Leaf temperature, Relative Humidity, Room temperature &VPD

Humidity, Relative Humidity and temperature

The definition of humidity is the amount of water in the air, which is present as vapor (not visible, unlike mist).

Relative Humidity (RH) differs slightly to humidity. It is a measure of the actual humidity in the air compared to the total amount of water vapor the air COULD hold at a given temperature.

Temperature and relative humidity are classic examples of closely related environmental elements, given that the ideal humidity range, largely depends on the temperature.

For instance, the way plants react to an environment of 24°C and 50% relative humidity is VERY different to the way plants react to an environment of 28°C and 50% relative humidity.

Before exploring this connection more in detail, it makes sense to start with the basics. Humidity is HUGE when it comes to growing plants. An important milestone in becoming a competent and responsive grower is developing an understanding of what humidity is, how plants respond to it, and how you can manage and ……. manipulate it.

It's astonishing…… a healthy growing plant will lose 90% of the water it takes up via transpiration! Those plants need to transpire to grow, but a balance is needed. Too much transpiration causes undue stress, whilst too little transpiration leads to poor growth…

Temperature plays a crucial role when it comes to humidity. The warmer the air, the more water vapor it can potentially hold. As the amount of water air can hold constantly changes with temperature it can be difficult to get a handle on what we need to measure.
Fortunately, an answer comes in the form of the concept of "Relative Humidity" (RH) - this is a measurement in terms of percentage of the water vapor in the air compared to the total water vapor potential that the air could hold at a given temperature.

The amount of water plants lose through transpiration is, to a point, regulated, by opening and closing their stomata. However, as a rule and logic is…the drier the air, the more plants will transpire.

Tip! – think of VPD as the 'drying power' of the air, or a measure of the airs power to pull water from plants

Vapor Pressure Deficit

First, we need to understand what Vapor Pressure Deficit (VPD) is?

Vapor Pressure Deficit (VPD) is the difference between the theoretical pressure exerted by water vapor held in saturated air (100% RH at a given temperature) and the pressure exerted by the water vapor that is held in the air being measured at the same given temperature.

The VPD is currently regarded of how plants really 'feel' and react to the humidity in the growing environment. From a plant's perspective the VPD is the difference between the vapor pressure inside the leaf compared to the vapor pressure of the air.

The water in the leaf and the water and air mixture leaving the stomata is (more often than not) completely saturated -100% RH.

If the air outside the leaf is less than 100% RH there is potential for water vapor to enter the air because gasses and liquids like to move from areas of high concentration into areas of lower concentration (the air). The VPD can be thought of as the shortage of vapor pressure in the air compared to the amount of vapor within the leaf itself.

VPD provides a more accurate picture of how plants feel towards their environment in relation to temperature and humidity which gives us growers a better platform for environmental control.

The only problem with VPD is it's difficult to determine accurately because you need to know the leaf temperature. This is quite complex as leaf temperature can vary from leaf to leaf depending on many factors like is a leaf is in direct light, partial shade or full shade. The most practical approach that most environmental control companies use to assess VPD is to take measurements of air temperature within the crop canopy.

Transpiration is very important for healthy plant growth because the evaporation of water vapor from the leaf into the air actively cools the leaf tissue. The temperature of a healthy transpiring leaf can be up to 2-6°C lower than a non-transpiring leaf, this may seem like a big temperature difference but to put it into perspective around 90% of a healthy plant's water uptake is transpired, while only around 10% is used for growth.

The problem with running a high relative humidity when growing indoors it that fungal diseases may become an issue and carbon filters become less effective.

Please understand that by presenting this information we do not want you to go to your indoor gardens and run your growing environment within strict VPD values. What's important to take from this is that VPD can help you provide a better indication of how much moisture the air wants to pull from your plants than RH can.
Plants cope with changing humidity by adjusting the stomata on the leaves. Stomata open wider as VPD decreases (high RH) and they begin to close as VPD increases (low RH). Stomata begin to close in response to low RH to prevent excessive water loss and eventually wilting but this closure also affects the rate of photosynthesis because CO2 is absorbed through the stomata openings. Consistently low RH will often cause very slow growth or even stunting. Humidity therefore indirectly affects the rate of photosynthesis so at higher humidity levels the stomata are open allowing CO2 to be absorbed.

VPD for non-excessive transpiration	**4 - 8mb**
VPD for healthy transpiration	**8 - 12mb**
VPD for high transpiration	**12 - 16mb**

Environmental Guidelines

Some data to support you

To provide an easy guide that everyone can follow, the next section outlines suitable temperature and humidity ranges you should target to keep your plants transpiring as desired.

Environmental Conditions for Low Transpiration

At times you may want your plants to undergo a low rate of transpiration. For example, it sometimes proves necessary if they have limited foliage and only a small root system offering little support – e.g. newly rooted cuttings, germinated seedlings and young plants in need of a non-demanding environment and a low VPD.
These environmental conditions are best achieved in a large propagator where high humidity control is easily achievable.

TYPICAL VPD - 4-8		
	OPTIMUM RH	ACCEPTABLE RH
TEMP		
19-20°C	70%	65-85%
21-22°C	75,00%	70-90%
23-24°C	80%	75-95%
24-26°C	85%	80-95%
27-28°C	90%	85-95%

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Environmental Conditions for Healthy Transpiration

Establishing healthy plant growth is not difficult, you just need to ensure there are no excessive environmental demands on the plant so that it can transpire at a healthy rate and focus on stress-free growing.
The following environmental conditions promote good vegetative growth and suit small-medium sized plants with a healthy developing root system. You can achieve these moderate VPD conditions in a grow room by installing a humidifier and humidistat, and a thermostatic fan speed controller. Further environmental control is also possible through use of air-cooled reflectors and dimmable digital lighting.

Note: you will find it a lot more practical maintaining lower temperatures and the relevant recommended humidity – somewhere between 23-25°C and 60-70%. Trying to keep RH over 70% when the temperature is above 27°C may be a bit of a challenge in a ventilated environment and can cause issues with other equipment, e.g. carbon filters.

TYPICAL VPD - 8-12		
	OPTIMUM RH	Acceptable RH
TEMP		
19-20°C	60%	55-65%
21-22°C	62,50%	57.5-67.5%
23-24°C	65%	60-70%
24-26°C	70%	65-75%
27-28°C	75%	70-80%
29-30°C	80%	75-85%

Environmental Conditions for High Transpiration

Under moderate VPD conditions that facilitate healthy transpiration, your plants will create lots of foliage and a healthy root system to support their growth. Once the plants are well established you can afford to run a more demanding environment in the grow room, maintaining them with a higher transpiration rate. VPD conditions such as these helps prevent fungal disease from forming on the foliage and also encourage water uptake, which offers benefits in the late stages of the bloom cycle.

Note: if you want to keep relative humidity down to reduce the risk of fungal diseases affecting your plants in the late stages of the fruiting/flowering cycle, it is advisable to keep temperatures down too. This way you also avoid the problem of too much transpiration stress with high VPD.

TYPICAL VPD - 12-16		
	OPTIMUM RH	ACCEPTABLE RH
TEMP		
19-20°C	40%	35-45%
21-22°C	45,00%	40-50%
23-24°C	50%	45-55%
24-26°C	55%	50-60%
27-28°C	60%	55-65%
29-30°C	65%	60-70%

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