STATE OF THE

GROWING ENVIRONMENT

An exclusive research report examining how the industry manages cannabis cultivation climates.

IN PARTNERSHIP WITH

HAWTHORNE™ GROWING ENVIRONMENT

CANNABIS BUSINESS TIMES

RETHINKING CLIMATE CONTROL
IN AN AGE OF FAST GROWTH

It's not news. Everyone knows as cannabis legalization spreads, the industry is exploding. What does warrant talking about, however, is the trend toward larger production spaces as growers go commercial to meet skyrocketing demand. This year's "State of the Growing Environment Report" seems to demonstrate this. Take, for example, that the average size of respondents' cannabis canopy is 44,300 square feet, up from an average of 34,700 square feet as reported in *Cannabis Business Times*' 2019 "State of the Cultivation Market Report" and 25,600 square feet from the same report in 2018. In an industry known for pioneering innovative ways to grow plants in any conditions, this is yet another reality that requires new ways of thinking, fast.

With growth comes opportunity—and increasing complexity for maintaining balanced indoor and greenhouse environments. Mitigating temperature swings, air pockets and moisture from thousands of plants transpiring in the same room gets even more complicated with each additional plant, light fixture and square foot. The consequences of getting it wrong can be devastating.

Yet support for managing these elements at scale, as well as access to equipment engineered specifically to balance growing environments, hasn't been as quick to expand. In fact, this year's results show that of the top five greatest challenges growers report in their operation, three are linked to unbalanced growing environments: temperature control, humidity control, and pest and disease control.

We're not surprised. A holistic understanding of what leads to issues like these—and tools built with that in mind—is required to get us where we want to go as an industry. It's why we've focused on expanding our technical services team, selecting market-leading partners like Quest with purpose-built portfolios, and improving education to empower growers with what they need to change the game.

Hawthorne is proud to support *Cannabis Business Times*' first-ever "State of the Growing Environment Report." While we believe in furthering the industry by gathering data and insights, that alone is not enough. To truly propel our industry forward, we must share those insights to help growers everywhere seize the opportunities of today and build the industry of tomorrow.

CHRIS HAGEDORN
General Manager, Hawthorne Gardening Company

"TO TRULY PROPEL OUR INDUSTRY FORWARD, WE MUST SHARE THOSE INSIGHTS TO HELP GROWERS EVERYWHERE SEIZE THE OPPORTUNITIES OF TODAY AND BUILD THE INDUSTRY OF TOMORROW."

INVISIBLE BUT ESSENTIAL

Many key components of a cultivation operation are tangible, such as lighting, growing media, nutrient solutions, irrigation and containers. *Cannabis Business Times* has conducted research in some of these areas, including lighting and nutrients, to examine how cultivation companies are managing their operations and to discover trends and best practices.

"Invisible" aspects that comprise an overall growing environment like humidity, temperature and airflow can get lost in the myriad responsibilities of running a healthy, productive facility, but they are essential. Maintaining appropriate temperature, humidity and airflow levels can protect crops from pests and disease. And, unlike people, cannabis plants can't cover up with a cardigan or take shelter when it's too hot or cold, as noted by David Bernard-Perron of The Green Organic Dutchman (TGOD) in the case study on page S13. They respond to stress differently, and those responses can greatly impact yield and cannabinoid and terpene development.

To better understand how cultivation companies manage their growing environments, *CBT*, with support from Hawthorne Gardening Company, conducted exclusive industry research for the first-ever "State of the Growing Environment Report." In order to get the most meaningful results about how cultivators approach temperature, humidity, airflow and more, the report includes data only from companies that grow cannabis indoors or in greenhouses.

Cultivation has often been referred to as an art and science, as growers account for everything from balancing the multiple variables in their cultivation environments, while factoring in facility size, geographic location, the type and number of supplemental lights used, plant genetics and the cultivator's objectives, whether focused on yield or cannabinoid or terpene content. There isn't a one-size-fits-all solution, which is part of the challenge and why research is so important.

This in-depth report explores everything from cultivators' biggest challenges to their struggles with and causes of pests and diseases to their climate preferences and primary considerations in selecting HVAC systems, among others.

The case study on TGOD chronicles how the company adjusted components of its growing environment for a greatly expanded operation, and a feature by John W. Bartok, Jr.—an agricultural engineer and emeritus extension professor at the University of Connecticut—provides tips on how to prevent pest and disease outbreaks using strategic environmental control (S9).

The "State of the Growing Environment Report" provides cultivators with the opportunity to review the strategies of their peers and compare them to their own, as well as to glean insights into best practices that can help improve their growing environments to improve yields, plant health, pest control and ultimately, profits.

71% OF PARTICIPANTS REPORT PEST OR DISEASE ISSUES IN THEIR GROWS IN THE PAST YEAR, WITH 36% CITING UNBALANCED HUMIDITY AS THE CAUSE.

RYLAND ZWEIFEL | ADOBE STOCK; HAGEDORN PHOTO COURTESY OF HAWTHORNE

CLIMATE CONTROL AMONG TOP CULTIVATION CHALLENGES

Cultivating cannabis requires a delicate balance of several factors—among the most significant of which are climate control, plant nutrition, lighting and genetics, not to mention the business/financial components. Research participants in the 2020 "State of the Growing Environment Report" indicated their greatest cultivation challenges include "cost" (42%), "pest and disease management" (37%), "humidity control" (28%), and "temperature control" and "watering/irrigation" (both 20%).

All of these factors tie into the cultivation environment, from the cost investment in the facility, equipment and oftentimes labor required for a controlled climate and healthy crop to the humidity and temperature controls required to prevent pests and diseases.

And while "pest and disease management" was ranked by just slightly more than a third of study participants as one of their greatest cultivation challenges, 71% of participants indicated they have had pest and disease issues in their growing operations during the past year, including the top culprit, powdery mildew (42%). Of those who indicated they have grappled with pests and disease, the largest number (44%) cited "external contamination" as the cause of those struggles. Many believe poor climate control was at play, as 36% attributed outbreaks to "unbalanced humidity," 26% indicated a "lack of airflow" as the cause, and 16% reported "uncontrolled temperature" was an issue.

TOP CULTIVATION CHALLENGES

COST | PEST AND DISEASE MANAGEMENT | HUMIDITY CONTROL | TEMPERATURE CONTROL | WATERING/ IRRIGATION

In the past year, have you had any of the following pest/disease issues in your grow?


powdery mildew: 42%


mites: 35%


mold: 20%


botrytis: 8%

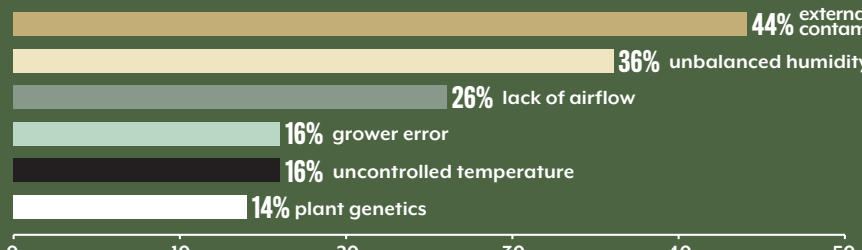
other: 13%

indicated at least one: 71%

none: 29%

Note: Totals exceed 100% because participants could select all that apply.

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



Note: Totals exceed 100% because participants could select all that apply.

other: 18%

indicated at least one: 96%

unknown: 4%

no answer: 4%

What are your operation's greatest cultivation challenges?

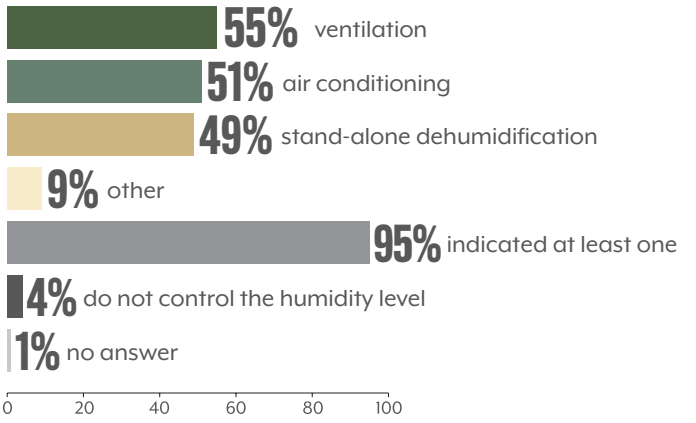
- cost: 42%
- pest and disease management: 37%
- humidity control: 28%
- temperature control: 20%
- watering/ irrigation: 20%
- fine-tuning for specific genetics: 19%
- air movement: 16%
- plant growth and development: 16%
- yield: 16%
- lighting: 12%
- nutrition: 11%
- odor mitigation: 4%
- other: 12%

Note: Totals exceed 100% because participants could select all that apply. Open-ended responses to "other" included: Construction (pre-grow phrase), cycle times, propagation, and weeds, among others.

CULTIVATOR CLIMATE PREFERENCES

Ideal temperature and humidity can vary greatly depending on the geographic location of a grow, facility type, time of day and the plant growth stage, to name a few factors. Achieving appropriate temperature and humidity levels is crucial to proper plant growth. As Mark June-Wells, Ph.D., principal of Sativum Consulting Group, wrote in a previous issue of *Cannabis Business Times,* "With very low humidity, the plant is drawing water from the soil at a very high rate, and if the humidity is too low, the plant is unable to draw water at a rate equal to the loss through the stomatal openings … which slows the photosynthetic process (due to carbon limitations) and leads to stress, slow growth and compromised yield." Conversely, diseases thrive in humidity levels that are too high. This importance was illustrated in this year's study, as 95% of participants indicated they control humidity within their growing spaces and use multiple methods to do so. The majority (55%) use "ventilation," while another 51% use "air conditioning," and 49% use "stand-alone dehumidification."

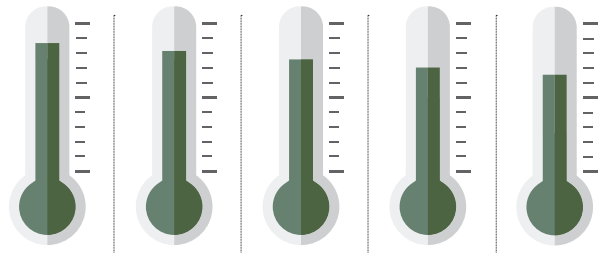
How are you controlling the level of humidity within your growing space?



Note: Totals exceed 100% because participants could select all that apply.

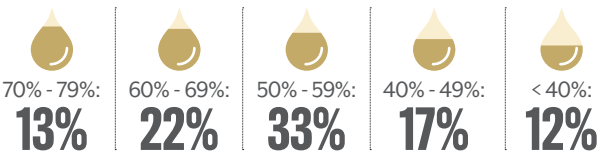
VEGETATIVE A majority of participants (66%) keep daytime temperatures between 70 and 79 degrees Fahrenheit during the vegetative stage. However, nearly a fifth of participants (19%) said they prefer higher temperatures when plants are in veg, dialing up to 80 to 84 degrees. There was less of a consensus for preferred humidity levels in this stage among participants, however. A plurality of participants (33%) reported a preference for humidity of 50% to 59%. Twenty-two percent preferred a range of 60% to 69%, while 17% desired levels of 40% to 49%. A fair number (13%) reported that they keep humidity at 70% to 79% during this stage.

What daytime (lights on) temperatures do you like to maintain in your *vegetative* rooms?



no answer: 6%

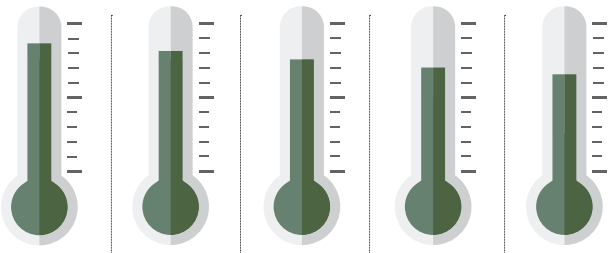
What humidity level do you like to maintain in your *vegetative* rooms?



no answer: 4%

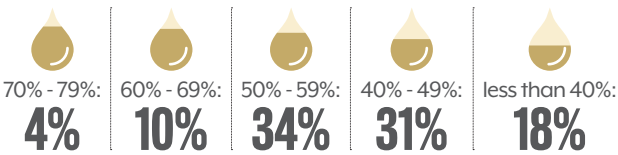
FLOWERING Most participants (73%) again reported that they stay within that 9-degree temperature range (70 to 79 degrees Fahrenheit) in the flowering stage, although 12% indicated they maintained their rooms at temps between 80 and 84 degrees. As with the vegetative stage, participants' ideal humidity levels varied greatly when examining study results in the flowering stage. The plurality (34%) reported keeping humidity levels in their flowering rooms between 50% and 59%, but close behind are those who keep levels between 40% and 49% (31%). Nearly a fifth of participants (18%) set the dials to less than 40% humidity at this growth stage.

What daytime (lights on) temperatures do you like to maintain in your *flowering* rooms pre-harvest?



no answer: 3%

What humidity level do you like to maintain in your *flowering* rooms?



no answer: 3%

DZMITRY; KIRILL; PINGEBAT; MARTIALRED; WARMWORLD | ADOBE STOCK; VECTOR GRAPHIC ARTIST | ISTOCKPHOTO

THE IMPORTANCE OF AIRFLOW

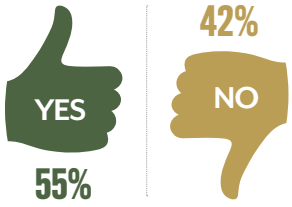
While temperature and humidity are often the focus, proper airflow is just as important to maintaining a healthy grow, as David Bonvillain, owner and principal of Elite Cannabis Enterprises/Elite Botanicals, noted in a previous issue of *Cannabis Business Times*. Cannabis requires a much heavier airflow than traditional horticulture crops, he noted. "I need circulating airflow through the entire environment at a pretty good clip," Bonvillain said. "I need channels of air on a low zone so I'm moving air around the lower canopy. If you don't, you increase your chances of mold and mildew and pests significantly."

Despite its importance, many cultivators (37%) say they rely on "anecdotal expertise" as their primary layout strategy. Another 29% sought advice from an "engineer/contractor," while 16% took the "manufacturer's recommendations." Fourteen percent reported that they have no airflow layout.

Those participants who map airflow in their facilities (86%) said that the three most important factors when laying out airflow in flowering rooms were "balancing temperature and humidity in room" (70%), "size of room" (54%) and "number of plants" (47%).

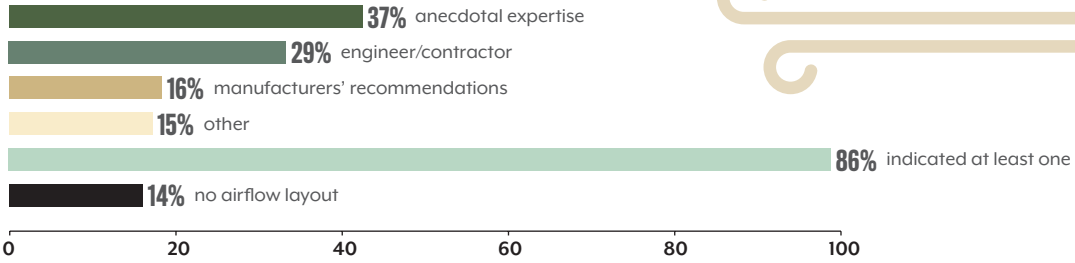
There was not a strong consensus among participants regarding enriching with CO_2, although the majority (55%) reported using CO_2; 42% said they do not.

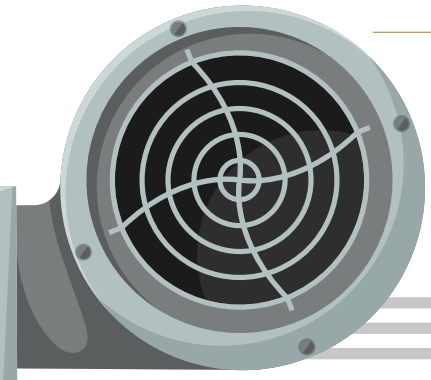
Do you enrich with CO_2?



I DON'T KNOW: 4%

How did you lay out airflow in your facility?





What factors were important to you when laying out your airflow in your flowering room?

balancing temperature and humidity in room:	size of room:	number of plants:	targeted air velocity/CFM:	density of canopy:	lighting used:	other:
70%	54%	47%	45%	41%	41%	12%

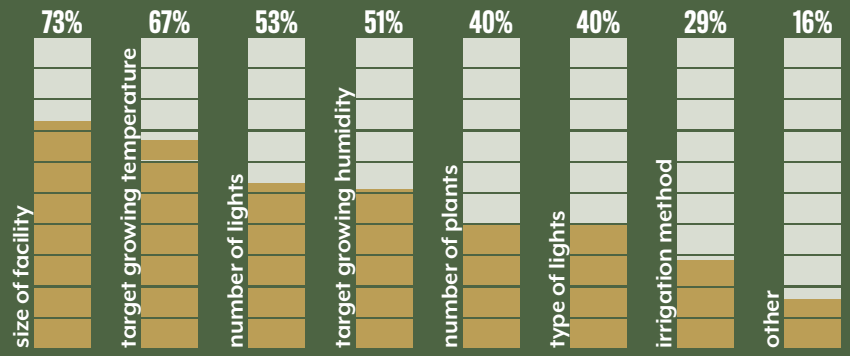
Note: Totals exceed 100% because participants could select all that apply.

RYLAND ZWEIFEL; SVITLANA | ADOBE STOCK

HVAC PRIORITIES

Results from the 2020 "State of the Growing Environment" study revealed participants consider many factors when planning to purchase HVAC systems, chief among them "size of facility" (73%). Other important aspects they examine include "target growing temperature" (67%), "number of lights" (53%) and "target growing humidity" (51%). When deciding which HVAC system to buy, those who were directly involved in purchasing once again noted several priorities that were important. The top 3 include "performance/efficiency, lead time" (78%), "price" (69%) and "customer support" (56%).

What factors did you take into consideration when planning to purchase your HVAC system?



Note: Totals exceed 100% because participants could select all that apply. Base: Those who own or work for a licensed operation that cultivates cannabis indoors or in a greenhouse and who are directly involved in HVAC purchases: 42%

How important were each of these factors when deciding which HVAC system to purchase?
Participants ranked each factor on a five-point scale where "5" equals "very important" and "1" equals "not at all important." Factors rated highest in importance were "performance/efficiency and lead time," "price" and "customer support." Factors are ordered from highest importance to lowest.

PERFORMANCE/EFFICIENCY & LEAD TIME

78%

of participants rated "performance/efficiency and lead time" as a 4 or 5 on the 5-point scale

1	2	3	4	5
4%	2%	13%	33%	44%

PRICE

69%

of participants rated "price" as a 4 or 5 on the 5-point scale

1	2	3	4	5
0%	0%	22%	24%	44%

CUSTOMER SUPPORT

56%

of participants rated "customer support" as a 4 or 5 on the 5-point scale

1	2	3	4	5
13%	4%	24%	16%	40%

EASE OF INSTALLATION

51%

of participants rated "ease of installation" as a 4 or 5 on the 5-point scale

1	2	3	4	5
11%	7%	22%	20%	31%

COMPATIBILITY WITH CONTROL SYSTEMS

49%

of participants rated "compatibility with control systems" as a 4 or 5 on the 5-point scale

1	2	3	4	5
11%	4%	29%	18%	31%

RECOMMENDATIONS FROM AN ENGINEER OR A CONTRACTOR

47%

of participants rated "recommendations from an engineer or contractor" as a 4 or 5 on the 5-point scale

1	2	3	4	5
16%	9%	18%	20%	27%

CERTIFICATES OF ANALYSIS (DOCUMENTS SHOWING AND CERTIFYING THIRD-PARTY TEST RESULTS)

42%

of participants rated "certificates of analysis" as a 4 or 5 on the 5-point scale

1	2	3	4	5
20%	7%	27%	7%	36%

RECOMMENDATIONS FROM OTHER GROWERS

42%

of participants rated "recommendations from other growers" as a 4 or 5 on the 5-point scale

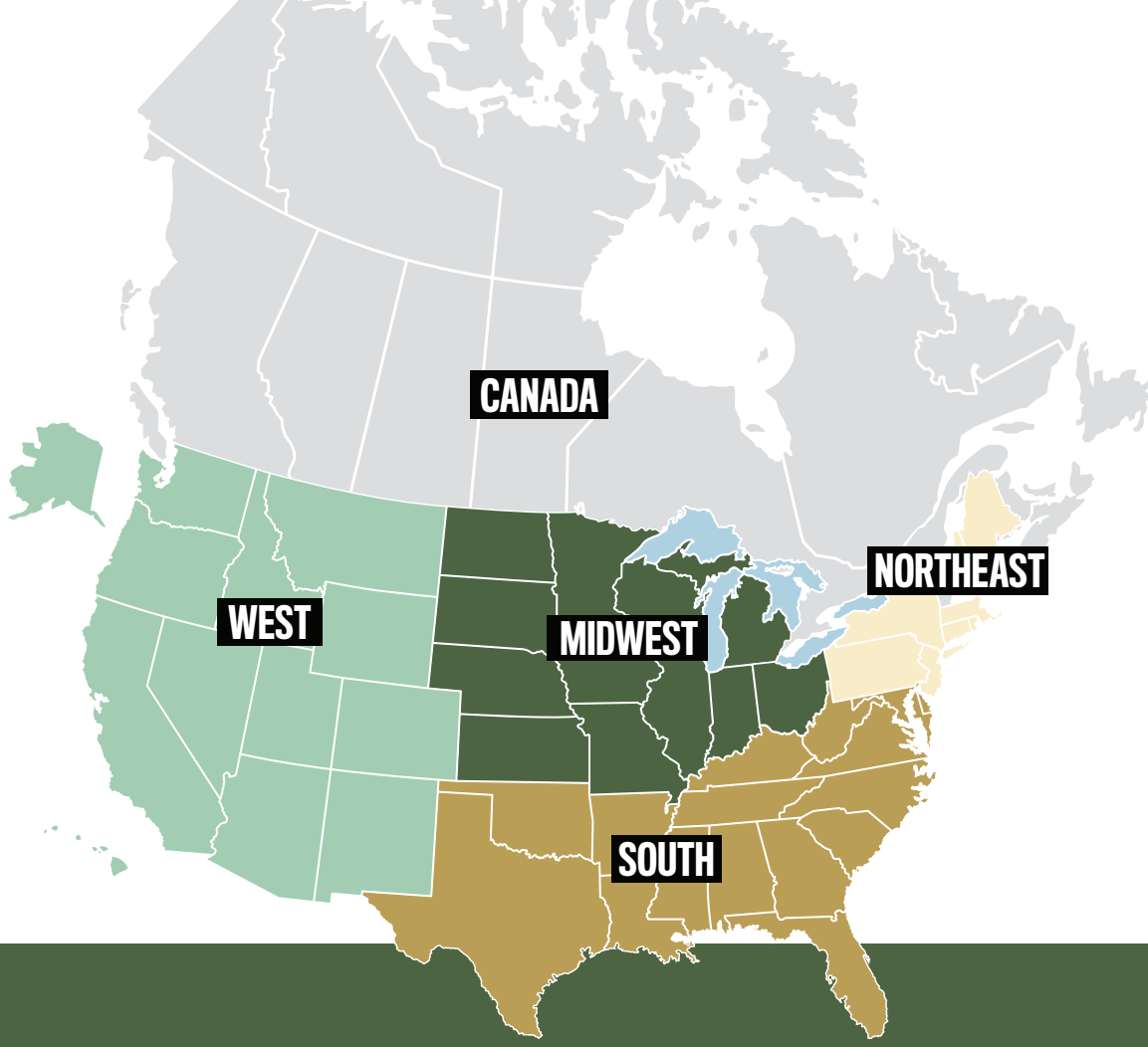
1	2	3	4	5
16%	13%	22%	20%	22%

Note: Totals exceed 100% because participants could select all that apply. Base: Those who own or work for a licensed operation that cultivates cannabis indoors or in a greenhouse and who are directly involved in HVAC purchases: 42%

Where is your operation located?

- Midwest: 7%
- Northeast: 10%
- South: 38%
- West: 37%
- Canada: 7%

Note: Figures may not total 100% due to rounding.

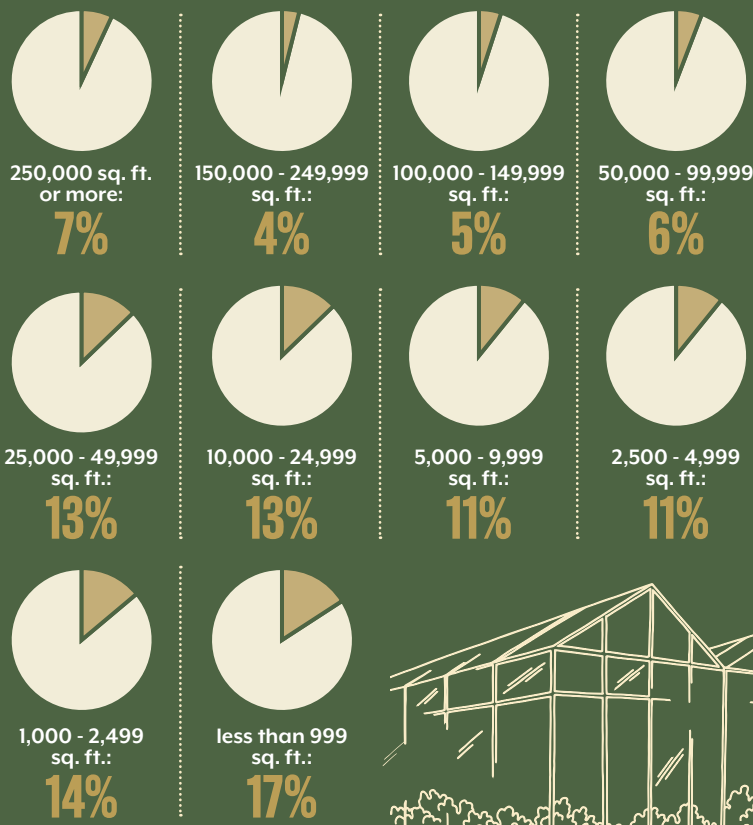


ABOUT THE RESEARCH AND PARTICIPANTS

Third-party researcher Readex Research conducted the study and compiled the data for the 2020 "State of the Growing Environment Report." *Cannabis Business Times* sent the study questionnaire to subscribers with known email addresses and/or e-newsletter subscribers located in the U.S., Canada or other (unknown) North American locations in January 2020.

Results are based on 108 participants who indicated they own or work for a licensed operation that cultivates cannabis for sale in the U.S. or Canada in an indoor or greenhouse growing environment. The margin of error for percentages based on the 108 participants who indicated they work for a cultivation operation that cultivates cannabis for sale in an indoor or greenhouse growing environment is approximately ±9.3 percentage points at the 95% confidence level.

What is the area of your operation's cannabis crop production (total plant canopy)?



Note: Figures may not total 100% due to rounding.

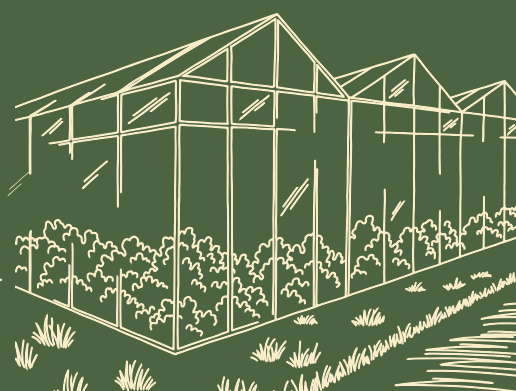


PHOTO BY JOHN BARTOK

CONTROL THE PLANT ZONE ENVIRONMENT TO

REDUCE DISEASE POTENTIAL

BY **JOHN W. BARTOK, JR.**

Disease prevention should be a top priority to achieve maximum cannabis yield and the highest-quality product. In addition to a clean growing area, balancing the environmental factors of temperature, humidity, airflow and water is required to help prevent diseases. Here are a few tips growers can use to reduce the disease potential in their cultivation areas.

1. PROVIDE UNIFORM HEATING.

As most heat sources are either point (unit heater or floor furnace) or linear (bare iron or fin pipe), providing uniform heat throughout the growing area presents a challenge. Natural convection is usually inadequate, and some forced-air movement is necessary. The most cost-effective system for large areas is a horizontal air flow (HAF) system that uses fractional horsepower, large-diameter circulating fans at a rate of 2 cubic feet per minute (cfm)/sq. ft. of floor area. An HAF creates a circular pattern of air flow at 50 feet to 100 feet per minute, which mixes the air from top to bottom in the growing space.

For small growing areas, vertical pattern fans provide good distribution but need to be overlapped to achieve uniformity. These fans draw the cool air from the floor and mix it with the lighter heated air overhead before returning it to the crop area. In addition to temperature uniformity, air movement reduces moisture from leaf surfaces, lowering the disease potential and providing

Above photo: Besides lowering humidity in the plant zone, HAF fans provide more uniform temperature and supply higher carbon dioxide to the leaf surface.

> “EVEN IN COLD WEATHER, IT ONLY COSTS A FEW CENTS TO HEAT THE REPLACEMENT GREENHOUSE AIR.”

replacement air with a higher carbon dioxide concentration for increased growth. Although more expensive to operate, fan cooling is better than side and roof vents, which are dependent on outside winds.

2. COVER YOUR COOLING VENTS.

To prevent insects and disease organisms from entering the greenhouse, growers should place screens over vents, shutters and other openings. Growers can protect entrance doors to some degree by installing air screens or double-door systems.

3. RESPOND QUICKLY TO HUMIDITY SPIKES.

A humidity level in the 40% to 60% range is standard, except for seedling production, where a slightly higher level is necessary. Excessive humidity levels can occur when irrigation water transpires or evaporates, creating an ideal environment for disease growth, such as powdery mildew, gray mold, *Fusarium* and *Pythium*. Ventilation is the standard method for reducing the humidity level in greenhouses because the air outside is drier than it is inside. Even in cold weather, it only costs a few cents to heat

Photo Right: Flood floors with hot-water radiant heat in them work well; in addition to providing heat for the greenhouse or warehouse, the heat dries the floor.

the replacement greenhouse air. However, a better system that growers can use to save energy is to incorporate a heat exchanger into the system to capture some of the heat from the moist air and return this to the greenhouse. Spray-on wetting agents for glasshouses and anti-drip additives for greenhouse plastic are other methods that growers can use.

For closed-system/warehouse production, refrigeration-based dehumidification is the standard method. But energy-conserving systems that return the water collected and the heat generated are

GREENHOUSE PHOTO BY JOHN BARTOK; L'EAGLE PHOTO BY BRIAN KRAFT

5 TIPS FOR INDOOR PLANT ZONE CONTROL

By Meredith McLoughlin, Cultivation Manager, L'Eagle Services, Denver

1. BUILD A STRONG SANITATION CULTURE.
Cross contamination needs to be avoided. Do workers come in for the day, or leave for breaks, and have to walk through plants outside? There are weeds and all types of associated contaminants just waiting to hitchhike on their shoes. One of the ways we combat this is with decontamination mats. Workers need to be clean at all times, and ideally dressed out in scrubs or Tyvek suits.

2. CLEAN EVERY ROOM AFTER HARVEST.
At L'Eagle in Denver, we have three flower rooms, and every three weeks a room gets taken down. Once a room is empty, we clean it from top to bottom, scrub trays, sanitize all fans, surfaces, and ducts and ozonate it all.

3. CONSIDER ADDING SANITATION FEATURES TO YOUR HVAC.
At L'Eagle, we consider an in-duct air purifier, often marketed as UV light or ozone generators, in our HVAC system mandatory.

4. MAINTAIN HVAC SYSTEMS.
In addition cleaning out ducts, getting HVAC coils maintained and cleaned is a great way to reduce pathogens in an environment. I think most people would be amazed at what is in their ventilation systems at home, let alone in a commercial system.

5. CHECK DRAIN TRAPS ON HVAC UNITS.
Some HVAC units come with poorly designed condensate drain traps, which can cause water buildup in the unit and spread mold in facilities. A good trap will likely have outward air-flow added inline to reduce blockages and prevent air from being taken into the unit. Traps with severe bends in the "u" also are better suited for trapping drainage and creating a seal.

Above photo: Limiting the size of growing areas can help reduce the spread of pests and disease.

> DUE TO THE INTERDEPENDENCY OF TEMPERATURE, HUMIDITY, LIGHT MOISTURE AND CARBON DIOXIDE, AN ENVIRONMENTAL CONTROL (EC) SYSTEM IS NECESSARY.

also available. This system needs to be designed for both lights-on and lights-off conditions as well as the seedling-to-flowering stages. In addition, some growers are using liquid desiccant systems. These move the humid air past a brine solution to absorb the moisture and then heat the solution to regenerate the desiccant.

4. AVOID OVERHEAD IRRIGATION.

Water management is another area that is critical for disease control. Overwatering adds moisture from runoff and wet surfaces and increases the need for humidity control. Drip systems and ebb-and-flood benches are an alternative to overhead systems that wet the foliage. Flood floors with hot-water radiant heat in them work well; in addition to providing heat for the greenhouse or warehouse, the heat dries the floor after the water drains back into the tank. This reduces humidity in the lower leaf area, minimizing disease potential.

Much of the water applied through overhead systems never reaches the growing media surface. Wireless base-station monitors that control nodes of multiple moisture sensors are available. Based on light accumulation, evapotranspiration, leachate volume and EC measurement, the nodes open or close solenoid valves in the water supply piping. These systems save water and fertilizer, increase yield and plant quality and reduce labor resulting in a very short payback.

5. INVEST IN A CENTRALIZED ENVIRONMENTAL CONTROL SYSTEM.

Individual equipment control devices (thermostat, humidistat, time clock, etc.) will not help create an environment that will support good production results in either a greenhouse or warehouse facility. Due to the interdependency of temperature, humidity, light, moisture and carbon dioxide, an environmental control (EC) system is necessary to balance these variables. It has the advantage of integrating the operation of different pieces of equipment based on a plant-growth model. The model is designed to take into account many variables, including the plant phenotype and stage of growth, room and equipment layout, projected timing of the crop and many other factors. It also can chart and analyze different growth stages to make future crops easier to replicate. Alarms are available to indicate when environmental conditions are out of established limits. Select a system that has flexibility in the type of equipment that it can control, the ability to make frequent updates to software as well as easy-to-replace components and reliable support service.

6. LIMIT THE SIZE OF PRODUCTION ZONES.

Limiting the size of growing areas can help to reduce or isolate any disease or insect infestation problems that occur. Small zones also allow different environments for the different stages of the growth cycle and more uniform temperature and humidity conditions.

John W. Bartok, Jr. is an agricultural engineer, an emeritus extension professor at the University of Connecticut and a regular contributor to *CBT*'s sister publication, *Greenhouse Management*.

OPENRANGESTOCK | ADOBE STOCK

STEER PLANT GROWTH WITH A BALANCED CLIMATE

How The Green Organic Dutchman employs a 'whole system approach' in its new 150,000-square-foot facility.

BY **JOLENE HANSEN**

When The Green Organic Dutchman (TGOD) expanded operations recently, the move transcended simply scaling what the Canadian cultivator had done before. Instead of a 7,000-square-foot indoor grow lit only with artificial lighting, the new 150,000-square-foot hybrid greenhouse offered natural light that the company could just supplement with artificial lighting—as well as much more room.

David Bernard-Perron, TGOD's vice president of growing operations, says the change required a redesign of the growing environment and environmental controls.

"We kept our growing methods. We kept the nutrient systems and the plant genetics and the type of artificial lights," Bernard-Perron says. "But the question was how we could adapt that into a commercial greenhouse production setting. We had to rethink the way we were growing to make sure it would be possible to do so at scale."

CANOPY CLIMATE

Some of TGOD's biggest changes involved workflow. The company focused on optimizing floor space to create an ergonomic environment for greenhouse workers to execute tasks—involving considerations to allow them to do their jobs more efficiently all while maximizing and optimizing their available canopy space. Keeping that process seamless for the 60-person grow team was inextricably linked to environmental controls for the enhanced greenhouse space.

When TGOD moved to its 150,000-square-foot growing facility, it adjusted its HVAC to be able to accommodate a much larger growing space.

Ensuring the heating, ventilation and air conditioning (HVAC) system was sized appropriately for the greenhouse, which Bernard-Perron describes as a glass-roofed warehouse, was top of mind. Compared to a limited ceiling height in conventional indoor gardens,

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TGOD accounted for the fact it cultivates with soil, which can block airflow and increase humidity levels, when installing an HVAC system.

GIVEN THE LARGE VOLUME OF SOIL USED IN TGOD OPERATIONS, OPTIMIZING CANOPY AIRFLOW IS CRITICAL.

the 23-foot-high greenhouse ceilings dramatically impact air circulation throughout the grow. To capitalize on climate stratification in the room, the team chose a design with roots in traditional greenhouse agriculture.

The approach targets climate at canopy level—the first 7 feet of grow-room height. TGOD plants grow on mobile benches, while HVAC systems deliver air from underneath. "We always inject the air from our HVAC where it's most critical to us," Bernard-Perron explains.

As cool air at crop level warms, it moves through the canopy, eliminating detrimental microclimates on its way to the ceiling-based exhaust. "We're really managing the canopy level instead of managing the whole grow room. Our profitability comes from the canopy, not from the whole room," Bernard-Perron says. "It's a very efficient way to cool a greenhouse."

LIVING SOIL CONSIDERATIONS

TGOD's use of soil, essential to its operations and its organic certification, creates unusual dynamics within the grow. Bernard-Perron explains that soil not only blocks airflow in the canopy, it also contributes to higher humidity levels. Canopy-level climate control mitigates those effects and keeps the living soil TGOD uses and is known for at room temperature.

"[Living soil] is basically a living system, so it works better or works faster if your soil is warm. The microbes are more active, the roots are more permeable, so the plant is just growing faster," he says. "We do have some efficacy gains when the soil is warmer. That's one of the benefits."

Given the large volume of soil used in TGOD operations, optimizing cano-

py airflow is critical. "These pockets of high humidity are where your disease always starts first. If you don't have proper airflow and proper setpoints for that airflow to be delivered to your plants, then that's where disease and pests start," he stresses.

'WHOLE SYSTEM APPROACH'

Systems designed separately often need adjustments once everything comes together, Bernard-Perron says. "There are little details that you only see once you're physically there and you walk the room yourself and you see all those components interacting together," he says.

TGOD didn't require major post-expansion adjustments largely due to pre-construction adjustments to HVAC plans, Bernard-Perron says. After deciding on the facility's cooling requirements, TGOD's expansion team double-checked calculations and talked with other growers about system sizing to make a more informed decision. The team opted to more than double the amount of cooling it had initially planned.

Bernard-Perron says he often hears stories about greenhouses that can't use all their lights. "It's always about cooling," he says. "When we have the amount of supplemental light that we're using in cannabis, you have to make sure that you're able to cool for that amount, and that's on top of the dehumidification and all that."

Environmental setpoints are only one piece. "It's still how you are going to bring those target levels of CO_2, humidity and temperature to your plants," he says. "If your system can give them to you, but then the air gets warmed up before it can cool your crop, you may have issues. This is why it's really the whole system approach you need to look at."

CLIMATE'S ESSENTIAL ROLE

For Bernard-Perron, climate outweighs nutrients in importance. He compares plants to racehorses given the finest feed, then subjected to hot workouts where performance takes a back seat to survival. In the same way, plants in stress-response mode pace themselves to stay alive.

"We're in the business of producing secondary metabolites, the business of producing cannabinoids, so this is where it really matters," he says.

He notes that, unlike animals, plants in hostile environments can't find shelter or leave. Instead, they turn to survival mechanisms like reductions in growth and yield. "They're going to limit themselves," he says. "If you remove that limitation, then they're going to use all that fertilizer you give them. Then they're going to produce all those secondary metabolites."

With proper controls, you can truly steer plants. "If you want to dry them out to increase your terpene production, you want to be able to do that at the right time by decreasing your relative humidity and your soil or growing medium moisture when you decide to do so, not because suddenly your HVAC or climate control couldn't keep up with whatever the environmental conditions were," he adds.

For growers designing a new grow or an expansion, Bernard-Perron emphasizes getting reliable HVAC equipment with a good warranty and a vendor you trust for training and service—and don't sell your HVAC short. "If you're setting it up, don't go for just the bare minimum," he says. "Make sure you have a bit of extra capacity in there."

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Determining HVAC size for a growing facility requires several considerations, including heat emitted from supplemental lighting, as TGOD discovered.

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