The Ultimate Vapor Pressure Deficit (VPD) Guide

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by Peter Koverda | February 12, 2020 | 10 min read | 28 Comments

"Why devote an entire guide to VPD?" you might ask. The answer is that the **vapor pressure deficit (VPD) is extremely important for growing plants.**

VPD helps you identify the correct range of temperature and humidity to aim for in your grow space. With VPD you can achieve the best results while avoiding pest and environmental problems. VPD also controls plant transpiration rates, stomata opening, CO2 uptake, nutrient uptake, and plant stress.

If you master VPD, you master your environment and become a better grower.

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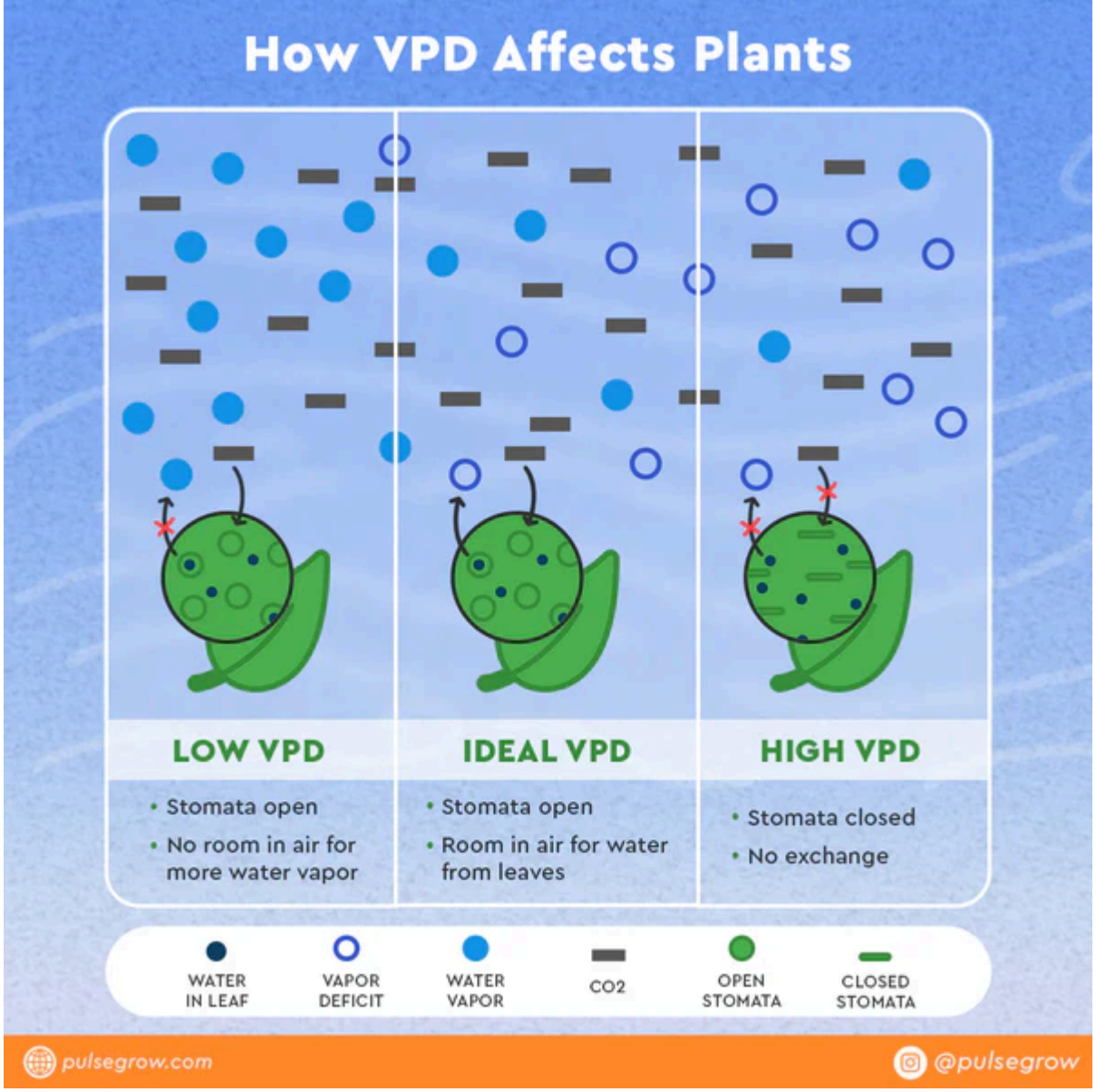
What is VPD?

Vapor Pressure, Temperature, and Humidity



Infographic: How VPD Affects Plants

VPD stands for Vapor Pressure Deficit, but what does it actually mean?

In short, VPD is a measure of how much more “room” there is for humidity (water vapor) in the air, at the current temperature.

Air is made up of many gases. Air is about 78% nitrogen, 21% oxygen, and much smaller parts of other gases. Water vapor, the gaseous form of water, is one of those other gases. The amount of water vapor in the air (expressed as pressure) is called “vapor pressure”.

Air can only hold a certain amount of water vapor at a given temperature before it starts condensing back to liquid water (in forms such as dew or rain). The maximum amount of water vapor that air can hold at a certain temperature is called **“saturation vapor pressure” or SVP.**

As the air gets hotter, the amount of water that the air can hold (its SVP) increases. As air cools down, the SVP decreases, meaning that the air can’t hold as much water vapor. That is why there is dew all over everything after a cool morning. The air just gets too full of water, and the water condenses out.

Similarly, the current actual amount of water vapor in the air is called the **“actual vapor pressure” or AVP.**

Some key points:

- **AVP / SVP x 100 = RH%**
    - *That’s right, RH is just the proportion of water the air is currently holding vs. its maximum capacity. That’s why it’s called “Relative” humidity.*
- **The maximum the AVP can be is the current SVP.**
    - *That means RH = 100%.*
    - *If AVP reaches SVP, any additional moisture will precipitate out of the air as liquid water (dew, etc).*
- **VPD = SVP − AVP**
    - *VPD: how much more room there is in the air for more water vapor. It’s as simple as that. Now you get why it’s called the Vapor Pressure Deficit.*

Get real time and historical VPD data with Pulse sensors.

How Do You Calculate VPD?

To calculate Air VPD you just need two things: temperature & humidity, but there are a couple of steps.

How to calculate air VPD:

1. **Figure out the SVP**
    - SVP = 610.78 x e^(T / (T +237.3) x 17.2694)
        - T is in degrees Celsius
        - The result, SVP, is in pascals (divide by 1000 to get kPa)
        - e is a mathematical constant called Euler's Number, approximately equal to 2.71828.
2. **Calculate the VPD**
    - SVP x (1 – RH/100) = VPD

However, since the inside of a plant is water, the **plants feel a different VPD than just the normal Air VPD**. If you want to figure out what's going on with the plant, you need to consider the cooling effect of evaporating water as it exits the leaves' stomata. To calculate this, you need to know the difference between the air temperature at canopy level, and the temperature of the leaves. An IR thermometer is useful for this.

How to calculate leaf VPD:

1. **Figure out the air SVP (ASVP)**
    - Same formula as getting the SVP for air VPD
2. **Figure out the leaf SVP (LSVP)**
    - It is the same formula as ASVP, but you use the leaf temperature in your calculation (typically 1-3 °C or 2-5 °F cooler)
3. **Leaf VPD = LSVP – (ASVP x RH/100)**

VPD Chart Maker 📊

Below is a VPD chart in degrees Fahrenheit, for flower stage, with a 0° offset for leaf temperature.

If you want to get the chart maker to **make your own custom chart** (you can modify the stage, the units, and the leaf temperature adjustment) click here.

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Grow good, and grow it well.

Vapor Pressure Deficit Chart Maker

Visit getpulse.co/blog/vpd to learn more

Select your settings to generate your custom VPD chart.

Clone / Veg / Flower

Fahrenheit / Celsius

Leaf Temperature Adjustment: 0 °F

(Leaf Temperature - Air Temperature)

Temp (°F) \ RH (%)	100	98	96	94	92	90	88	86	84	82	80	78	76	74	72	70	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	0
50	0	0	0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1	1	1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2
52	0	0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1	1	1	1	1.1	1.1	1.2	1.2	1.2	1.2	1.3	1.3	1.3
54	0	0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	1	1	1	1	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.3	1.3	1.4	1.4	1.4
55	0	0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	1	1	1	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5
57	0	0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	1	1	1	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.5	1.6	1.6
59	0	0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1	1	1	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.5	1.6	1.6	1.6	1.7	1.7
61	0	0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	1	1	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8
63	0	0	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1	1	1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.5	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.9	1.9	1.9
64	0	0	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.7	1.7	1.8	1.8	1.8	1.9	1.9	2	2	2.1
66	0	0	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.9	1.9	2	2	2.1	2.1	2.1	2.2
68	0	0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8	1.9	1.9	2	2	2.1	2.1	2.2	2.2	2.3	2.3	2.3
70	0	0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8	1.9	1.9	2	2	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5
72	0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8	1.9	1.9	2	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.6
73	0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8	1.9	2	2	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.5	2.5	2.6	2.6	2.7	2.7	2.8
75	0	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1.1	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.5	1.6	1.7	1.7	1.8	1.8	1.9	2	2	2.1	2.1	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.7	2.8	2.8	2.9	3
77	0	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1	1.1	1.1	1.2	1.3	1.3	1.4	1.4	1.5	1.6	1.6	1.7	1.8	1.8	1.9	2	2	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6	2.6	2.7	2.8	2.8	2.9	3	3	3.1	3.1
79	0	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.9	0.9	1	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.7	1.7	1.8	1.9	1.9	2	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6	2.7	2.7	2.8	2.9	2.9	3	3.1	3.1	3.2	3.3	3.3
81	0	0.1	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.8	0.8	0.9	1	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.7	1.8	1.8	1.9	2	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6	2.7	2.8	2.8	2.9	3	3	3.1	3.2	3.3	3.3	3.4	3.5	3.5
82	0	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.8	0.9	1	1.1	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.7	1.8	1.9	2	2	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.6	2.7	2.8	2.9	2.9	3	3.1	3.2	3.2	3.3	3.4	3.5	3.5	3.6	3.7	3.8
84	0	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.6	0.7	0.8	0.9	1	1	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.7	1.8	1.9	2	2.1	2.1	2.2	2.3	2.4	2.5	2.5	2.6	2.7	2.8	2.9	2.9	3	3.1	3.2	3.3	3.3	3.4	3.5	3.6	3.7	3.7	3.8	3.9	4
86	0	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.9	1	1.1	1.2	1.3	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.9	2	2.1	2.2	2.3	2.4	2.4	2.5	2.6	2.7	2.8	2.9	2.9	3	3.1	3.2	3.3	3.4	3.5	3.5	3.6	3.7	3.8	3.9	4	4	4.1	4.2
88	0	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.9	3	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.7	3.8	3.9	4	4.1	4.2	4.3	4.4	4.5
90	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4	2.5	2.5	2.6	2.7	2.8	2.9	3	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4	4.1	4.2	4.2	4.3	4.4	4.5	4.6	4.7
91	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5
93	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	3	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.9	5	5.1	5.2	5.3
95	0	0.1	0.2	0.3	0.4	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.5	2.6	2.7	2.8	2.9	3	3.1	3.2	3.3	3.5	3.6	3.7	3.8	3.9	4	4.1	4.2	4.3	4.5	4.6	4.7	4.8	4.9	5	5.1	5.2	5.4	5.5	5.6
97	0	0.1	0.2	0.4	0.5	0.6	0.7	0.8	0.9	1.1	1.2	1.3	1.4	1.5	1.6	1.8	1.9	2	2.1	2.2	2.4	2.5	2.6	2.7	2.8	2.9	3.1	3.2	3.3	3.4	3.5	3.7	3.8	3.9	4	4.1	4.2	4.4	4.5	4.6	4.7	4.8	4.9	5.1	5.2	5.3	5.4	5.5	5.7	5.8	5.9
99	0	0.1	0.2	0.4	0.5	0.6	0.7	0.9	1	1.1	1.2	1.4	1.5	1.6	1.7	1.9	2	2.1	2.2	2.4	2.5	2.6	2.7	2.9	3	3.1	3.2	3.4	3.5	3.6	3.7	3.9	4	4.1	4.2	4.4	4.5	4.6	4.7	4.9	5	5.1	5.2	5.4	5.5	5.6	5.7	5.8	6	6.1	6.2
100	0	0.1	0.3	0.4	0.5	0.7	0.8	0.9	1.1	1.2	1.3	1.4	1.6	1.7	1.8	2	2.1	2.2	2.4	2.5	2.6	2.8	2.9	3	3.2	3.3	3.4	3.5	3.7	3.8	3.9	4.1	4.2	4.3	4.5	4.6	4.7	4.9	5	5.1	5.3	5.4	5.5	5.6	5.8	5.9	6	6.2	6.3	6.4	6.6
102	0	0.1	0.3	0.4	0.6	0.7	0.8	1	1.1	1.2	1.4	1.5	1.7	1.8	1.9	2.1	2.2	2.4	2.5	2.6	2.8	2.9	3	3.2	3.3	3.5	3.6	3.7	3.9	4	4.2	4.3	4.4	4.6	4.7	4.9	5	5.1	5.3	5.4	5.5	5.7	5.8	6	6.1	6.2	6.4	6.5	6.7	6.8	6.9
104	0	0.1	0.3	0.4	0.6	0.7	0.9	1	1.2	1.3	1.5	1.6	1.8	1.9	2	2.2	2.3	2.5	2.6	2.8	2.9	3.1	3.2	3.4	3.5	3.7	3.8	3.9	4.1	4.2	4.4	4.5	4.7	4.8	5	5.1	5.3	5.4	5.6	5.7	5.8	6	6.1	6.3	6.4	6.6	6.7	6.9	7	7.2	7.3
106	0	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5	1.7	1.8	2	2.2	2.3	2.5	2.6	2.8	2.9	3.1	3.2	3.4	3.5	3.7	3.9	4	4.2	4.3	4.5	4.6	4.8	4.9	5.1	5.2	5.4	5.5	5.7	5.9	6	6.2	6.3	6.5	6.6	6.8	6.9	7.1	7.2	7.4	7.6	7.7
108	0	0.2	0.3	0.5	0.6	0.8	1	1.1	1.3	1.5	1.6	1.8	1.9	2.1	2.3	2.4	2.6	2.8	2.9	3.1	3.2	3.4	3.6	3.7	3.9	4.1	4.2	4.4	4.5	4.7	4.9	5	5.2	5.4	5.5	5.7	5.8	6	6.2	6.3	6.5	6.7	6.8	7	7.1	7.3	7.5	7.6	7.8	8	8.1
109	0	0.2	0.3	0.5	0.7	0.9	1	1.2	1.4	1.5	1.7	1.9	2.1	2.2	2.4	2.6	2.7	2.9	3.1	3.3	3.4	3.6	3.8	3.9	4.1	4.3	4.4	4.6	4.8	5	5.1	5.3	5.5	5.6	5.8	6	6.2	6.3	6.5	6.7	6.8	7	7.2	7.4	7.5	7.7	7.9	8	8.2	8.4	8.6
111	0	0.2	0.4	0.5	0.7	0.9	1.1	1.3	1.4	1.6	1.8	2	2.2	2.3	2.5	2.7	2.9	3.1	3.2	3.4	3.6	3.8	4	4.1	4.3	4.5	4.7	4.9	5	5.2	5.4	5.6	5.8	5.9	6.1	6.3	6.5	6.7	6.8	7	7.2	7.4	7.6	7.8	7.9	8.1	8.3	8.5	8.7	8.8	9
113	0	0.2	0.4	0.6	0.8	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.8	3	3.2	3.4	3.6	3.8	4	4.2	4.4	4.6	4.7	4.9	5.1	5.3	5.5	5.7	5.9	6.1	6.3	6.5	6.6	6.8	7	7.2	7.4	7.6	7.8	8	8.2	8.3	8.5	8.7	8.9	9.1	9.3	9.5

getpulse.co

VPD Calculator

Solve For: ○ Temp ○ RH ◉ VPD

Temp (F) 66.2

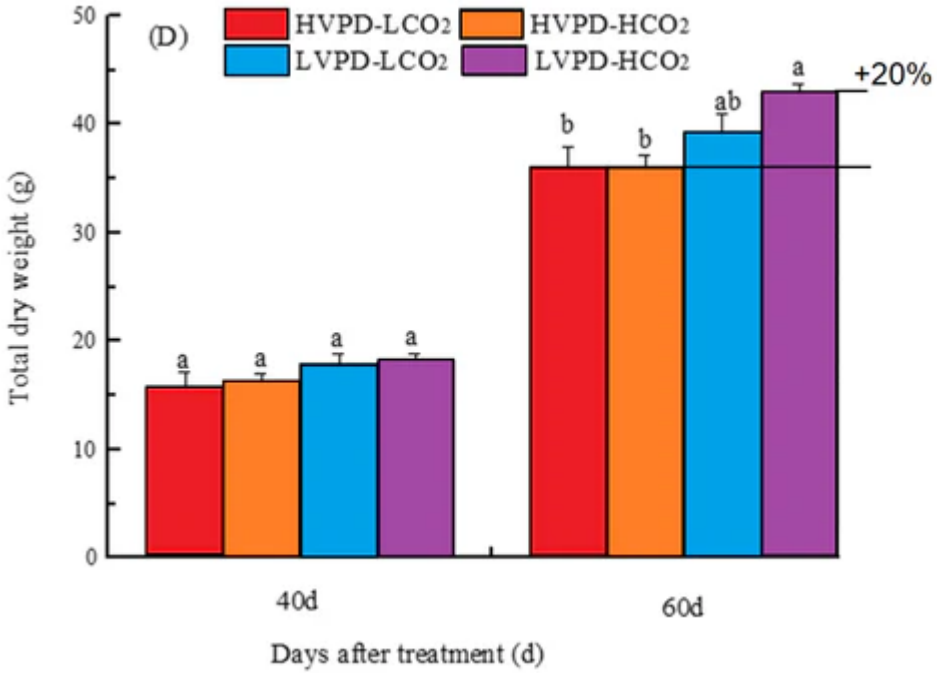
Temp (C)	19
RH (%)	65
VPD Air (kPa)	0.78
Leaf Offset (F)	-7.2
Leaf Offset (C)	-4
VPD Leaf (kPa)	0.28

VPD Chart Maker and Calculator

I WANT IT

Why is VPD Important?

You probably already know that VPD is an important thing to keep track of in your grow's environment, that's why you're looking it up. But why is VPD important?



Impact of ideal VPD on Tomato Plant Dry Weight [2]

Having your grow at the correct VPD is one of the **most important things you can do for improving yields**. VPD influences five key things that are all somewhat related.

1. **Stomata Opening**
    - As VPD increases, stomata get smaller.
2. **CO2 uptake**
    - As VPD increases and stomata get smaller, CO2 uptake gets reduced.
3. **Transpiration**
    - As VPD increases, the plant transpires (evaporates from leaves) faster due to the larger difference in vapor pressures between the leaf and the air.

4. **Nutrient intake at the roots**

- As VPD increases, and transpiration increases, the roots pull in more nutrients. The plant is like one connected system of plumbing!

5. **Plant stress**

- As VPD increases, there are more forces acting on the plant – from the leaves to the roots – and the plant experiences more stress.

As you can see there's a complicated tradeoff between VPD and a variety of factors. You can increase how much CO2 the plant absorbs, but reduce the amount of nutrition. You can increase the amount of nutrition, but also stress the plant more. VPD is a very powerful tool in the grower's toolbox. To get the best results you need to find the correct VPD sweet spot for the plant's stage of growth.

VPD and Indoor Growing

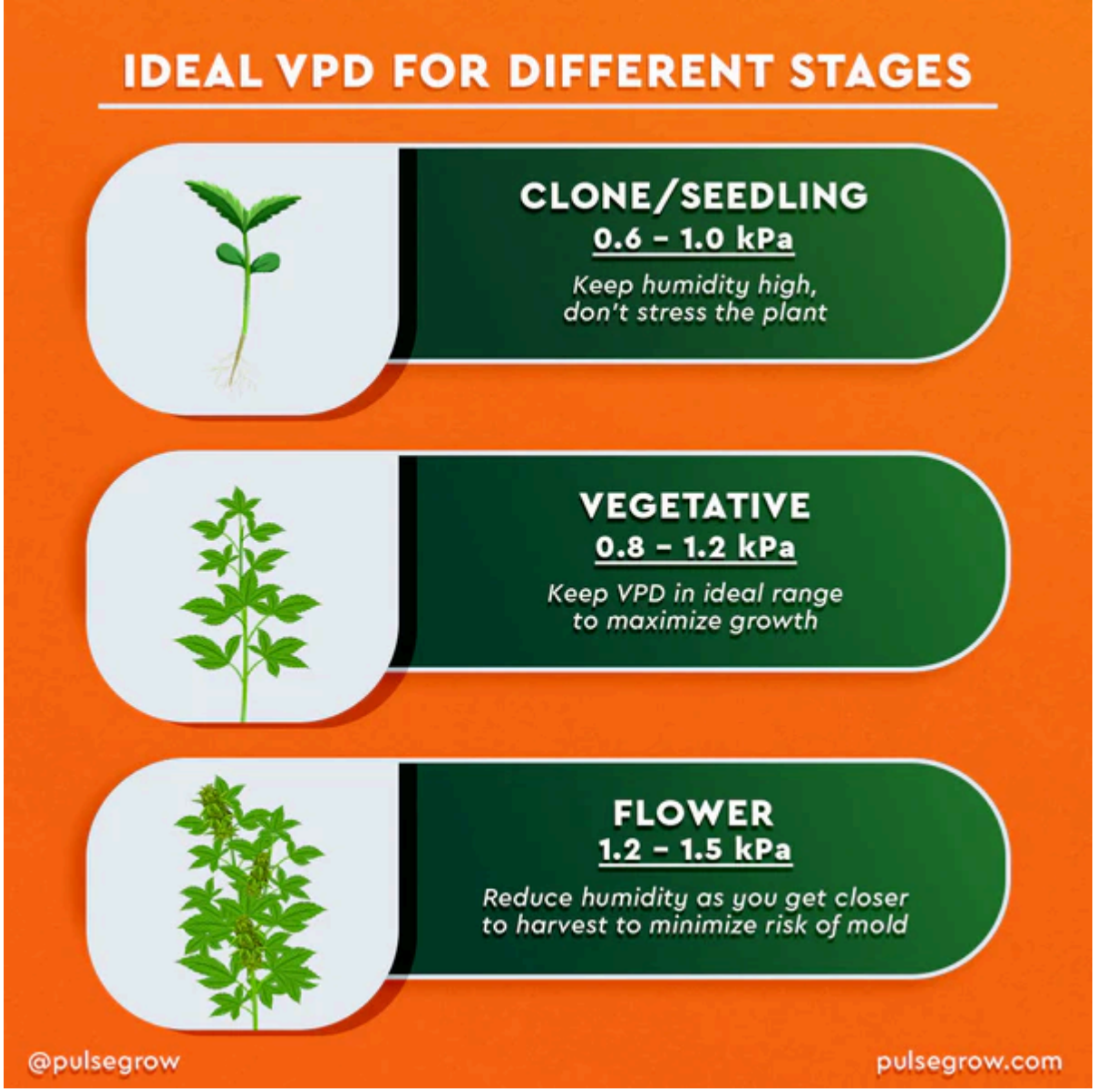
Indoor growing comes with huge advantages. You get to have control over the environment that your plants grow in. Environment is one of the essential “knobs” you can twist in order to get better results in your grow, and VPD is the key part of that formula.

How you can influence and change VPD:

1. **Temperature**
    - Increase temperature (run a heater or reduce AC): increase VPD
    - Decrease temperature (increase AC): decrease VPD
2. **Humidity**
    - Increase humidity (run a humidifier): decrease VPD
    - Decrease humidity (run a dehumidifier): increase VPD
3. **Light Intensity**
    - Increase light intensity (move lights closer, etc): increase leaf temps: increase VPD
    - Decrease light intensity (move lights farther, etc): decrease leaf temps: decrease VPD

Ideal VPD for Different Stages of Growth

So now you know what VPD is, how it impacts plants, and how you can change VPD. All that’s left is to figure out how to use this information in your own grow. Ideal VPD, as a general rule for plant growth, is around 0.8 – 1.2 kPa (kilopascals). However, your plants have different needs during different stages of growth. You need to tailor your grow environment to the stage of growth that your plants are in. Below are some general recommendations, but keep in mind that these recommendations can vary from strain to strain, and setup to setup. As always, observe your plants and tweak things accordingly.



Infographic: Ideal VPD for Clone, Veg, and Flower

1. **Ideal VPD for Seedlings and Clones**

- Clones and seedlings are baby plants, they can't handle a lot of stress because they are still just trying to form roots. Target a higher humidity and VPD closer to the lower end of the general range.
- The ideal VPD for seedlings and clones is closer to 0.8 kPa.

2. **Ideal VPD for Vegetative Stage**

- In veg (vegetative) stage the plants are bigger and more robust. You can reduce the humidity in your environment to increase VPD. This will increase water and nutrient uptake, but you don't want to increase VPD too much. This will cause the stomata of the plants to close, causing them to absorb less CO2. CO2 is particularly important in the vegetative stage, because that's the main ingredient that plants use to grow large.
- The ideal VPD for the vegetative stage is close to the middle of the general range, around 1.0 kPa.

3. **Ideal VPD for Flower Stage**

- In flower stage the plants are robust, but the flowers are sensitive to various issues. You need to avoid excess humidity.
- The ideal VPD for the flower stage is closer to the top end of the range, 1.2kPa – 1.5kPa.

VPD at Night

If you didn't already know, VPD is a measurement related to humidity and temperature. It is an absolute measure of **how much more moisture the air can hold at the current temperature**. VPD is very important for plants because it controls stomatal opening, transpiration rate, CO2 uptake, nutrient uptake, and plant stress. It also directly impacts yields[1][2]. Ideal VPD can **boost yields by 20%** or more.

VPD Measured At Night. Click for an Interactive Chart

What Plants Do At Night

At night, most plants **close their stomata and stop photosynthesis** since there is no light available. This closure prevents water from escaping through the open pores, and significantly reduces transpiration. See below a comparison of day and night transpiration as measured in C. Sativa hemp plants:

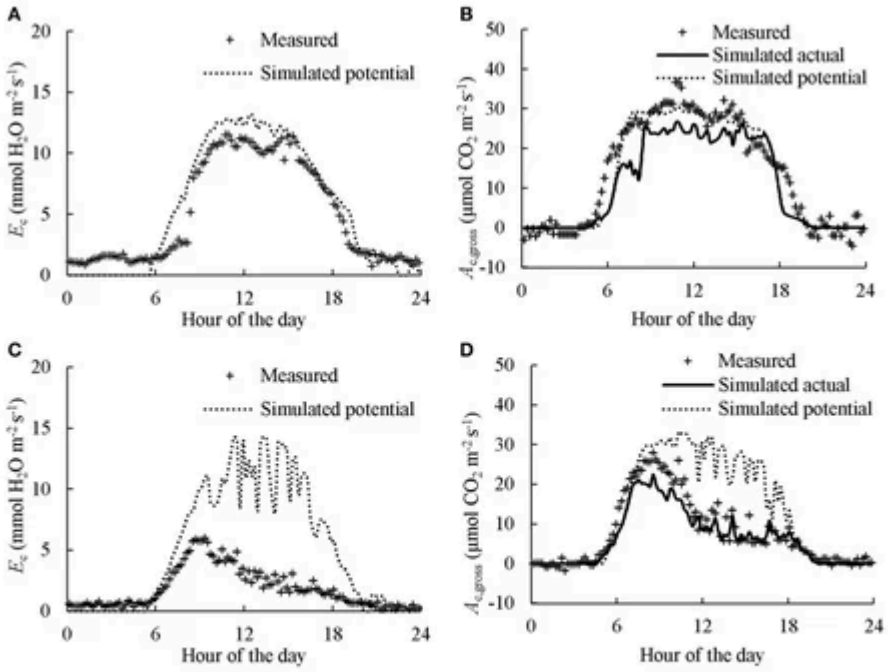


FIGURE 3 | Diurnal courses of measured and simulated canopy transpiration (E_C; **A,C**) and gross photosynthesis rates ($A_{C,gross}$; **B,D**). The "Measured" dots present the values calculated from gas exchange measurement. The "Simulated potential" line presents the outcome of model simulation without considering water stress. The "Simulated actual" line in **B,D** presents the outcome of model simulation considering the estimated E_C as actual available water for transpiration while the effect of water deficiency on stomatal resistance was estimated using Equation (7). Data presented was collected in the first day of N2 in CAN1.The canopy in **A,B** received sufficient water while water supply in **C,D** was halved.

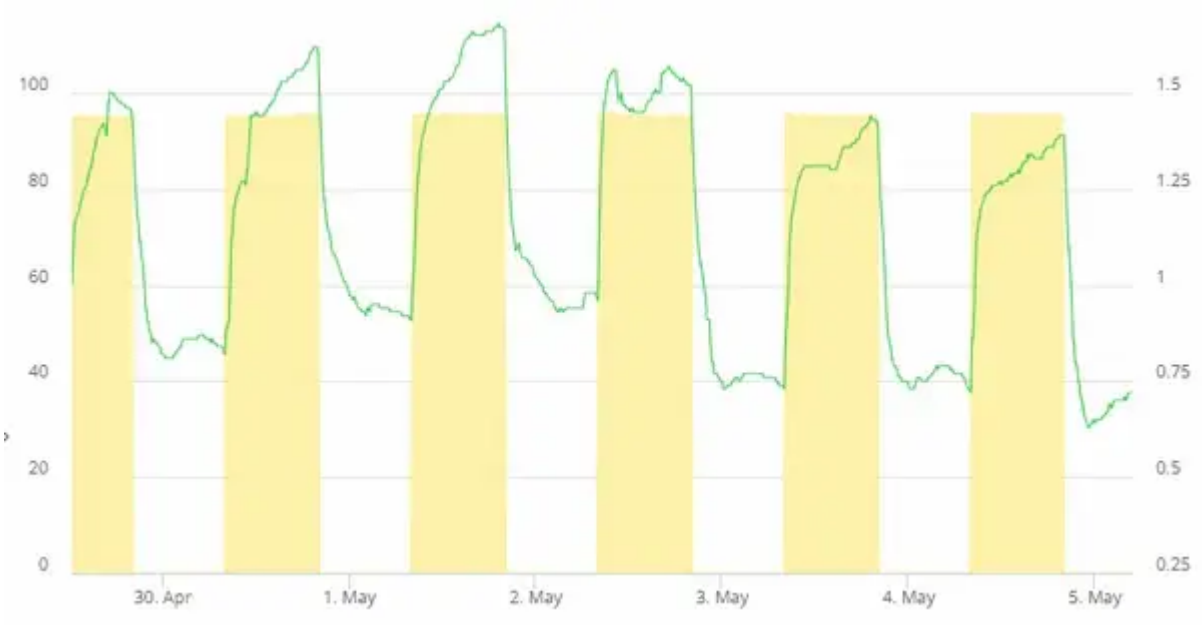
Transpiration is about 10x lower at night than it is during the day. [1]

Instead of photosynthesis, at night, plants mostly perform **respiration**. Like in humans, respiration in plants converts stored sugars (made by photosynthesis) to energy. As you may already know, that means plants actually **produce CO2 during the night!**

How to Make the Most of the Night Period

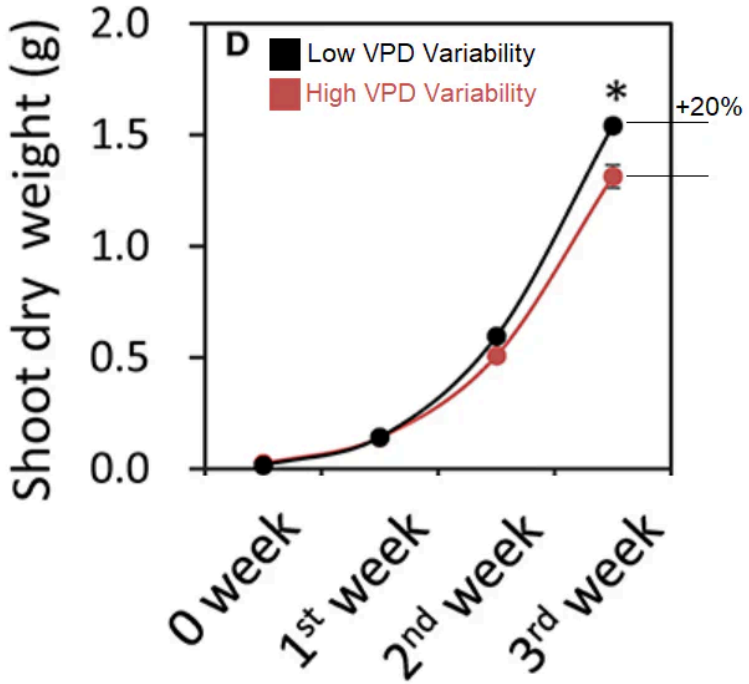
You may be wondering what you should do as a cultivator during the night period, if the plants aren't photosynthesizing. There are a few key things you can use the night period to achieve.

- **Disease Prevention:** use nighttime to keep RH on the lower end to prevent mold such as bud rot and powdery mildew.
- **Keep Nighttime VPD Close to Daytime VPD:** plants still need to release CO2 created by respiration through the stomata, so keep VPD relatively close to the daytime ranges.
- **Minimize VPD Swings:**



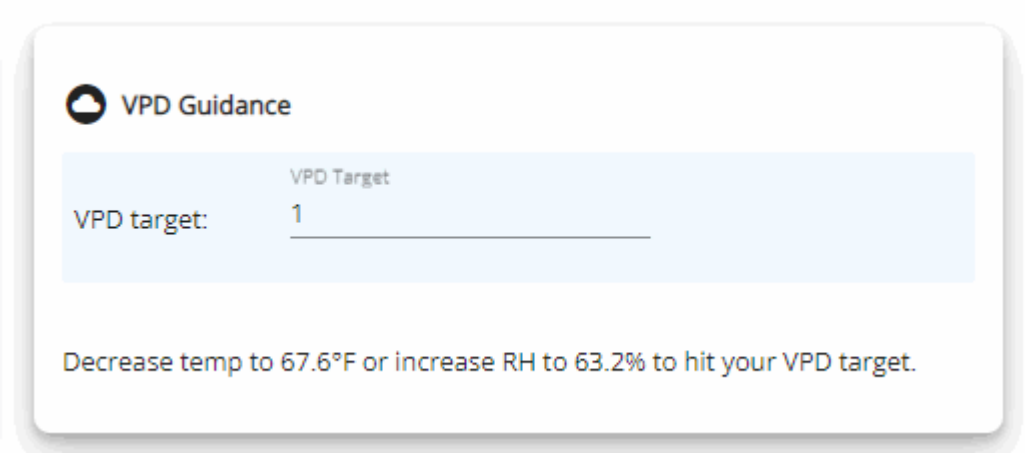
Vpd swings from day to night. Click for an Interactive Chart.

According to research[3] done in 2021 Frequent VPD swings greater than 0.4kPa can **drop yields by as much as 20%:**



Yield Impact from VPD Swings [3]

Ideal Night Period VPD



VPD Dialed In on the Pulse App

Overall you want to **keep nighttime VPD close to daytime VPD**, but you can be a bit more lenient since VPD matters less at night. Ideal VPD, as a general rule for plant growth, is around 0.8 – 1.2 kPa (kilopascals).

However, your plants have different needs during different stages of growth. You need to tailor your grow environment to the stage of growth that your plants are in. Below are some general recommendations, but keep in mind that these recommendations can vary strain from to strain, and setup to setup. As always, observe your plants and tweak things accordingly.

Nighttime VPD for Seedlings and Clones

- Clones are baby plants, and they can't handle a lot of stress because they are still just trying to form roots. Target a higher humidity and VPD closer to the lower end of the general range.
- The ideal nighttime VPD range for seedlings and clones is 0.6kPa to 1.0kPa (ideally **0.8kPa**)

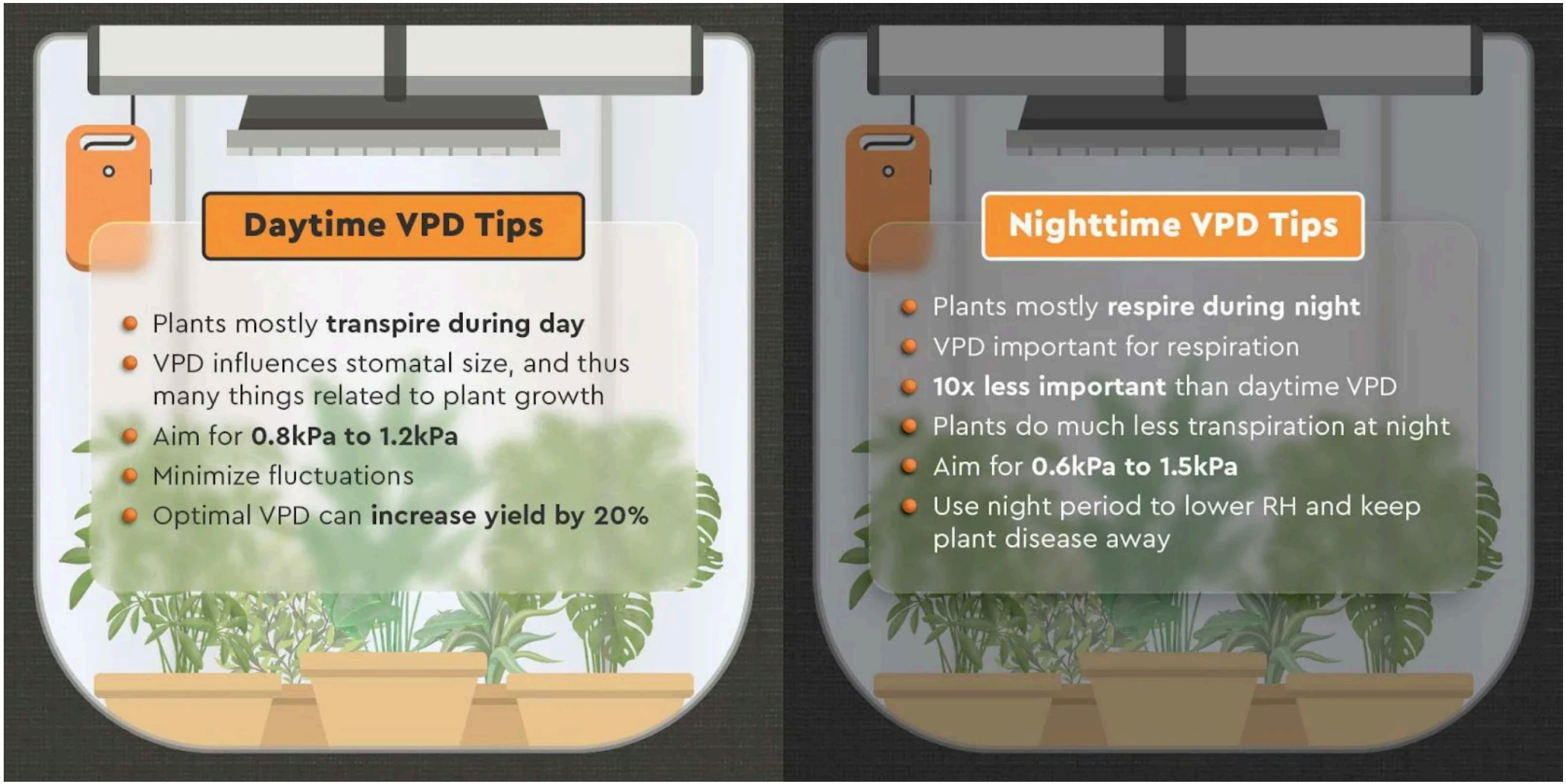
Nighttime VPD in Veg

- In veg (vegetative) stage the plants are bigger and more robust. You can reduce the humidity in your environment to increase VPD. This will increase water and nutrient uptake, but you don't want to increase VPD too much. This will cause the stomata of the plants to close, causing them to absorb less CO2. CO2 is particularly important in the vegetative stage, because that's the main ingredient that plants use to grow large.
- The ideal VPD for the vegetative stage is close to the middle of the general range 0.8kPa to 1.2kPa (ideally **1.0kPa**)

Nighttime VPD in Flower

- In the flower stage the plants are robust, but the flowers are sensitive to various issues. You need to avoid excess humidity.
- The ideal nighttime VPD range for the flower stage is closer to the top end of the range: 1.0kPa to 1.5kPa (ideally **1.2kPa**)

Summary and Key Points



Night VPD Infographic

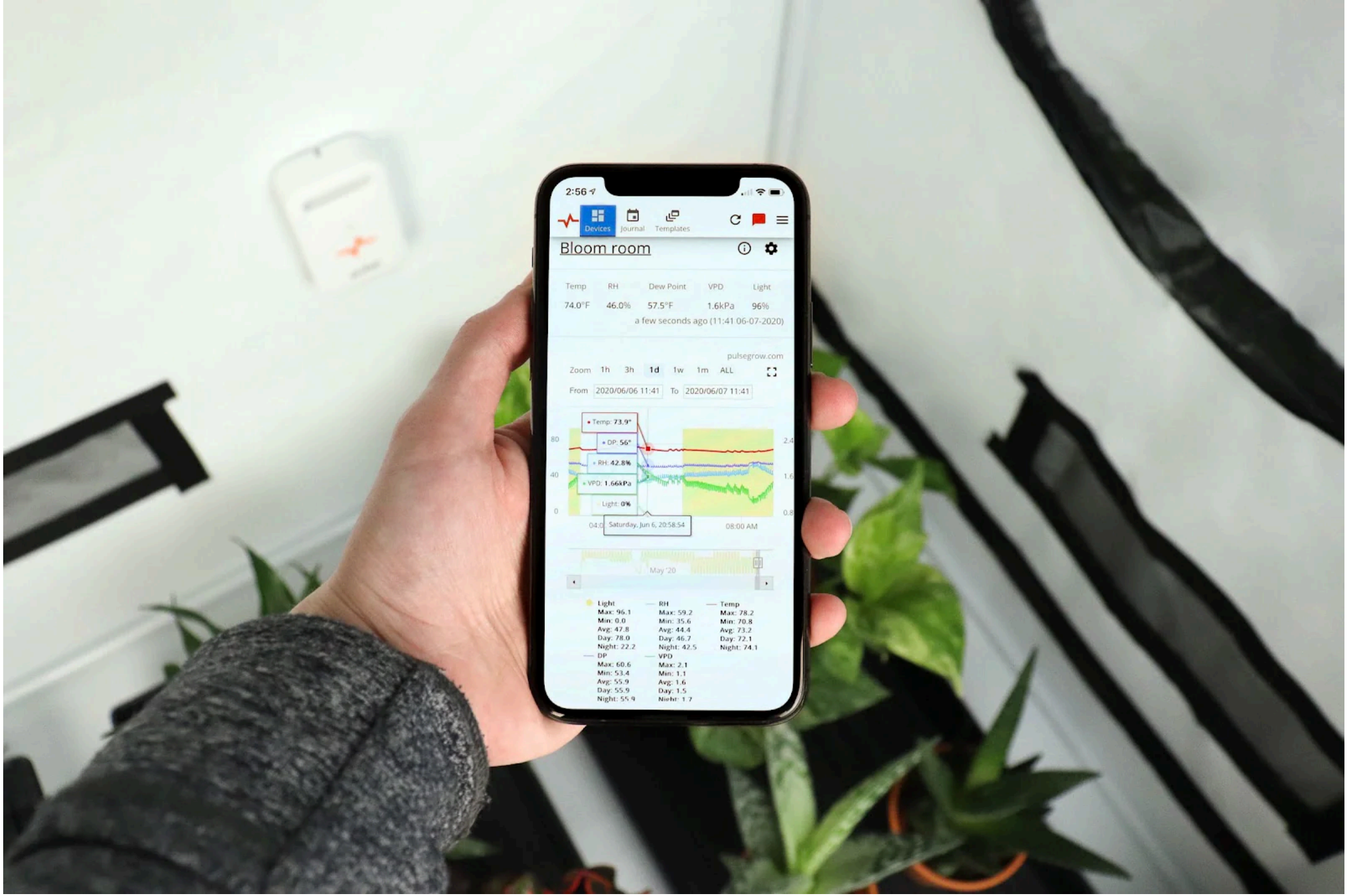
1. VPD is mostly about transpiration

2. Plants transpire significantly less at night
3. Use night period for preventing disease by keeping humidity and temps lower
4. Try to minimize VPD fluctuations (less than 0.4kPa)
5. VPD still matters for respiration at night
6. Daytime VPD is about 10x more important than nighttime VPD
7. Optimal VPD can increase yields as much as CO2 enrichment

To sum it up:

> **Although VPD at night isn't nearly as important as your day VPD, it's still an important factor to consider for vigorous plant growth and increased yields.**

Monitoring VPD At Night



Monitor VPD With Pulse

Since VPD is so important and has such an **impact on your yield**[1], you may be wondering how to monitor and track VPD when you're not in your grow. My partner Chris, a long-time grower, and I teamed up to build the Pulse One and Pulse Pro sensors along with the Pulse App to track VPD and

other key things about your grow.

Pulse helps you boost your yields, optimize your environment, and the instant alerts finally give you peace of mind when you're away from the garden.

Further Reading on VPD

1. Tang, K., Fracasso, A., Struik, P. C., Yin, X., & Amaducci, S. (2018). Water- and Nitrogen-Use Efficiencies of Hemp (C. sativa L.) Based on Whole-Canopy Measurements and Modeling. Frontiers in Plant Science, 9. doi:10.3389/fpls.2018.00951
2. Jiao, XC., Song, XM., Zhang, DL. et al. Coordination between vapor pressure deficit and CO2 on the regulation of photosynthesis and productivity in greenhouse tomato production. Sci Rep 9, 8700 (2019). doi:10.1038/s41598-019-45232-w
3. Inoue T, Sunaga M, Ito M, Yuchen Q, Matsushima Y, Sakoda K and Yamori W (2021) Minimizing VPD Fluctuations Maintains Higher Stomatal Conductance and Photosynthesis, Resulting in Improvement of Plant Growth in Lettuce. Front. Plant Sci. 12:646144. doi: 10.3389/fpls.2021.646144

Leave a Comment

Continue Discussion 26 replies

peet Jun '23

Thanks for reading my article. Let me know if you have any questions!

Paul_S Jul '23

Hi, I enjoyed reading your article. I'm new to VPD and have always just used humidity. Currently, my tent is 75°, humidity is 64.2% and the VPD is 1.01. According to what I've read, the VPD is ideal as well as the temperature. The humidity seems high. Early veg. Any advice? Do I just ignore humidity? Thanks!

paul

1 reply

Noah ▶ Paul_S Jul '23

Hi Paul,

I am a commercial grower and I cultivate indoors using artificial lighting and co2 enrichment, with inorganic salts in coir as a medium. This is considered "high performance" cultivation which means that the plants are much more sensitive to the conditions they are placed in, and achieving optimal values is critical to the business. For home growers, achieving optimal environmental parameters is not typically necessary, and is also sometimes not even desired.

In my facility, I keep the humidity between 68% and 75% throughout veg and deep into flower, only dropping once the buds start to swell and become dense enough that I become concerned about the moisture within the bud itself being significantly higher than the air in the room. These may seem like high humidity levels but they are necessary in our case to have healthy, tender plants at a high temperature and light levels while also keeping the plant able to rapidly absorb CO2. The high humidity reduces transpiration which reduces water consumption by the roots, which allows us to maintain a higher fertilizer strength without harming the plants.

If I were growing for personal reasons (i.e., in a tent), I would not grow this way. I would cultivate with low nutrient strength at lower humidity levels so that mold/mildew risk was reduced as well as reduce the risk of fertilizer toxicity. I would also grow with lower light levels, which would allow me to either use lower CO2 ppm or use outside air as my CO2 source which would avoid the unnecessary dangers of CO2 enrichment in a home environment. At more mild conditions, there is little to be gained and maybe even something to be lost by shooting for the commonly cited "optimal" vpd ranges.

This is my way of saying that there really is no "correct" vpd at any stage of growth, it depends on your setup, how you like to grow, how your plants are responding, and what your goals are. I'm positive some of the suggestions you read will not work for you, and some things that work for you are probably considered wrong by someone else. I suggest you keep notes of when you achieve good results and create your own targets and strategies over time.

Short answer: 64.2% is not high humidity for early veg. One way of understanding VPD is the "drying power" of the air, and while I suggest you

pay more attention to temperature and humidity levels since they are intuitive, calculating vpd can help you decide how to compare one setup to another. For instance, if you typically like your growth at a VPD of 1.0, and for some reason you must run your room at 100 degrees F, you can use VPD to calculate that the humidity you should probably shoot for to avoid stress is 85%.

2 replies

Paul_S Jul '23

Hi Noah,

Thank you for the reply! I really appreciate it. It's always great to hear from an expert. I've been growing a very long time, but it's always been very unscientific with no measurements. I've had some good success, I love growing autos. Currently, I have a 5 x 5 x 8 tent with an HLG6 650, 600 W LED light, AC Infinity fan and filter, AC infinity humidifier and their Pro 69 controller. This provides me with a lot of information, including humidity and VPD. The peak amount of light is around 1000 µmol/m2/s. I use a GH nutrient blend and high frequency fertigation. Temperature and humidity/VPD have been hard to figure out. I read an article last night that recommended a maximum of 700 µmol/m2/s, with another advising up to 1500, but with CO2 supplements. It was my understanding, and I will defer to your expertise, that we as growers want to encourage transpiration, which causes the plant to draw nutrients from the media (I use very well washed coco and perlite.) This is always been my concern regarding the humidity being too high. I presume, and it seems incorrectly, that if it were too high, the plant could no longer transpire as the air was too saturated. I want to squeeze out every last little bit I can from these autos. The average yield is 4 ounces per plant. That's good in my understanding. So if you were using my set up, what would you recommend for humidity/VPD for autos in the various stages of growth? Should I forget about VPD for a while and just focus on humidity? Thank you again! This is so much fun.

paul

1 reply

Noah ▶ Paul_S Jul '23

Hi Paul,

I'm surprised you can only get 1000 µmol/m2/s (which I'm going to refer to as ppfd) in a tent with that light, you must have it hung pretty high up. But if so, that's good, because those HLG lights have a tight spread. I consider them to be high-bay lights; I have them in one of my rooms and have them connected to the ceiling, not even on a hanger, so I can have a remote hope of spreading the light around evenly. Every other one of my rooms has bar style lights which is nice because the plants can grow to within 4 inches of them without damage and I still have even light across the canopy.

700-800ppfd is a good recommendation for 12 hours of light for hungry plants (tomatoes, peppers, cannabis) grown without CO2 supplementation. 1500 ppfd is enough to cook almost any plant and if anyone gets results with these values they are an exception, not a rule. Technically I can get a plant to grow under 1500, but it's not going to look as good as the one under 1300. If you are vegging with 18+ hours, you should be under 700ppfd even with CO2. Get used to calculating DLI; my lights are always set based on DLI.

As far as transpiration, like I alluded to in my last comment, there can be too much of a good thing. Traspiration is your way of getting the plant to suck nutrients out of the soil and dry the soil back which pulls oxygen into the soil. For one, if you are growing in deep water hydro you don't ever dry back so you "need" even less transpiration. There is also an idea amount of fertlizer, too much being a way more common result of poor yields

than too little. As a grower, I do my best to match transpiration to the amount of nutrient I feed. If I'm used to growing with 1000ppm of a nutrient at 70% humidity, and I decide to switch things up and drop to 50% humidity then my plant will be consuming far more water so I have to drop my nutrient to say 750ppm to avoid burning.

You can actually get very scientific about this: for instance if I want my plants to consume 5.5 grams of a nutrient mix per day, and the plant consumes 1 gallon of water per day at 70% humidity, then I would mix 5.5 grams per gallon in the irrigation water; if I then reduce my humidity to 50% and the plant consumes 1.3 gallons per day, I would reduce my nutrient to 5.5*1/1.3= 4.2 grams per gallon as a good estimate.

Put another way, you don't need transpiration to increase the amount of food the plants consumes, you can also just increase the amount of food you put in the soil. You must balance the two factors. But as I've said to a hundred other growers and had a hundreds other growers say to me, less is often more when it comes to nutrients. Show me ten photos of glossy curled up burnt tipped plants being fed 3.0 EC and I'll show you ten thousand photos of supple healthy green beautiful flawless leaves being fed at 1.8 EC.

There is plenty of transpiration occurring at 70% humidity provided the airflow is good. My pots can go from fully saturated to deeply dry in less than 24 hours.

Yield per plant is another relative thing. This is totally dependent on which plant, which media, how much media etc. I used to grow autos as a seed producer and in a deep water culture setup with unrestricted root growth I have grown autos with 2.5 pounds of flower on a single plant. One unfortunate thing about autos is that your only control over their "veg" time is the amount of space you give the roots; they basically go to flower as soon as the roots hit a wall. My average for autos in 2 gallons of coir given 2.2 square feet per plant and grown under 18+ hour light cycles is about 4-5 ounces.

As far as *my* recommendations go, it's hard to go out on a limb and assume I know what your environment and pest/disease pressure is like as well as how your plants respond to the nutrient you are giving it. You kinda have to read the plants and ask them what they want. I also don't disagree with the recommendations in the article at the top of this thread, my reason for chiming in was to reinforce putting things in perspective.

But if I was setting up a tent and had CO2 and had good airflow and was ontop of my deleafing/pruning then I'd shoot for around 1.2 kPa vpd beginning to end, only considering dropping at the end of flower if I was worried about bud rot or air flow. And if I was growing autos I'd have my lights dimmed to provide 700 to 750 umol for 18 hours which is a **lot** of light; I'd set my CO2 ppms to match the umols, so around 750ppm. If my dehus or ACs were struggling or I was growing in an area with poor insulation causing light/dark temp or humidity swings I'd grow with 24 hours of light and dim the light proportionally. The only thing I'd adjust throughout the cycle is the temp, starting at 82-85F, eventually landing at ~72F (adjusting the humidity to keep the vpd about the same). That's just me tho, there are a hundred ways to fry an egg.

1 reply

Paul_S Jul '23

Hi Noah!

Thank you so much, that is a lot of useful information. My app does measure DLI as well as PPFD. BTW, my light will make way more than 1000 PPFD, that's just the highest I've ever gone. I'm just starting a new grow. I'm going to try a VPD of 1.2 per your suggestion (I promise I won't get angry if I screw something up :-). My tent is in the basement which is rather cool, so I always need to add heat, certainly at the beginning. I have a heater hooked up to my system. It turns on and off based on the temperature. I will try higher temperatures as well. I admit to being afraid of

mold/bud rot. Killer yields with your autos! Thank you again!

paul

S **SleepyGary** Jul '23

Hi, awesome article, I've read it many many times at this point haha… I've got a question about nighttime VPD, specifically leaf surface temperature and what I should do about the offset , daytime is -6, but at night it has to be closer to 0 I assume? More wondering if my humidity is too high at night or not…

I'm doing my first ever grow, currently in early stages of flower and I'm noticing high humidity in the tent at night… During the daytime I've got a -6 surface temp offset and I run 1.2 vpd, but it drops to 0.65ish range at night… But if I set the offset to 0 at night then I'm in range… Seeing this I figured I'm okay at night… Is this wrong to assume the leaf temp and room temp are the same or very similar when the lights are out? Sorry for the long reply. Hope I didn't miss anything, listed more #s below for night and day. Thank you!

About 83F and 51%RH during day, 1.2ish VPD, -6 offset for leaf surface temp
Currently 74F and 57.8% putting me at .69 VPD w/ -6 offset for leaf surface temp, turns to 1.1ish with 0 offset.

Edit: I guess it just occurred to me that I could check it myself… but its forbidden to go into the tent when the lights have been off 😅 soo i'm hoping for some insight.

1 reply

 **peet** ▶ SleepyGary Aug '23

Hi @SleepyGary , thanks for the kind words. At night your offset is indeed closer to zero, but overall there's no real transpiration going on at night (1/10th to 1/100th of the amount happening during the day), so VPD is pretty much irrelevant.

I wrote a section here on it: The Ultimate Vapor Pressure Deficit (VPD) Guide - Pulse Grow

---

A **Aidan** ▶ Noah Sep '23

BRO

This is super spicy content, I'm facing some issues in this vein in my grow currently.

We're facing huge problems with our AC in our building and temperatures are rising like a bastard. We're reticent to add more tables into production because of how much additional heat the lights will throw.

I'm curious though, we went overkill on some enormous fans (evaporative cooler units ironically enough) to help cool the grow off.

If we were to run those extra tables, would the increased airflow over the plants offset the risk for mold/mildew with increased temperature and humidity?

Have you ever had experience running rooms at such high temperatures?

Cheers,
Aidan

Have

Aidan Sep '23

Also, By virtue of your post below, would we need to adjust our EC accordingly to help the plants acclimate to the need for more water?

Cheers,
Aidan

---

igetayes ▶ Noah Dec '23

I recently came across this site researching VPD . I am new to all of this and with the overwhelming amount of contradicting information i've come to the conclusion that trial and error and learned experience is the only way !
I say that to say, i learned more from the few paragraphs you wrote in response to a post than i have since i started this particular information hunt.
The information is hard enough to understand but add in the attempt to sell you something and everyone is an expert. especially if im not. Thanks again Sean

---

Kevin_B Jan '24

The is no SINGLE VPD for everyone, VPD is not the answer, but an means to track your grow. VPD is the ratio of temp and humidity, but other factors weigh in heavily for each persons situation, such as a C02 enrichment and DLI preference. So my VPD will vary based on how I choose to grow my plants. Figure HOW you want to grow, then just use VPD as a way to keep your temp/humidity ratio correct for all your other variables.

1 reply

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elliott_debell ▶ Kevin_B Jan '24

Interesting, can you give some examples of parameters you would play with if you co2 enrichment or different stages of bud growth. I'm assuming you're thinking about growth steering at different times?

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[Feature Highlight] Zones w/ Batch & Phase Tracking

Growing with Pulse: Jayplantspeaker

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