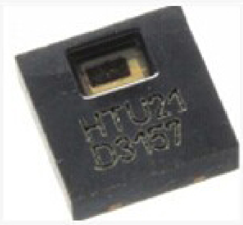
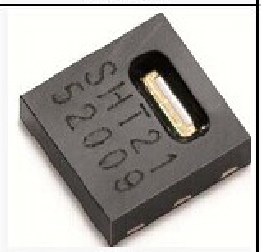
Five important things you should know about humidity in hydroponics

Humidity is one of the most important metrics in hydroponic culture. In order to have a successful crop it is critical to understand what humidity actually is, how we measure it, why we need to control it and where we want it to be. Today I want to share with you five things you should know about humidity in hydroponics. These pointers should be equally useful to newer growers and those who want to get even higher performance out of their current hydroponic crops.

There is a big difference between relative humidity and absolute humidity. Although we generally understand humidity as the amounts of water in the air in reality what we usually measure in hydroponics is "relative humidity" (RH) which does not measure how much water there is in the air but what percentage of the available capacity we are using. A measure of 70% tells you that the air currently holds 70% of the water it could hold, but it doesn't tell you anything about how much water there actually is in the air. Absolute humidity, on the other hand, tells you how much water you actually have in the air. As warmer air can carry significantly more water it is important to realize that a 70% humidity at 80F implies there is way more water in the air than a 70% humidity measurement at 50F.

Relative humidity meters are not reliable instruments. We often buy instruments to monitor ambient conditions without much thought about how they work or how good or bad they are. Relative humidity is a tricky measurement and cheap, semiconductor based relative humidity meters have not been very reliable or accurate. Usually a humidity meter will have an error of +/- 5% and it’s accuracy will not be on point if it has been exposed to very high humidity values (if there was ever any condensation on the sensor it probably was damaged to a significant extent). I often recommend buying at least 3 instruments with different chipsets. Having just one – or even several meters with the exact same chip – can be a recipe for disaster. The chipsets below are setting a new standard for precision and accuracy, so I would recommend you give sensors with those a try if you’re looking for more accurate RH measurements.

Company	Humirel	Sensirion
Part Number	HTU21D	SHT21
Product		
Humidity Accuracy	±2%RH	±2%RH
Temperature Accuracy	±0.3℃	±0.3℃
Operating Range	0—100%RH	0—100%RH
Power Supply	1.5—3.6V	2.1—3.6V
Interface	I2C	I2C
Power Consumption	400uA	300uA
Response Time	5s	8s
Package	3x3mm DFN	3x3mm DFN

It is often better to go over than to go under. Although higher or lower relative humidity values are both sub-optimal for plants, it is often better to go with higher humidities rather than lower humidities in terms of crop yields. Lower RH values will tend to stress plants more – especially if the temperature is high – while higher RH values are often easier to deal with for tropical plants (which are the kind we often grow in hydroponics). Although higher humidity can definitely cause important issues – such as fungal diseases – we have ways to deal with this that are more effective than our ways to deal with stress caused by low relative humidity. Of course extreme values will be very detrimental to plants either way, so when I say high consider I don't mean 95% RH at 80F.

Relative humidity can change a lot depending where you measure it. It is important to place RH meters at different places that represent what the plant is actually being exposed to. If you place RH meters in a greenhouse, far away from plant canopy, you will get a very poor representation of what the plant is actually experiencing and you might try to increase humidity substantially when this might not be needed. Ventilation is critical to alleviate this issue but in order to stay on top of it I always advice having meters within plant canopies in order to know for a fact how much your humidity values diverge between different places in your growing environment. Humidity is always bound to be higher closer to plants – as they transpire – but we should know how different it is. A big difference is a strong hint that there is not enough ventilation around the plants.

Humidifiers are often needed during the winter. Most crops that grow in warehouses during winter times require humidifiers, since the plants often do not evaporate enough water to compensate for the complete lack of water within the dry winter air (this is specially true if the volume of the growing warehouse is large). If you want to have a successful crop during winter times it will be paramount for you to have adequate humidifiers to ensure that your RH values are within what's ideal for your plants. Depending on the size of your crop this might require significant planning and investing so make sure you always consider this when designing your winter growing cycles.

I hope you have found the above pointers useful. There are certainly many other important aspects of humidity, such as relative humidity meter calibration, judging ideal humidity using vapor pressure charts, or ensuring that plants have enough defenses if they happen to get exposed to exceedingly high humidity levels within their canopy. We will certainly discuss some more of these within future posts!

Vapor pressure deficit (VPD) in hydroponics

If you have read books or articles about greenhouse environmental control you have probably heard about Vapor Pressure Deficit, also known as VPD. This is an important variable to measure as it helps us understand the conditions our plants are facing, gauge their water use and even predict whether we will be getting better or worse yields. Today I am going to talk about vapor pressure deficit in hydroponics, what this variable means, what it takes to control it and why it is so important to understand and even change this value to obtain better results.

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Table 3. References VPD (kPa) for greenhouse production, recommended by Argus Ltd, (2009)

T(°C)	rH (%)													
	35	40	45	50	55	60	65	70	75	80	85	90	95	100
15	1.11	1.02	0.94	0.85	0.77	0.68	0.60	0.51	0.43	0.34	0.26	0.17	0.09	0
16	1.18	1.09	1.00	0.91	0.82	0.73	0.64	0.55	0.45	0.36	0.27	0.18	0.09	0
17	1.26	1.16	1.06	0.97	0.87	0.77	0.68	0.58	0.48	0.39	0.29	0.19	0.10	0
18	1.34	1.24	1.13	1.03	0.93	0.83	0.72	0.62	0.52	0.41	0.31	0.21	0.10	0
19	1.43	1.32	1.21	1.10	0.99	0.88	0.77	0.66	0.55	0.44	0.33	0.22	0.11	0
20	1.52	1.40	1.29	1.17	1.05	0.93	0.82	0.70	0.58	0.47	0.35	0.23	0.12	0
21	1.62	1.49	1.37	1.24	1.12	0.99	0.87	0.75	0.62	0.50	0.37	0.25	0.12	0
22	1.72	1.59	1.45	1.32	1.19	1.06	0.92	0.79	0.66	0.53	0.40	0.26	0.13	0
23	1.82	1.68	1.54	1.40	1.26	1.12	0.98	0.84	0.70	0.56	0.42	0.28	0.14	0
24	1.94	1.79	1.64	1.49	1.34	1.19	1.04	0.89	0.75	0.60	0.45	0.30	0.15	0
25	2.06	1.90	1.74	1.58	1.42	1.27	1.11	0.95	0.79	0.63	0.47	0.32	0.16	0
26	2.18	2.02	1.85	1.68	1.51	1.34	1.18	1.01	0.84	0.67	0.50	0.34	0.17	0
27	2.32	2.14	1.96	1.78	1.60	1.43	1.25	1.07	0.89	0.71	0.53	0.36	0.18	0
28	2.46	2.27	2.08	1.89	1.70	1.51	1.32	1.13	0.94	0.76	0.57	0.38	0.19	0
29	2.60	2.40	2.20	2.00	1.80	1.60	1.40	1.20	1.00	0.80	0.60	0.40	0.20	0
30	2.76	2.54	2.33	2.12	1.91	1.70	1.48	1.27	1.06	0.85	0.64	0.42	0.21	0
31	2.92	2.69	2.47	2.24	2.02	1.80	1.57	1.35	1.12	0.90	0.67	0.45	0.22	0
32	3.09	2.85	2.61	2.38	2.14	1.90	1.66	1.43	1.19	0.95	0.71	0.48	0.24	0
33	3.27	3.02	2.76	2.51	2.26	2.01	1.76	1.51	1.26	1.01	0.75	0.50	0.25	0
34	3.46	3.19	2.92	2.66	2.39	2.13	1.86	1.59	1.33	1.06	0.80	0.53	0.27	0
35	3.65	3.37	3.09	2.81	2.53	2.25	1.97	1.69	1.40	1.12	0.84	0.56	0.28	0

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Vapor pressure deficit – measured in kPa – basically measures how much water vapor pressure we would need to put into a room with a certain humidity and temperature to get it to the point where relative humidity would be 100%. The larger the VPD the more water you need to put into the air to get it to saturate while the lower the VPD the closer the air is to full saturation. Since air holds more water with increasing temperature this means that at a fixed relative humidity the VPD is directly proportional to the room's temperature. This simply means that the hotter the room, the higher the VPD and the colder the room, the smaller the VPD if humidity remains constant.

The problem with a very low VPD – room close to 100% humidity – is two fold. First, it's difficult for any organism to evaporate water and second, it's easy for water to condense on any surface it temperature drops just a bit. For humans this basically means having to wear a t-shirt soaked with your own sweat but for plants this means both an inability to cool their surfaces and an inability to transport nutrients to their leaves. A low VPD generates a lot of stress because it makes plants unable to properly transport water.

A high VPD is equally problematic as it means that the plants need to transpire a lot. If air can hold a lot of additional water vapor this means that plants will lose more water through their stomata and this permanent loss puts pressure on the roots to transport more and more water. If root mass is not large enough or water availability is not high enough then plants will face important problems and will simply tend to wilt as the air takes away more water than what the plant can effectively transport through its tissues. You can actually often create models using VPD to predict a crop's water usage (see image below).

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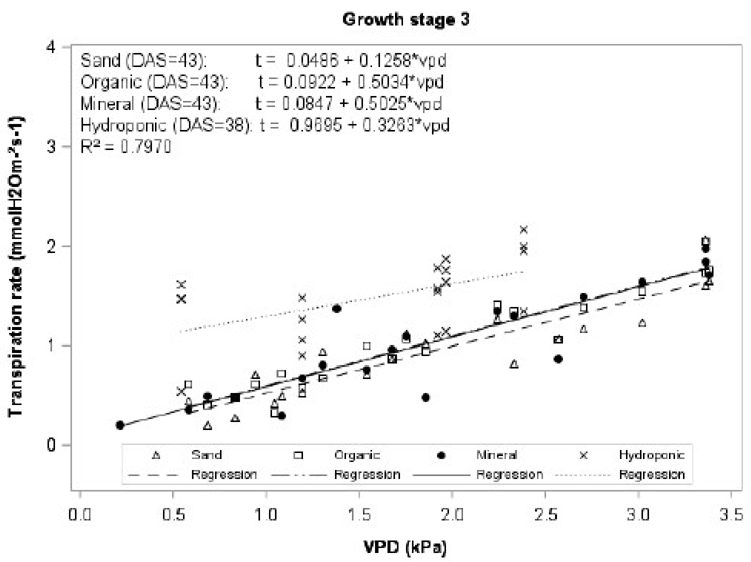

Figure 7: Transpiration rate in Panicum (*Panicum maximum* cv. *tanzania*) under VPD with different substrates in growth stage three.

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The first graph in this post (which I took from [this study](#) on tomatoes) shows the optimum VPD – in green – as a function of humidity and temperature for greenhouse production of tomatoes. In general a range between 0.5 and 1.1 seems to work best but the window under which these conditions are possible becomes narrower as temperature increases. Ideally we would want to be somewhere around 20-25°C where we should sustain humidity values between 65-70%. This would give us a VPD value between 0.7-0.8 which is around what is commonly held to be most beneficial for greenhouse crops under normal conditions.

However optimal VPD can also change depending on lighting conditions and other sources of supplementation. For example the optimal VPD during the day is usually higher than the optimal VPD during the night. In general it’s better to have a drop in VPD during the night relative to the VPD that is maintained during the day. Declines in canopy carbon dioxide exchange rates can be correlated with increases in the VPD during this time (see here for a study about this on soy bean). If you’re supplementing carbon dioxide – which puts further transpiration stress on the plants – the optimal VPD is also likely to be lower than if you didn’t use any supplementation at all (you can see a practical application of this here).

Changing the VPD can be a challenge but under closed environments it is much easier to do. You can reduce the humidity using a dehumidifier to increase your VPD and you can use a humidifier to increase your VPD. Ideally you will want to use an AC unit to keep your temperature at exactly the value you want it to be and you can then use a humidifier/dehumidifier to control the exact point where you want your VPD to be by controlling the value of your relative humidity at the fixed temperature provided by the AC unit.