

SPECIAL REPORT:

HUMIDITY AND CLIMATE CONTROL

In this Special Report, made possible by Quest, we take a holistic look at the challenges facing cultivations and **the important role of climate control.**



HANDLING HUMIDITY:

AIR QUALITY LEADS TO QUALITY CANNABIS



Back in 2017, Quest worked closely with *Cannabis Business Times* to publish the first “Smart Humidity Special Report.” Our goal was to educate the industry and provide helpful and thorough information around the role humidity plays in indoor cultivations. This year, we are back with an updated report.

Not surprisingly, both pest and disease management and humidity control remain some of the top challenges in cannabis cultivation operations today. These two things are tightly interwoven and have a large impact on each other. The best way to combat these issues is by prevention. By maintaining proper humidity, growers can create an environment where it is difficult for pests and disease to thrive. With growing concern over pesticide use and more rigorous product testing, humidity control remains the most effective and healthy way to manage these types of issues.

Quest has a long history of humidity control in both indoor gardening as well as a breadth of other industries. We were one of the first companies over a decade ago to recognize the important role humidity played in the success of a cultivator and the need for high-quality, efficient dehumidification. Since then, we have worked hand-in-hand with thousands of operators across the globe, dialing in their environmental control to enable them to grow high-quality product that is free of pests and disease.

This year’s report will feature insights around prevention, surveys that show current trends such as growing conditions, and helpful information around VPD and what it means. More than ever, producing consistent, high-quality products is a must for a successful cultivator. We hope this report aids in that effort. Beyond this, we have many helpful resources on our website (questclimate.com/blog).

We look forward to working with you in your upcoming ventures.

Cheers,

JOSH SPALDING, SALES APPLICATION ENGINEER, QUEST DEHUMIDIFIERS

This report is based on data from proprietary research conducted by *Cannabis Business Times*, with support from Hawthorne Gardening Company and Quest, as well as insights from cultivators and experts on the challenges facing cultivations and tips to address them.



Survey Says...

Humidity along with pest and disease management continue to be top concerns as plant health is critical to a cultivation business's success.

Participants in *Cannabis Business Times*' 2021 "State of the Growing Environment" research report indicated they were very aware of the dangers associated with poor plant health management, with 41% of growers noting it as one of their greatest cultivation challenges, followed closely by humidity control (32%).

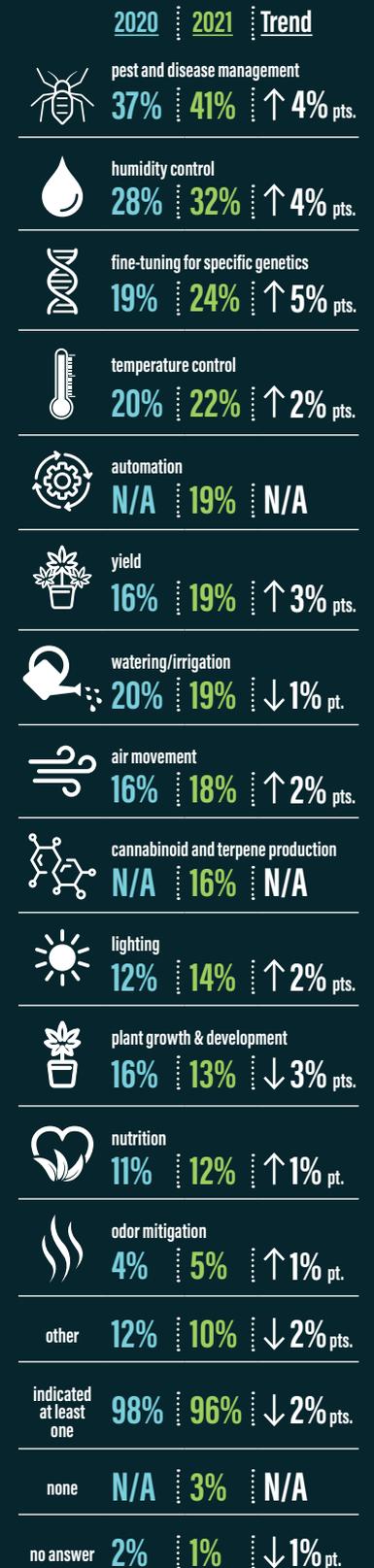
While 41% of participants noted "pest and disease management" as a top cultivation challenge in this year's report, 65% indicated having to deal with a pest or disease problem in their facilities in the past 12 months. Although this is a significant portion of participants experiencing pest and disease issues, that figure is down 6 percentage points from 2020, when 71% of participants reported dealing with pest and/or disease issues in the past 12 months.

The most commonly encountered pest

and disease problems were: mites (30%), powdery mildew (29%), and aphids (26%). All occurrences of diseases and pests noted in 2021 were down from the 2020 report except for botrytis (12% of research participants indicated they had botrytis contamination, up from 8% in 2020).

More than half (54%) of this year's research participants pointed to external contamination, either through contaminated inputs or staff tracking in contaminants, as the cause of pest and/or disease issues in their grows. Relatedly, growers seem to have gained a better understanding of how to control their environments to prevent plant health problems. About one-quarter (24%) of cannabis growers blamed unbalanced humidity levels for their pest and disease outbreaks (down 12 percentage points from last year's study); Sixteen percent blamed a lack of airflow (down 10 percentage points from 2020); and 15% blamed uncontrolled temperature (down 1 percentage point from last year's study).

What are your operation's greatest cultivation challenges?



Note: Total exceeds 100% because participants could select all that apply.

Pests + Humidity = Loss

Plants contaminated by pests and disease can result in drastically reduced yields, lower cannabinoid and terpene levels, or, in worst case scenarios, completely collapse, leading to total crop failure.

In addition to trying to limit external contaminants, unbalanced humidity is considered a main contributor to pest and disease issues. Cannabis crops suffer when humidity levels aren't just right. Many growers know that low humidity and dry conditions can create an appealing environment for spider mites, and high humidity can create an environment ripe for botrytis (bud rot), among other diseases.

Finally, a constant swing in humidity can create an unhealthy environment for the plant, which invites certain diseases such as powdery mildew to infiltrate the crop.

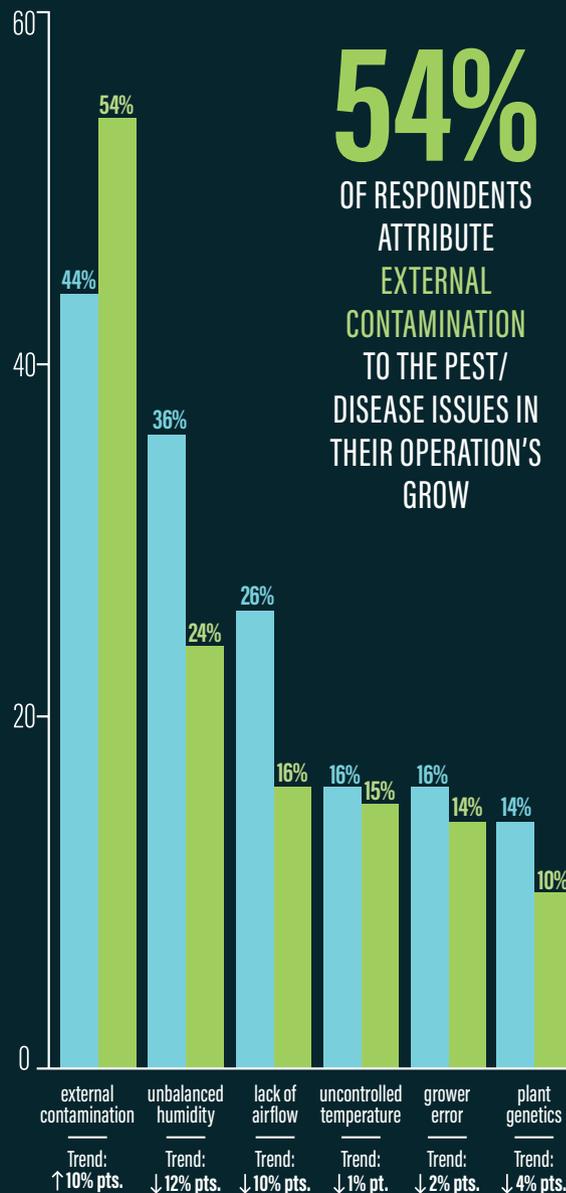
In the past year, has your operation had any of the following pest/disease issues in its grow?

| | 2020 | 2021 | Trend |
|------------------------|------|------|------------|
| mites | 35% | 30% | ↓ 5% pts. |
| powdery mildew | 42% | 29% | ↓ 13% pts. |
| aphids | N/A | 26% | N/A |
| mold | 20% | 19% | ↓ 1% pt. |
| thrips | N/A | 19% | N/A |
| botrytis | 8% | 12% | ↑ 4% pts. |
| whiteflies | N/A | 4% | N/A |
| other | 13% | 9% | ↓ 4% pts. |
| indicated at least one | 71% | 65% | ↓ 6% pts. |
| none | 29% | 34% | ↑ 5% pts. |
| no answer | 0% | 1% | ↑ 1% pt. |

Note: Total exceeds 100% because participants could select all that apply.

To what do you attribute the pest/disease issues in your operation's grow?

● 2020* ● 2021**



54%
OF RESPONDENTS
ATTRIBUTE
EXTERNAL
CONTAMINATION
TO THE PEST/
DISEASE ISSUES IN
THEIR OPERATION'S
GROW

Note: Total exceeds 100% because participants could select all that apply. *Base: those who own or work for a licensed operation that cultivates cannabis for sale either indoor or in a greenhouse and indicated they experienced pest/disease issues in the past year (77). **Base: those who own or work for a licensed operation that cultivates cannabis for sale either indoor or in a greenhouse and indicated they experienced pest/disease issues in the past year (91).

19 TIPS FOR Regulating Humidity

Note: This article originally was published in the July 2017 issue of Cannabis Business Times as part of its "Special Report: Smart Humidity" supplement sponsored by Quest Dehumidifiers.

As part of this research project, Cannabis Business Times asked cultivators to share their strategies for maintaining optimal humidity levels. Here's what they said:

1. "The use of a dehumidifier has been critical for my operations. Removing lower leaves as soon they begin to fade and adequate spacing between plants coupled with excellent air circulation. ... Also, keeping the humidity level below 50% outside of the rooms." - Scott Stanley, Owner/Operator, Artisan Greenery, Minnesota

2. "... A humid drying room could cause the plant to not properly dry. ... I find that AC units work well. [So do] fans and dehumidifiers, but [they] require monitoring." - Jaymie Vacura, Owner, CannaVision, Washington

3. "Cuttings need to retain moisture until roots show. Then, VPD [vapor pressure deficit] plays a role in veg and flower. And in flower, we do not want to invite molds or mildew of any kind with thick buds forming. ... [Use the] correct equipment [fans, dehumidifiers, temperature control]." - Max White, Production Manager, Aroma Cannabis, Oregon

4. "We are located in a dry, high-altitude environment where day-to-night temperatures can swing 50 degrees difference. There was a

learning curve understanding how to set up our automated greenhouse controls to properly deal with humidity spikes during our monsoon season. Keep an eye on incoming weather and make proactive adjustments to [automated] environmental control settings." - Scott Holland, Director of Operations, Durango Organics, Colorado

5. "Dehumidification, circulation fans at top and sides of the greenhouse or room. Proper intake and outtake of fresh air. [Use] an automated environmental control system." - Michael Redmond, Owner/Cultivator, Red Bud Harvest, Michigan

6. "Final results of an indoor grow are greatly influenced by the way growers keep in control of parameters that influence their plants' growth. There are two basic factors that can easily be forgotten when we're busy thinking of other ways to increase yields, size and overall health of our plants: temperature and relative humidity. [Use] humidity and temperature data loggers and recorders." - (preferred to remain anonymous, state not provided)

7. "Keeping VPD in the optimal range, especially in the early stages of plant lifecycle, ensures optimal growth rates. Stomata on the leaves are more open, allowing the plant to uptake more CO₂, and growth rates increase. PM and other issues are less likely to occur in the optimal RH/temperature range. [Use] a humidifier during 'lights on,' and have enough dehumidification power when lights are off in flowering rooms. Hygrometer, constant monitoring, and dehumidifiers/fans are automated." - (preferred to remain anonymous, Washington)

What do you use to monitor humidity in your cultivation operation?



“
THERE WAS A LEARNING CURVE
UNDERSTANDING HOW TO SET UP OUR AUTOMATED GREENHOUSE CONTROLS.

What tools do you use to regulate humidity?



81%
FANS



71%
DEHUMIDIFIER



67%
TEMPERATURE CONTROL

Note: Exceeds 100% because participants could select more than one option. The study was conducted during May and June 2017. Results are based on 104 research participants who indicated that they own or work for a cannabis cultivation business. The survey was conducted online with a link provided for participants.

EXPERT OPINION: DID YOU KNOW?

BY NADIA SABEH, PH.D., PE, LEED AP

HUMIDITY, PESTS, AND PATHOGENS

Controlling humidity is important to ensure good plant health and productivity. ... Under both too-dry and too-wet conditions, the plant will be stressed and, if prolonged, can result in nutrient deficiencies and greater susceptibility to pests and pathogens.

Many growers believe that keeping the humidity “as low as possible” is a good thing, especially as it relates to mold prevention. Although true for many molds, such as botrytis, there are other cases where low humidity can be detrimental. For instance, did you know that powdery mildew doesn’t need free moisture to propagate or travel? Perhaps even more surprising is that their reproductive spores are resistant to dry conditions. In fact, air temperature is a bigger indicator of risk than humidity. And, unfortunately, they love grow room temperatures of 75 degrees to 85 degrees.

Warm, dry conditions are also favored by spider mites. So when growers tell me they want a high vapor pressure deficit (VPD) greater than 1.5 kPa (kilopascal), I always ask them to reconsider, explaining that low humidity is essentially an open invitation for pests to kick a plant while it’s down.

WHY IS VAPOR PRESSURE DEFICIT IMPORTANT?

VPD is a measure of the difference between the amount of water in the air versus the

maximum amount of water the air can hold at a given temperature (the saturated condition). It is typically measured in units of kPa or mbars. A low VPD is indicative of high moisture content in the air, and a high VPD is indicative of low moisture content.

Stomatal opening of plant leaves is directly related to VPD. If VPD is too high, stomata will close to conserve water. If it’s too low, stomata may be fully open, but evapotranspiration will be slow since the difference in water quantity of the leaf (which is saturated) and the air is very small, reducing evaporation potential. Both conditions can cause wilting, leaf tip burn, and other crop maladies. When VPD is managed correctly, plants will transpire freely, move nutrients readily to cells, and maximize CO₂ uptake.

RELATIVE HUMIDITY VS. ABSOLUTE HUMIDITY

Relative Humidity (RH) is also a measure of the difference between the amount of water in the air versus the maximum amount of water the air can hold at a given temperature (the saturated condition). However, it is measured as a ratio (or percentage) of how saturated the air is. This value does not provide information about how the plant is responding directly to its environment. However, it is a common input for controlling HVAC equipment.

Absolute Humidity (AH) measures the actual amount of water in the air, regardless of temperature. It is measured in units of pounds of water per pounds of air (or kilograms). This value is important for calculating how much water to add or remove via humidification or dehumidification, respectively, to achieve the desired RH or VPD at a given temperature.

5 TIPS FOR HUMIDITY CONTROL

1. Control air temperature and humidity to achieve a VPD of 0.8 kPa to 1.25 kPa.
2. Use humidity control to manage stomatal opening, photosynthetic rates, and nutrient delivery.
3. When VPD is right, plants are healthy and can better defend themselves against pathogens.
4. Air movement around plants reduces the infection potential of mildews and molds.
5. Don’t be afraid of a relative humidity of 65% to 75% if air temperature is 75 degrees to 80 degrees. (The result: VPD = 0.9kPa to 1.2 kPa)

Dr. Nadia Sabeh is founder of Dr. Greenhouse, an engineering consulting firm that specializes in the design, specification and analysis of environmental control systems. Dr. Sabeh is a licensed Mechanical Engineer in California and received her Ph.D. in Agriculture and Biosystems Engineering from the University of Arizona’s Controlled Environment Agriculture Center (CEAC).

8. “Your grow/flowering room should have at least two temperature and humidity gauges.” - [preferred to remain anonymous, California]

9. “We change watering strategies slightly when we have days where we will fight high humidity.” - Trey Anderson, Director of Production, IESO, Illinois

10. “Keeping optimum soil moisture. Containment of run-off, air flow to reduce micro-climates.” - Eric Edgerton, Owner, Tilth LLC, California

11. “I use a HOBO data logger that monitors and records both temperature and relative humidity every 5 minutes. The data is accessible via Bluetooth on my iPhone. ... Lots of air movement, large dehumidifiers and drip watering systems.” - Rick Harder, Owner/Grower, Oregon Cannabis Authority LLC, Oregon

12. “Keep your equipment clean and serviced.” - Mark Robertson, Owner, Going Green, Washington

13. “Use commercial HVAC/humidity control systems designed for plants, not people.” - [preferred to remain anonymous, Illinois]

14. “Dehumidify and ventilate the greenhouse while irrigating

the crop to prevent trapping any unwanted humidity.”

- Samuel Thoman, Chief of Business Development, Strawberry Fields, Colorado

15. “Have a dehumidifier or two for the night hours. Run the AC at a bit lower temperatures at night to extract moisture.”

- Jason Roberts, Owner, Loving Kindness Farms, California

16. “Great air circulation.” - [preferred to remain anonymous, California]

17. “The more water (plants) I have in the room, the more humidity reduction I need.” - (preferred to remain anonymous, state not provided)

18. “As an organic dirt grower, I found that the more I paid attention to watering throughout flower and went light (i.e., let them get a bit thirsty from time to time), the less of a humidity problem. I use AC and a 90-pint dehumidifier for a 32-plant flower room of approximately 15 feet by 40 feet. And I run four 16-inch ... fans on low 24/7, oscillating.” - Keith James, Detroit High-Ons, Michigan

19. “Different strains may need different humidity levels.”

- [preferred to remain anonymous, Washington]

A Deeper Dive into Humidity



Humidity control can be the bane of some cultivators' existence. Rapid temperature drops in the night may cause humidity to jump upward, often into the danger zone. Daytime heat, or heat from lighting, causes a temperature increase which in turn causes the humidity to drop, and thirsty plants can wilt under that stress. But temperature is just one consideration in controlling humidity; there are other factors that come into play.

What some may not know, however, is that in addition to the obvious risks to crops, you and your staff could also face health risks. "The combination of warm temperatures and high humidity found in many indoor marijuana grow operations can fuel extensive mold growth," stated Dr. John Martyny in a press release from National Jewish Health, regarding a

study of the potential hazards of cannabis cultivation. "Airborne levels of mold spores that we found inside these structures may subject the occupants ... to significant health hazards, especially allergies, asthma, hypersensitivity pneumonitis and other respiratory diseases."

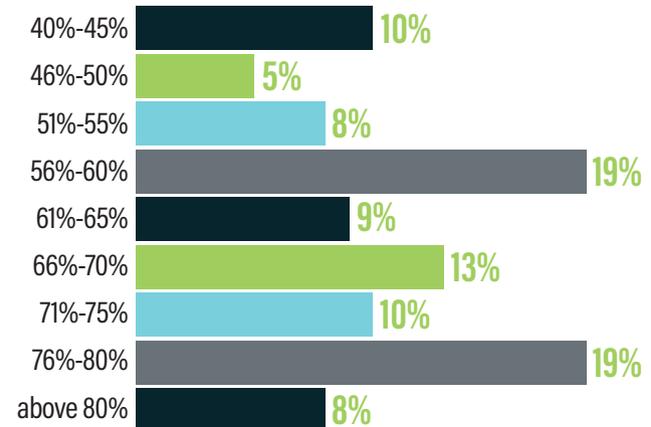
CONTROL AT EVERY STAGE OF GROW

While most growers agree that humidity is a concern, they are not in agreement on the optimal humidity levels at various growth stages of the cannabis plant.

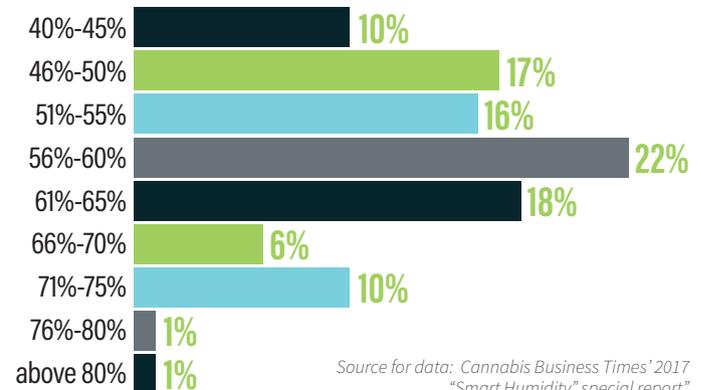
And while many growers admit to being unsure of their humidity-control practices, others say that their optimal room humidity levels absolutely work for them.

For clone rooms, 19 percent of research participants in *Cannabis Business Times'* 2017 "Smart Humidity" special report said the ideal humidity level is 56%-60%. The same number of respondents

What is your optimal clone room humidity level?



What is your optimal vegetative room humidity level?



Source for data: *Cannabis Business Times'* 2017 "Smart Humidity" special report

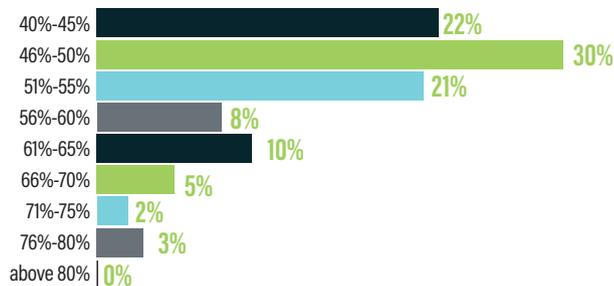
said that, ideally, the humidity level should fall in the range of 76% to 80%. In all, the research showed that desired humidity levels in clone rooms vary from 40%-45% to above 80%.

For veg rooms, study participants' responses varied almost as much, with the same number of respondents (10%)

saying the ideal humidity level in these rooms is 40%-45% as those who said 71%-75%. The largest number of respondents (22%)—well shy of any kind of majority—indicated their ideal humidity level in veg rooms is 56%-60%, followed by 18% who said ideal humidity in these rooms is 61%-65%.

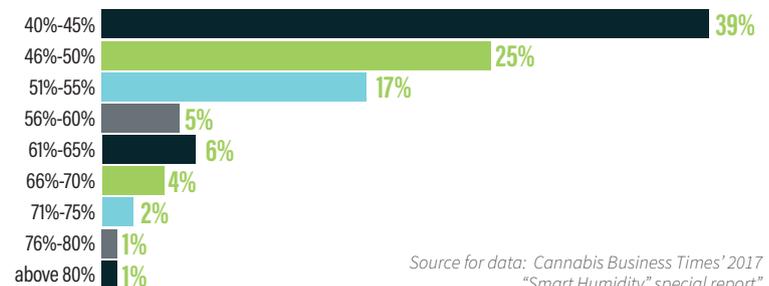


What is your optimal flowering room humidity level?



In the flowering stage, growers came closer to a consensus. Nearly three-fourths (73%) of respondents said the optimal humidity level in flowering rooms is in the range of 40% to 55%. Eighteen percent said 56% to 65%, while 3% of cultivators said their ideal flower room humidity level

What is your optimal humidity level during the final stages of flowering?



is in the range of 76% to 80%. No respondents said humidity above 80% was ideal. **The late flowering stage** saw even more consensus among cultivators in the study. Nearly two-thirds (64%) indicated the optimal humidity level in the final stages of flowering is in the range of 40%

to 50%. Within that range, more cultivators (39%) said 40%-45% was optimal than those who said 46%-50% was ideal (25%). Just 4% said humidity levels during late flower are ideally above 70%, while only 1% said they prefer humidity above 80% in this stage.

Source for data: Cannabis Business Times' 2017 "Smart Humidity" special report

Mastering Measurements of VPD

There is a growing understanding around monitored levels of humidity results in thriving plants, and gone are the days of keeping grow rooms as dry as possible to avoid mold and mildew.

Cultivators benefit from applying vapor pressure deficit, or VPD, in grow rooms because it enables them to encourage plant growth and optimize the environment by monitoring the relationship between plant transpiration, humidity, and temperature.

To understand VPD, it is first important to grasp transpiration,

which is the biological process where moisture travels from plant roots to leaf pores, where it evaporates into the air as water vapor. In hot and dry conditions, plants transpire more, just as humans sweat in the heat, resulting in increased water use and watering requirements.

VPD correlates directly to plant transpiration rates, so by controlling VPD, growers can control how quickly moisture and nutrients travel through plants. Increased VPD results in increased water and nutrient uptake through plant roots, which, at the appropriate life stage, boosts plant growth.



VPD when leaves are 1C cooler than air temperature

Relative Humidity (%)

| | VPD |
|---|-------------|
| Low Transpiration/Propagation/Early Veg | 0.4-0.8 |
| Healthy Transpiration/Late Veg/Early Flower | 0.8-1.2 |
| High Transpiration/Late Flower | 1.2-1.6 |
| Danger Zone | <0.4 / >1.6 |

| Air Temp (F/C) | 81 | 80 | 79 | 78 | 77 | 76 | 75 | 74 | 73 | 72 | 71 | 70 | 69 | 68 | 67 | 66 | 65 | 64 | 63 | 62 | 61 | 60 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | |
|----------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 50/10 | 0.15 | 0.17 | 0.18 | 0.19 | 0.20 | 0.21 | 0.23 | 0.24 | 0.25 | 0.26 | 0.28 | 0.29 | 0.30 | 0.31 | 0.33 | 0.34 | 0.35 | 0.36 | 0.37 | 0.39 | 0.40 | 0.41 | 0.42 | 0.44 | 0.45 | 0.46 | 0.47 | 0.48 | 0.50 | 0.51 | 0.52 | 0.53 | 0.55 | 0.56 | 0.57 | 0.58 | 0.60 | 0.61 | 0.62 | 0.63 | 0.64 | 0.66 | 0.67 | |
| 51.8/11 | 0.17 | 0.18 | 0.19 | 0.20 | 0.22 | 0.23 | 0.24 | 0.26 | 0.27 | 0.28 | 0.30 | 0.31 | 0.32 | 0.34 | 0.35 | 0.36 | 0.37 | 0.39 | 0.40 | 0.41 | 0.43 | 0.44 | 0.45 | 0.47 | 0.48 | 0.49 | 0.51 | 0.52 | 0.53 | 0.55 | 0.56 | 0.57 | 0.58 | 0.60 | 0.61 | 0.62 | 0.64 | 0.65 | 0.66 | 0.68 | 0.69 | 0.70 | 0.72 | |
| 53.6/12 | 0.18 | 0.19 | 0.20 | 0.22 | 0.23 | 0.25 | 0.26 | 0.27 | 0.29 | 0.30 | 0.32 | 0.33 | 0.35 | 0.36 | 0.37 | 0.39 | 0.40 | 0.42 | 0.43 | 0.44 | 0.46 | 0.47 | 0.49 | 0.50 | 0.51 | 0.53 | 0.54 | 0.56 | 0.57 | 0.58 | 0.60 | 0.61 | 0.63 | 0.64 | 0.65 | 0.67 | 0.68 | 0.70 | 0.71 | 0.72 | 0.74 | 0.75 | 0.77 | |
| 55.4/13 | 0.19 | 0.20 | 0.22 | 0.23 | 0.25 | 0.26 | 0.28 | 0.29 | 0.31 | 0.32 | 0.34 | 0.35 | 0.37 | 0.38 | 0.40 | 0.41 | 0.43 | 0.44 | 0.46 | 0.47 | 0.49 | 0.50 | 0.52 | 0.53 | 0.55 | 0.56 | 0.58 | 0.59 | 0.61 | 0.62 | 0.64 | 0.65 | 0.67 | 0.68 | 0.70 | 0.71 | 0.73 | 0.74 | 0.76 | 0.77 | 0.79 | 0.80 | 0.82 | |
| 57.2/14 | 0.20 | 0.22 | 0.24 | 0.25 | 0.27 | 0.28 | 0.30 | 0.31 | 0.33 | 0.35 | 0.36 | 0.38 | 0.39 | 0.41 | 0.43 | 0.44 | 0.46 | 0.47 | 0.49 | 0.51 | 0.52 | 0.54 | 0.55 | 0.57 | 0.59 | 0.60 | 0.62 | 0.63 | 0.65 | 0.67 | 0.68 | 0.70 | 0.71 | 0.73 | 0.75 | 0.76 | 0.78 | 0.79 | 0.81 | 0.83 | 0.84 | 0.86 | 0.87 | |
| 59/15 | 0.22 | 0.23 | 0.25 | 0.27 | 0.29 | 0.30 | 0.32 | 0.34 | 0.35 | 0.37 | 0.39 | 0.40 | 0.42 | 0.44 | 0.46 | 0.47 | 0.49 | 0.51 | 0.52 | 0.54 | 0.56 | 0.58 | 0.59 | 0.61 | 0.63 | 0.64 | 0.66 | 0.68 | 0.69 | 0.71 | 0.73 | 0.75 | 0.76 | 0.78 | 0.80 | 0.81 | 0.83 | 0.85 | 0.87 | 0.88 | 0.90 | 0.92 | 0.93 | |
| 60.8/16 | 0.23 | 0.25 | 0.27 | 0.29 | 0.31 | 0.32 | 0.34 | 0.36 | 0.38 | 0.40 | 0.41 | 0.43 | 0.45 | 0.47 | 0.49 | 0.51 | 0.52 | 0.54 | 0.56 | 0.58 | 0.60 | 0.61 | 0.63 | 0.65 | 0.67 | 0.69 | 0.71 | 0.72 | 0.74 | 0.76 | 0.78 | 0.80 | 0.81 | 0.83 | 0.85 | 0.87 | 0.89 | 0.91 | 0.92 | 0.94 | 0.96 | 0.98 | 1.00 | |
| 62.6/17 | 0.25 | 0.27 | 0.29 | 0.31 | 0.33 | 0.35 | 0.37 | 0.38 | 0.40 | 0.42 | 0.44 | 0.46 | 0.48 | 0.50 | 0.52 | 0.54 | 0.56 | 0.58 | 0.60 | 0.62 | 0.64 | 0.66 | 0.68 | 0.69 | 0.71 | 0.73 | 0.75 | 0.77 | 0.79 | 0.81 | 0.83 | 0.85 | 0.87 | 0.89 | 0.91 | 0.93 | 0.95 | 0.97 | 0.99 | 1.00 | 1.02 | 1.04 | 1.06 | |
| 64.4/18 | 0.27 | 0.29 | 0.31 | 0.33 | 0.35 | 0.37 | 0.39 | 0.41 | 0.43 | 0.45 | 0.47 | 0.49 | 0.51 | 0.53 | 0.55 | 0.58 | 0.60 | 0.62 | 0.64 | 0.66 | 0.68 | 0.70 | 0.72 | 0.74 | 0.76 | 0.78 | 0.80 | 0.82 | 0.84 | 0.86 | 0.88 | 0.91 | 0.93 | 0.95 | 0.97 | 0.99 | 1.01 | 1.03 | 1.05 | 1.07 | 1.09 | 1.11 | 1.13 | |
| 66.2/19 | 0.28 | 0.31 | 0.33 | 0.35 | 0.37 | 0.39 | 0.42 | 0.44 | 0.46 | 0.48 | 0.50 | 0.53 | 0.55 | 0.57 | 0.59 | 0.61 | 0.64 | 0.66 | 0.68 | 0.70 | 0.72 | 0.75 | 0.77 | 0.79 | 0.81 | 0.83 | 0.86 | 0.88 | 0.90 | 0.92 | 0.94 | 0.97 | 0.99 | 1.01 | 1.03 | 1.05 | 1.07 | 1.10 | 1.12 | 1.14 | 1.16 | 1.18 | 1.21 | |
| 68/20 | 0.30 | 0.33 | 0.35 | 0.37 | 0.40 | 0.42 | 0.44 | 0.47 | 0.49 | 0.51 | 0.54 | 0.56 | 0.58 | 0.61 | 0.63 | 0.65 | 0.68 | 0.70 | 0.72 | 0.75 | 0.77 | 0.79 | 0.82 | 0.84 | 0.86 | 0.89 | 0.91 | 0.93 | 0.96 | 0.98 | 1.00 | 1.03 | 1.05 | 1.07 | 1.10 | 1.12 | 1.14 | 1.17 | 1.19 | 1.21 | 1.24 | 1.26 | 1.29 | |
| 69.8/21 | 0.32 | 0.35 | 0.37 | 0.40 | 0.42 | 0.45 | 0.47 | 0.50 | 0.52 | 0.55 | 0.57 | 0.60 | 0.62 | 0.65 | 0.67 | 0.70 | 0.72 | 0.75 | 0.77 | 0.80 | 0.82 | 0.85 | 0.87 | 0.90 | 0.92 | 0.95 | 0.97 | 1.00 | 1.02 | 1.05 | 1.07 | 1.09 | 1.12 | 1.14 | 1.17 | 1.19 | 1.22 | 1.24 | 1.27 | 1.29 | 1.32 | 1.34 | 1.37 | |
| 71.6/22 | 0.35 | 0.37 | 0.40 | 0.42 | 0.45 | 0.48 | 0.50 | 0.53 | 0.56 | 0.58 | 0.61 | 0.64 | 0.66 | 0.69 | 0.72 | 0.74 | 0.77 | 0.79 | 0.82 | 0.85 | 0.87 | 0.90 | 0.93 | 0.95 | 0.98 | 1.01 | 1.03 | 1.06 | 1.09 | 1.11 | 1.14 | 1.16 | 1.19 | 1.22 | 1.24 | 1.27 | 1.30 | 1.32 | 1.35 | 1.38 | 1.40 | 1.43 | 1.46 | |
| 73.4/23 | 0.37 | 0.40 | 0.42 | 0.45 | 0.48 | 0.51 | 0.54 | 0.56 | 0.59 | 0.62 | 0.65 | 0.68 | 0.71 | 0.73 | 0.76 | 0.79 | 0.82 | 0.85 | 0.87 | 0.90 | 0.93 | 0.96 | 0.99 | 1.01 | 1.04 | 1.07 | 1.10 | 1.13 | 1.15 | 1.18 | 1.21 | 1.24 | 1.27 | 1.30 | 1.32 | 1.35 | 1.38 | 1.41 | 1.44 | 1.46 | 1.49 | 1.52 | 1.55 | |
| 75.2/24 | 0.39 | 0.42 | 0.45 | 0.48 | 0.51 | 0.54 | 0.57 | 0.60 | 0.63 | 0.66 | 0.69 | 0.72 | 0.75 | 0.78 | 0.81 | 0.84 | 0.87 | 0.90 | 0.93 | 0.96 | 0.99 | 1.02 | 1.05 | 1.08 | 1.11 | 1.14 | 1.17 | 1.20 | 1.23 | 1.26 | 1.29 | 1.32 | 1.35 | 1.38 | 1.41 | 1.44 | 1.47 | 1.50 | 1.53 | 1.56 | 1.59 | 1.62 | 1.65 | |
| 77/25 | 0.42 | 0.45 | 0.48 | 0.51 | 0.54 | 0.58 | 0.61 | 0.64 | 0.67 | 0.70 | 0.73 | 0.77 | 0.80 | 0.83 | 0.86 | 0.89 | 0.92 | 0.96 | 0.99 | 1.02 | 1.05 | 1.08 | 1.11 | 1.15 | 1.18 | 1.21 | 1.24 | 1.27 | 1.30 | 1.34 | 1.37 | 1.40 | 1.43 | 1.46 | 1.49 | 1.53 | 1.56 | 1.59 | 1.62 | 1.65 | 1.68 | 1.72 | 1.75 | |
| 78.8/26 | 0.44 | 0.48 | 0.51 | 0.55 | 0.58 | 0.61 | 0.65 | 0.68 | 0.71 | 0.75 | 0.78 | 0.81 | 0.85 | 0.88 | 0.92 | 0.95 | 0.98 | 1.02 | 1.05 | 1.08 | 1.12 | 1.15 | 1.18 | 1.22 | 1.25 | 1.28 | 1.32 | 1.35 | 1.39 | 1.42 | 1.45 | 1.49 | 1.52 | 1.55 | 1.59 | 1.62 | 1.65 | 1.69 | 1.72 | 1.76 | 1.79 | 1.82 | 1.86 | |
| 80.6/27 | 0.47 | 0.51 | 0.54 | 0.58 | 0.62 | 0.65 | 0.69 | 0.72 | 0.76 | 0.79 | 0.83 | 0.87 | 0.90 | 0.94 | 0.97 | 1.01 | 1.04 | 1.08 | 1.11 | 1.15 | 1.19 | 1.22 | 1.26 | 1.29 | 1.33 | 1.36 | 1.40 | 1.44 | 1.47 | 1.51 | 1.54 | 1.58 | 1.61 | 1.65 | 1.69 | 1.72 | 1.76 | 1.79 | 1.83 | 1.86 | 1.90 | 1.93 | 1.97 | |
| 82.4/28 | 0.50 | 0.54 | 0.58 | 0.62 | 0.65 | 0.69 | 0.73 | 0.77 | 0.81 | 0.84 | 0.88 | 0.92 | 0.96 | 0.99 | 1.03 | 1.07 | 1.11 | 1.15 | 1.18 | 1.22 | 1.26 | 1.30 | 1.33 | 1.37 | 1.41 | 1.45 | 1.49 | 1.52 | 1.56 | 1.60 | 1.64 | 1.68 | 1.71 | 1.75 | 1.79 | 1.83 | 1.86 | 1.90 | 1.94 | 1.98 | 2.02 | 2.05 | 2.09 | |
| 84.2/29 | 0.54 | 0.58 | 0.62 | 0.66 | 0.70 | 0.74 | 0.78 | 0.82 | 0.86 | 0.90 | 0.94 | 0.98 | 1.02 | 1.06 | 1.10 | 1.14 | 1.18 | 1.22 | 1.26 | 1.30 | 1.34 | 1.38 | 1.42 | 1.46 | 1.50 | 1.54 | 1.58 | 1.62 | 1.66 | 1.70 | 1.74 | 1.78 | 1.82 | 1.86 | 1.90 | 1.94 | 1.98 | 2.02 | 2.06 | 2.10 | 2.14 | 2.18 | 2.22 | |
| 86/30 | 0.57 | 0.61 | 0.65 | 0.70 | 0.74 | 0.78 | 0.82 | 0.87 | 0.91 | 0.95 | 0.99 | 1.04 | 1.08 | 1.12 | 1.16 | 1.21 | 1.25 | 1.29 | 1.33 | 1.37 | 1.42 | 1.46 | 1.50 | 1.54 | 1.59 | 1.63 | 1.67 | 1.71 | 1.76 | 1.80 | 1.84 | 1.88 | 1.93 | 1.97 | 2.01 | 2.05 | 2.10 | 2.14 | 2.18 | 2.22 | 2.27 | 2.31 | 2.35 | |
| 87.8/31 | 0.60 | 0.65 | 0.69 | 0.74 | 0.78 | 0.83 | 0.87 | 0.92 | 0.96 | 1.01 | 1.05 | 1.10 | 1.14 | 1.19 | 1.23 | 1.28 | 1.32 | 1.37 | 1.41 | 1.46 | 1.50 | 1.55 | 1.59 | 1.64 | 1.68 | 1.73 | 1.77 | 1.82 | 1.86 | 1.91 | 1.95 | 2.00 | 2.04 | 2.09 | 2.13 | 2.18 | 2.22 | 2.27 | 2.31 | 2.36 | 2.40 | 2.45 | 2.49 | |
| 89.6/32 | 0.64 | 0.69 | 0.74 | 0.78 | 0.83 | 0.88 | 0.93 | 0.97 | 1.02 | 1.07 | 1.12 | 1.16 | 1.21 | 1.26 | 1.31 | 1.35 | 1.40 | 1.45 | 1.50 | 1.54 | 1.59 | 1.64 | 1.69 | 1.74 | 1.79 | 1.84 | 1.89 | 1.94 | 1.99 | 2.04 | 2.09 | 2.14 | 2.19 | 2.24 | 2.29 | 2.34 | 2.39 | 2.44 | 2.49 | 2.54 | 2.59 | 2.64 | 2.69 | 2.74 |
| 91.4/33 | 0.68 | 0.73 | 0.78 | 0.83 | 0.88 | 0.93 | 0.98 | 1.03 | 1.08 | 1.13 | 1.18 | 1.23 | 1.28 | 1.33 | 1.38 | 1.43 | 1.48 | 1.54 | 1.59 | 1.64 | 1.69 | 1.74 | 1.79 | 1.84 | 1.89 | 1.94 | 1.99 | 2.04 | 2.09 | 2.14 | 2.19 | 2.24 | 2.29 | 2.34 | 2.39 | 2.44 | 2.49 | 2.54 | 2.59 | 2.64 | 2.69 | 2.74 | 2.79 | |
| 93.2/34 | 0.72 | 0.77 | 0.83 | 0.88 | 0.93 | 0.99 | 1.04 | 1.09 | 1.15 | 1.20 | 1.25 | 1.31 | 1.36 | 1.41 | 1.47 | 1.52 | 1.57 | 1.63 | 1.68 | 1.73 | 1.78 | 1.84 | 1.89 | 1.94 | 2.00 | 2.05 | 2.10 | 2.16 | 2.21 | 2.26 | 2.32 | 2.37 | 2.42 | 2.48 | 2.53 | 2.58 | 2.64 | 2.69 | 2.74 | 2.80 | 2.85 | 2.90 | 2.95 | |
| 95/35 | 0.76 | 0.82 | 0.88 | 0.93 | 0.99 | 1.05 | 1.10 | 1.16 | 1.21 | 1.27 | 1.33 | 1.38 | 1.44 | 1.50 | 1.55 | 1.61 | 1.66 | 1.72 | 1.78 | 1.83 | 1.89 | 1.95 | 2.00 | 2.06 | 2.11 | 2.17 | 2.23 | 2.28 | 2.34 | 2.40 | 2.45 | 2.51 | 2.56 | 2.62 | 2.68 | 2.73 | 2.79 | 2.84 | 2.90 | 2.96 | 3.01 | 3.07 | 3.13 | |
| 96.8/36 | 0.81 | 0.87 | 0.93 | 0.99 | 1.05 | 1.11 | 1.17 | 1.23 | 1.29 | 1.34 | 1.40 | 1.46 | 1.52 | 1.58 | 1.64 | 1.70 | 1.76 | 1.82 | 1.88 | 1.94 | 2.00 | 2.06 | 2.12 | 2.18 | 2.24 | 2.29 | 2.35 | 2.41 | 2.47 | 2.53 | 2.59 | 2.65 | 2.71 | 2.77 | 2.83 | 2.89 | 2.95 | 3.01 | 3.07 | 3.13 | 3.19 | 3.25 | 3.30 | |
| 98.6/37 | 0.86 | 0.92 | 0.98 | 1.05 | 1.11 | 1.17 | 1.23 | 1.30 | 1.36 | 1.42 | 1.49 | 1.55 | 1.61 | 1.67 | 1.74 | 1.80 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



Something in the Air

Maintaining proper humidity levels is critical to cultivation operations growing in controlled environments. Research participants in *CBT's* 2021 “State of the Growing Environment” report indicated using a wide range of systems to control air moisture levels, often employing a range of equipment in their facilities. Standalone dehumidifiers were the most commonly reported systems used to control humidity in cultivation areas (48%). Ventilation (44%), air conditioning (37%), and integrated HVAC-D (HVAC systems with a built in reheat, 35%) made up the rest of the humidity control systems growers reported using.

Airflow is another critical component to humidity control in indoor and greenhouse operations. Participants in the 2021 research report indicated using a variety of resources when configuring the airflow layout in their

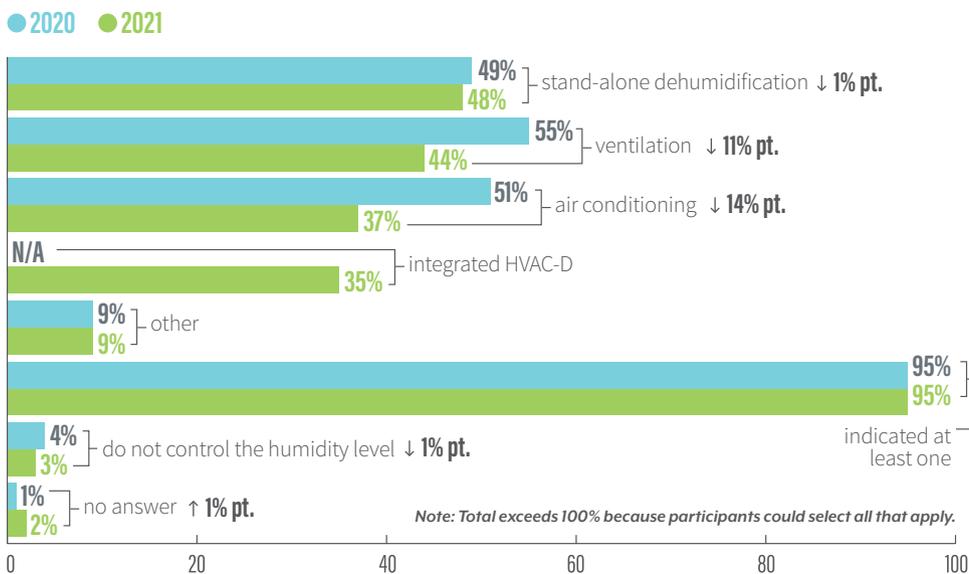
**STANDALONE
DEHUMIDIFIERS**
WERE THE MOST
COMMONLY
REPORTED SYSTEMS
USED TO CONTROL
HUMIDITY IN
CULTIVATION AREAS

48%



facilities. Nearly half (46%) of research participants reported relying on a contractor or engineer to help map out airflow, while 35% went with manufacturer recommendations. Just under one-third (32%) of growers noted relying on anecdotal expertise, while only 9% said they did not lay out the airflow in their grow.

How is the humidity level being controlled within your operation’s growing space?



What resources were used when configuring the airflow layout in your operation’s facility?

46%
ENGINEER/CONTRACTOR

.....

35%
MANUFACTURERS’
RECOMMENDATIONS

.....

32%
ANECDOTAL EXPERTISE

.....

22%
OTHER

.....

88%
INDICATED AT LEAST ONE

.....

9%
NO AIRFLOW LAYOUT

.....

3%
NO ANSWER



THE
**TRUSTED
PARTNER**

FOR SUPPORT AND SERVICE.

To master your grow room you need more than the best environmental control equipment. You need a partner to help you maximize your return on investment – to support you in everything from sizing and setup to installation to support and service.

Since 2006, Quest has advanced the industry with the most energy efficient, widest selection of standalone dehumidifiers designed specifically for growing cannabis. We are continuing to push the envelope.

LET'S FACE IT. YOU CANNOT AFFORD TO GROW WITHOUT A QUEST.

 **QUEST**
QUESTCLIMATE.COM