RH should be not higher than 80% to avoid condensation on cold spots.

High humidity and transpiration

Another reason why high humidity is undesirable, is because it prohibits transpiration. Humid air has less 'space' to absorb more water vapour. High humidity, especially in combination with lower light levels in winter is detrimental for plant transpiration. Low plant transpiration leads to insufficient uptake and transport of nutrients, and hence reduces plant quality. Humidity control for transpiration should be based on Vapour Pressure Deficit (see previous article), but most growers prefer to stick with RH.

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It is hard to state what the desirable level of RH is for transpiration control, as there is not an absolute level. A guideline can be the radiation from the sun, because this is the driving factor for transpiration. If there is a reasonable level of radiation, there will be a reasonable level of transpiration, and no reason to control humidity for stimulating transpiration. However, if the radiation is very low, there is very little driving force for transpiration. It is then desirable to lower the humidity and thus stimulate the transpiration. A good set point for RH in this situation can be 75-80%. The computer must be set to activate the heating and/or venting to lower the air humidity, which will greatly help the transpiration.

Summary

Greenhouse air humidity depends on various factors, including air humidity of outside air, air exchange rate, transpiration by plants and indirectly radiation from the sun. It is hard to accurately control the air humidity. The best a grower can do is adjusting the air humidity and trying to avoid the extremes (too high and too low air humidity). In the autumn/winter season it is particularly important to avoid too high humidity levels.

Lowering the humidity is often achieved by venting and heating at the same time (see previous article). It costs a lot of energy. Humidity is often controlled for the purpose of avoiding condensation on the plants (leaves and fruit), and thus avoiding disease outbreak. Relative humidity (RH) can be used as an indication of the chance of condensation. Generally, condensation can be avoided by keeping the RH below 90%. However, in greenhouses with poor temperature distribution (very uneven temperature levels and thus some very cold spots), it is safer to aim for RH not higher than 80%.

Humidity control can also be applied in order to ensure enough transpiration on dull days. For that reason a good set point for maximum RH can be 75-80% on dull days. The humidity control will activate concurrent heating and venting which will stimulate the transpiration.

Table. Air humidity in different units

RH = relative humidity (%); abs.hum. = absolute humidity (g/m^3); VPD = Vapour Pressure Deficit (kPa) and Dewpoint ($^{\circ}\text{C}$). 1 kPa (kilo-Pascal) = 10 mbar (10 millibar). They are units for vapour pressure and for vapour pressure deficit (VPD).

RH %	10 °C			15 °C			20 °C			25 °C			30 °C		
	abs. hum. g/m^3	VPD kPa	Dew point $^{\circ}\text{C}$	abs. hum. g/m^3	VPD kPa	Dew point $^{\circ}\text{C}$	abs. hum. g/m^3	VPD kPa	Dew point $^{\circ}\text{C}$	abs. hum. g/m^3	VPD kPa	Dew point $^{\circ}\text{C}$	abs. hum. g/m^3	VPD kPa	Dew point $^{\circ}\text{C}$
100	9.4	0	10.0	12.9	0	15.0	17.3	0	20.0	23.1	0	25.0	30.4	0	30.0
95	8.9	0.06	9.2	12.2	0.09	14.2	16.5	0.12	19.2	21.9	0.16	24.1	28.9	0.21	29.1
90	8.5	0.12	8.4	11.6	0.17	13.4	15.6	0.23	18.3	20.8	0.32	23.2	27.4	0.42	28.2
85	8.0	0.18	7.6	10.9	0.26	12.5	14.7	0.35	17.4	19.6	0.48	22.3	25.9	0.64	27.2
80	7.5	0.25	6.7	10.3	0.34	11.6	13.9	0.47	16.4	18.8	0.63	21.3	24.3	0.85	26.2
75	7.1	0.31	5.8	9.6	0.43	10.6	13.0	0.59	15.4	17.3	0.79	20.3	22.8	1.06	25.1
70	6.6	0.37	4.8	9.0	0.51	9.6	12.1	0.70	14.4	16.2	0.95	19.1	21.3	1.27	23.9
60	5.6	0.49	2.6	7.7	0.68	7.3	10.4	0.94	12.0	13.9	1.27	16.7	18.3	1.70	21.4
50	4.7	0.61	0.1	6.4	0.85	4.7	8.7	1.17	9.3	11.6	1.59	13.9	15.2	2.12	18.4
40	3.8	0.74	-2.9	5.2	1.02	1.5	6.9	1.41	6.0	9.2	1.90	10.5	12.2	2.55	14.9
30	2.8	0.86	-6.7	3.9	1.20	-2.4	5.2	1.64	1.9	6.9	2.22	6.2	9.1	2.97	10.5