WHAT'S INSIDE:

2025 STATE OF THE CANNABIS LIGHTING MARKET

THE 10TH ANNUAL DEEP DIVE

INTO LIGHTING TRENDS AMONG COMMERCIAL CULTIVATORS

IN PARTNERSHIP WITH

FLUENCE

CANNABIS BUSINESS TIMES

LIGHTING THE NEXT DECADE

OF CANNABIS CULTIVATION

As we mark the 10th anniversary of the "State of the Cannabis Lighting Market" report, I'm struck by how much this industry has evolved—and how growers continue to push the boundaries of what's possible with light. For more than a decade, this report has provided an unmatched window into the evolution of cannabis cultivation technology—reflecting where we are today and how far we've come. Fluence's long-standing support of this research underscores our commitment to the science of cultivation and to the growers who continue to move the industry forward.

When this report was first launched, LEDs were still the outlier. Today, they're the standard. Nearly 80% of growers now use LEDs in flower—a remarkable jump from just 15% in 2016. It's proof that innovation, supported by data and science, continues to drive our industry forward.

76%

OF COMMERCIAL GROWERS RANKED 'CROP QUALITY' AMONG THEIR TOP THREE PRIORITIES FOR USING LEDs IN CANNABIS PRODUCTION.

This search for increased efficiency helps explain one of the topics that seems top of mind in this year's survey—dynamic lighting. Growers across North America are taking notice and are looking at tunable, responsive lighting environments that can be adjusted to the needs of the plant in real time. "Managing energy costs" ranked as the top lighting challenge for cultivators, and 58% cited "energy efficiency" among their top five lighting purchasing considerations. Combine that with the 76% of commercial growers who named "crop quality" among their top three priorities for LED use, and it's no surprise that 43% are exploring dynamic lighting as the next step forward. Their motivations are clear—better flowering quality, higher yields, and greater control throughout the cultivation cycle.

Another major advancement is how growers are using control systems to bring all these technologies together. The 2025 report shows that 93% of commercial indoor cultivators and greenhouse cultivators who use supplemental lighting now use some form of lighting control, whether through integrated building automation systems, environmental control platforms, or wireless dimming. This growth reflects a deeper shift toward precision cultivation—where every micromole and watt is optimized for plant response, energy efficiency, and data-driven decision-making. Growers are increasingly connecting lighting, HVAC, and irrigation through unified systems to achieve greater consistency, reduce manual intervention and focus on crop quality. This integration of hardware, software, and science represents the next frontier in controlled environment agriculture.

Growers across North America are beginning to explore how dynamic spectrum and automation can be practical tools in driving measurable crop improvements. By fine-tuning light recipes and integrating connected light solutions, cultivators are looking to improve consistency, reduce operational costs, and elevate quality across their facilities. These aren't theoretical benefits—they're tangible outcomes proving that technology, when guided by plant science, can take cultivation to new levels of precision and performance.

As the cannabis industry continues to mature, Fluence remains committed to advancing research and empowering cultivators worldwide. For a decade, this exclusive report—produced by *Cannabis Business Times* in collaboration with Fluence—has provided growers with unparalleled insight into lighting trends, challenges, and opportunities. We're proud to help illuminate not just the science of light, but the future of cultivation itself.

Thank you for being part of this journey—and here's to another decade of innovation and growing smarter together. ●

— STEVE GRAVES

Senior Vice President, Global Sales, Fluence

PHOTO COURTESY FLUENCE

BY **JOLENE HANSEN**

A DECADE IN THE GROW ROOM:

MAJOR SHIFTS IN LIGHTING TRENDS

THE 10TH ANNUAL 'STATE OF THE CANNABIS LIGHTING MARKET' report highlights LED's rapid and still-growing dominance, recent and emerging tech interests, and advancing cultivation expertise.

WELCOME TO THE 10TH ANNUAL *CANNABIS BUSINESS TIMES* "STATE OF THE CANNABIS LIGHTING MARKET" REPORT. A decade of exclusive research into cannabis lighting trends and practices marks a milestone for *CBT*. Fittingly, this 2025 "State of the Cannabis Lighting Market" report reflects how rapidly and extensively cannabis lighting technologies have transformed the way growers grow.

In the years since this in-depth research report launched in 2016, we've seen LED lighting move from being an untrusted, untested, outsider technology to dominating cannabis lighting solutions. Not just in flower, but in propagation and vegetation, too. We've seen research and cannabis knowledge on a technology-fueled trajectory totally reshaping cultivation expectations. All with lighting at the core.

NEW THIS YEAR:

43% **OF INDOOR AND GREENHOUSE COMMERCIAL GROWERS** reported they are familiar with and "actively engaged in exploring" tunable spectrum/dynamic lighting.

LEDS RAPID GROWTH:

63%

The percentage-point increase in the **USE OF LEDS IN BOTH FLOWER AND VEG OVER THE PAST 10 YEARS.**

In this 2025 "State of the Cannabis Lighting Market" report, you'll once again find valuable insights into the past, present and future of cannabis cultivation and lighting, thanks to data you won't find anywhere else. You will also be able to see how your company's lighting choices, priorities and practices compare to those of your peers.

The study behind this proprietary research report was conducted on behalf of *Cannabis Business Times* by third-party research organization Readex Research and made possible with support from Fluence, a global leader in LED lighting solutions, which has supported this critical research report since its launch 10 years ago. ●

Jolene Hansen is a freelance writer specializing in the cannabis, horticulture and CEA industries.

10 YEARS OF ADVANCES AND ADOPTION

When *Cannabis Business Times* first launched this exclusive lighting market research in 2016, only 17% of study participants reported using LED technology in the vegetative stage and 15% in flowering stages. By 2022, that percentage had grown to 70%, which marked a milestone for cannabis lighting at the time. Since then, use of LED lighting solutions in veg and flower has continued to expand.

Vegetative: 80% of commercial growers participating in this year's research reported using "light emitting diodes (LEDs)" for the vegetative stage in their grows. Up slightly from last year's 78%, that represents a 63-percentage-point increase since this report's first year. The second most commonly cited vegetative lighting this year was "fluorescent lights (compact, T5, other HO fluorescents)" at 20%.

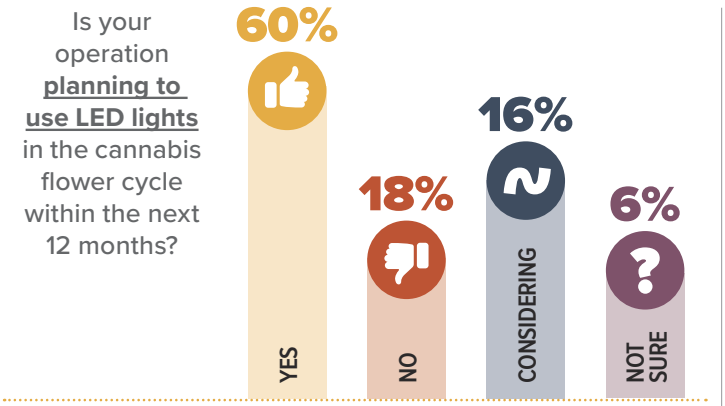
Some growers used other lighting types in veg in 2025, reporting "high-pressure sodium (HPS) lights" and "metal halide (MH) lights," at 11% and 10% respectively. (Growers could select more than one lighting type used, so they are not necessarily exclusively using any one type of lighting.) Looking back to 2016, "metal halide (MH) lights" were the most common type of light for veg, used by nearly half (43%) of all participants.

Flowering: In 2016, the first year this study was conducted, HPS took the top spot with 62% of participants using HPS lighting in their flower rooms. As previously noted, just 15% of participants used LEDs in flower that year.

This year, 78% of research participants said they use LEDs in flower, up 1 percentage point from last year. Also holding fairly steady from 2024, less than a quarter (23%) of research participants reported using HPS in flower this year. That reflects a 39-percentage-point drop compared to 2016.

As lighting technology has advanced, more growers who don't use LEDs or who grow in a greenhouse and don't use any supplemental lighting for flower are planning a switch. Of commercial indoor or greenhouse growers in those categories, 60% plan to use LED lights for flower within the next 12 months. Another 16% said they are considering it.

Is your operation **planning to use LED lights** in the cannabis flower cycle within the next 12 months?



Base: Commercial cannabis growers who do not use LEDs in flower or who grow only in greenhouses without lighting (50). No response: 0%

TYPES OF LIGHTING USED

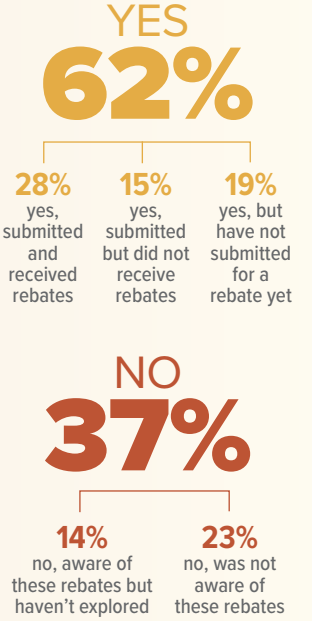
	VEGETATION			FLOWER		
	2016	2025	% pt. change	2016	2025	% pt. change
LIGHT EMITTING DIODES (LEDS)	17%	80%	↑ 63% pts.	15%	78%	↑ 63% pts.
FLUORESCENT LIGHTS (COMPACT, T5, OTHER HO FLUORESCENTS)*	37%	20%	↓ 17% pts.	8%	9%	↑ 1% pts.
HIGH-PRESSURE SODIUM (HPS) LIGHTS	31%	11%	↓ 20% pts.	62%	23%	↓ 39% pts.
METAL HALIDE (MH) LIGHTS**	43%	10%	↓ 33% pts.	12%	6%	↓ 6% pts.
OTHER	8%	8%	0%	5%	8%	↑ 3% pts.

*Total may exceed 100% because participants could select all that apply. Base: Participants who indicated they work for a commercial operation that grows cannabis indoors or in greenhouses (79). *In 2016, "compact fluorescent lights" was a separate category; in 2023, "compact fluorescent lights" was combined under "fluorescent lights," so 2016 data reflects the total of what was previously two separate categories. **In 2016, metal halide (MH) lights was separated into two categories, "ceramic" and "quartz." In 2023, those categories were combined, so for comparison, 2016 data reflects the total of what was previously two separate categories.*

EXPLORATION OF **UTILITY REBATES** CONTINUES TO GROW.

This year, 62% of participants have explored utility rebates to subsidize LED solutions for their commercial operations, up 13 percentage points from 2024. Of those participants, more than one-fourth (28%) have "submitted and received rebates." While nearly one-fourth (23%) indicated they were "not aware of these rebates," this number reflects a 6-percentage-point drop from last year. Another 14% said they are aware of these rebates but haven't explored them.

Has your operation explored utility rebates and incentives?



Base: Participants who grow cannabis commercially in an indoor facility or a greenhouse (79). No response: 1%

FACTORS AND FEATURES

INFLUENCING LIGHTING CHOICES

When considering a lighting feature for the flowering stage, commercial indoor and greenhouse growers in this year's "State of the Cannabis Lighting Market" study were focused.

Nearly 1 in 4 (24%) ranked "must be LED" as **the most important factor when purchasing a lighting fixture (of any type) for flower.** "Price" was ranked as the most important factor by 19% of participants. Next in line of the top most important factors were "scientific research supporting product development" (11%) and "product warranty" (10%).

"Energy efficiency," which was ranked as the most important factor by more growers than any other factor in both 2022 and 2023, was ranked as most important by 9% of 2025 participants. However, 19% of growers ranked "energy efficiency" as their second most important consideration in choosing lighting for flower.

This year's study participants who grow cannabis commercially in indoor facilities or greenhouses and use or would consider using LEDs for at least one growing stage also ranked their **top three most important "considerations for current or future LED use" in cannabis cultivation.**

Results in this 10th annual "State of the Cannabis Lighting Market" report followed the same order as last year but with a slightly different balance.

"Crop quality" was ranked as the most important consideration for LED use by more than a third (34%) of participants in this category, down 8 percentage points from 2024. Meanwhile, 31% of participants called out "yield" as their most important consideration, a 5-percentage-point increase from last year. Nine percent of participants said "energy efficiency" was their leading consideration for LED use, compared with 11% last year.

For many of those not ranking "crop quality" as their most important consideration, this consideration was still significant. "Crop quality" was ranked as the second most important consideration for LED use in cannabis cultivation by nearly a quarter (24%) of participants and as third most important by nearly 1 in 5 (19%) participants. Yield ranked as second most important among nearly a third (31%) of growers.

GREATEST LIGHTING CHALLENGES

For commercial cannabis cultivators, challenges don't end with lighting choices or adoption. While many lighting-related cultivation challenges have been resolved over the years, some familiar challenges appeared again this year. But they were joined by intriguing newcomers.

For the fifth straight year, indoor and/or greenhouse cultivators using lighting ranked "managing energy costs" as the **top lighting-related challenge for their operation**. While this challenge was ranked in the top spot by 18% of 2025 participants, this represents a 5-percentage-point drop from 2024.

Moving up as 2025's second most commonly reported "top" challenge with cultivation lighting was "managing heat load" at 16%, up 4 percentage points from last year. Last year, "lighting's impact on plant growth (yield, internodal spacing, etc.)" ranked in the second spot, but dropped out of the spot this year, falling 5 percentage points to 8%.

Additional top-ranked lighting-related cultivation challenges this year were "adjusting light distance to canopy" (12%), "ensuring consistent/even lighting across crops" (11%), and "how to explore and find the right spectrum" and "lighting's impact on and terpene/cannabinoid content," both cited by 8% of participants.

Though small in percentage, some 2025 participants ranked as their "greatest lighting-related challenge" those that reflect the increasing sophistication of cultivation facilities, including "tunable spectrum" (4%), "measurement/data collection" (4%), "automation of spectrum adjustment" (3%) and "automation of intensity adjustments" (3%).

TOP LIGHTING CHALLENGE

2021-2025:
MANAGING ENERGY COSTS

2020:
CONSISTENCY BETWEEN CROPS

What is your cannabis cultivation operation's ***greatest* challenge** when it comes to lighting?

TOP CHALLENGES IN 2024		TOP CHALLENGES IN 2025	
MANAGING ENERGY COSTS	23%	MANAGING ENERGY COSTS	18%
LIGHTING'S IMPACT ON PLANT GROWTH (YIELD, INTERNODAL SPACING, ETC.)	13%	MANAGING HEAT LOAD	16%
MANAGING HEAT LOAD	12%	ADJUSTING LIGHT DISTANCE TO CANOPY	12%
ADJUSTING LIGHT DISTANCE TO CANOPY	9%	ENSURING CONSISTENT/EVEN LIGHTING ACROSS THE CROPS	11%
ENSURING CONSISTENT/EVEN LIGHTING ACROSS THE CROPS	8%	HOW TO EXPLORE AND FIND THE RIGHT SPECTRUM	8%

Base: Participants who grow cannabis commercially in an indoor facility or a greenhouse with supplemental lighting: 76

INTEREST IN NEW TECHNOLOGIES

As lighting technology adoption has increased, along with well-documented research on LED's impact on yield and quality, cannabis cultivators look toward newer technologies, such as those that follow, to get even more from their lighting solutions:

Dimming: For 2025, only 16% of commercial indoor or greenhouse growers using lighting reported that they did *not* use dimming technology, down 9 percentage points from 2024. Of the 83% of this year's participants who *do* use dimming technology, the largest percentages report using "wireless (Bluetooth, Wi-Fi, Zigbee)" (29%); "daisy-chainable T-cables" (21%); RJ45/RJ12 cables (18%); and onboard dimming (17%).

DIMMING TECHNOLOGY USE:

83%

PERCENTAGE OF CULTIVATORS who use dimming technology in 2025, compared to 75% in 2024.

Base: Commercial growers who grow cannabis in indoor facilities or greenhouses with lighting (76). No answer: 1%

Control systems: Of 2025 participants growing indoors or with lighting in greenhouses, 93% use some kind of control system, up 2 percentage points from last year. The top three types of control systems currently in use: "integrated building automation system" (37%), "light scheduler with sunrise/sunset" (34%) and "environmental control system (0-10V)" (34%).

Tunable spectrum/dynamic lighting: In response to a new question this year, 43% of commercial indoor and greenhouse growers reported they are familiar with and "actively engaged in exploring" tunable spectrum/dynamic lighting. Another 42%, though "not really" familiar with the technology, said they are "interested in learning more."

Of the growers "actively engaged in exploring or interested in learning more" about tunable spectrum/dynamic lighting, their primary motivation was clear: 70% reported that "enhanced flowering quality or yield" was most important for them to achieve with tunable spectrum/dynamic lighting.

Other top tunable spectrum/dynamic lighting aspirations were "flexibility to adjust lighting across different growth stages" (46%), "improved vegetative growth" (45%), "ability to experiment with and refine light recipes" (39%), and "optimized energy efficiency throughout the cultivation cycle" (39%).

Augmenting top lighting: Of commercial indoor and greenhouse growers with lighting or those considering adding greenhouse lighting within the next 12 months, 78% expressed interest in exploring lighting types to supplement top lighting. That's a 13-percentage-point increase from last year, and a gain of 27 percentage points since 2022.

To augment top lighting, of greatest interest among growers this year was intercanopy lighting (43%), up 11 percentage points from last year. Exploring side lighting was second in line—of interest to 38% of growers. The greatest growth of interest in a single category was subcanopy lighting (36%), up 12 percentage points from 2024.

TUNABLE SPECTRUM/ DYNAMIC LIGHTING:

Are you familiar with tunable spectrum/dynamic lighting?

43% Yes, and actively engaged in exploring

42% Not really, but interested in learning more

13% No, and not interested

Base: Commercial growers who grow cannabis in indoor facilities or greenhouses (79). No answer: 3%

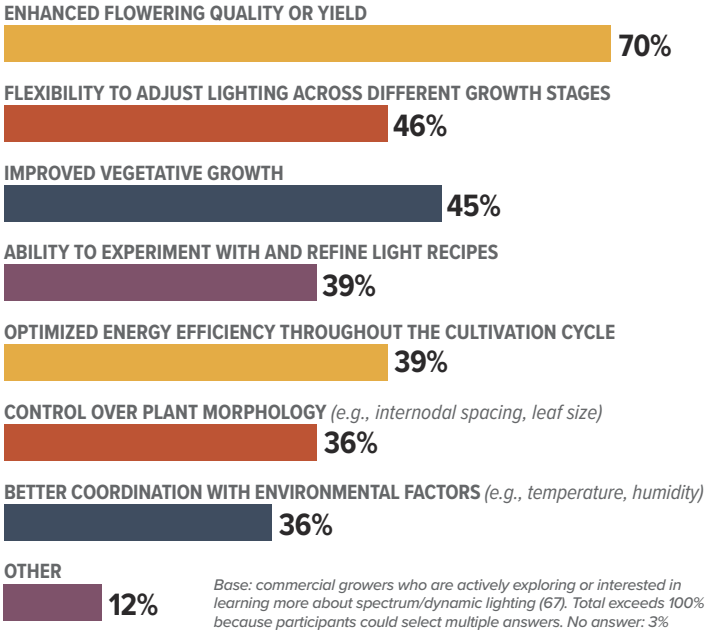
What **other lighting types** are you interested in exploring, in addition to top lighting?

SIDE LIGHTING	38%
INTERCANOPY	43%
SUB CANOPY	36%
OTHER	10%
NOT APPLICABLE - I AM NOT EXPLORING LIGHTING	21%

**Total may exceed 100% as participants could select more than one answer. Base: those who grow cannabis commercially in an indoor facility or greenhouse with lighting or those without lighting who are considering adding greenhouse lighting in the next 12 months: 77. No answer: 1%.*

TUNABLE SPECTRUM/ DYNAMIC LIGHTING GOALS

What is most important for you to achieve with tunable spectrum/dynamic lighting?



Base: commercial growers who are actively exploring or interested in learning more about spectrum/dynamic lighting (67). Total exceeds 100% because participants could select multiple answers. No answer: 3%

CULTIVATION FACILITY BENCHMARKS:

YIELDS, CANOPY SIZE, VERTICAL FARMING

From square footage in canopy to maximizing that footprint with vertical racks, cultivation facilities and their capabilities have changed dramatically over this report's history, as noted in the key areas that follow:

Total canopy: For 2025 commercial cultivators growing in indoor facilities or greenhouses with lighting, the average area of crop production (total plant canopy) among research participants was 47,800 square feet. Five years ago, in 2020, the average was 34,200 square feet.

The median value for total plant canopy (the number where half of participants fall above and half fall below) was 15,900 square feet, a 27% decrease from 2024's median canopy of 21,670 square feet.

However, 19% of commercial growers who grow cannabis in indoor facilities or greenhouses with lighting reported a total plant canopy of 80,000 square feet or more—unchanged from 2024. Another 8% reported a crop production area of 250,000 square feet or more, a 5-percentage-point increase over last year. Smaller grows with plant canopy less than 5,000 square feet were reported by 29% of growers, down from 35% in both 2024 and 2023.

Average yields: Total grams per square foot cultivated, on average, across genetics, continued to show the impact of increased cultivation knowledge and technology, as well as perhaps a drive to maximize yield to offset production costs in many markets where price pressure is prevalent.

In 2022, average yields of 50 grams or more per square foot were reported by 55% of research participants. By 2024, 70% of

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

250,000 sq. ft. or more	8%
150,000 - 249,999 sq. ft.	3%
100,000 - 149,999 sq. ft.	5%
80,000 - 99,999 sq. ft.	3%
50,000 - 79,999 sq. ft.	5%
25,000 - 49,999 sq. ft.	14%
10,000 - 24,999 sq. ft.	20%
5,000 - 9,999 sq. ft.	13%
less than 5,000 sq. ft.	29%

Base: Participants who grow cannabis for a commercial operation in indoor facilities or greenhouses with lighting: 76

CULTIVATION FACILITY TYPES

In what **type of facility** does your operation grow cannabis?*

76%
indoor facility**

33%
outdoors***

31%
greenhouse with supplemental lighting**

13%
greenhouse without supplemental lighting

**Total may exceed 100% because participants could select all that apply. **To examine lighting trends among cultivators specifically, CBT's research primarily looks at the responses of the 89 participants who grow commercially indoors and/or in greenhouses. ***Responses from participants who grow outdoors only were excluded from the final report.*

participants fell in that category. 2025 saw the percentage of participants averaging 50 grams or more across all genetics increase to 77%.

Take that up a notch to commercial operations averaging 80 grams per square foot or more across all genetics, and gains have been steady. In 2023, the first year this report included the 80-gram-plus category, 14% of commercial participants averaged 80 grams or higher per square foot. The following year, that figure climbed 33 percentage points to nearly half of participants (47%). For 2025's "State of the Cannabis Lighting Market" report, participants averaging 80 grams or more per square foot rose another 10 percentage points to hit 57%.

In addition, 14% of 2025 participants reported average yields across all genetics of 130 grams or more per square foot, up 2 percentage points from last year.

Vertical racks: This report first asked about vertical racks in 2017. That year, 31% of participants reported using vertical rack systems for "vegetation (not including propagation)," with 13% reporting vertical rack systems used in flower.

In 2025, vertical racks for veg were reported by 46% of participants, up 15 percentage points since 2017. For flower, 26% of 2025 participants reported using vertical rack systems, double the percentage in 2017.

Facility types: As in past years, the commercial cultivators reported operating multiple types of facilities. More than three-fourths (76%) of participants report operating an "indoor facility." One-third report growing "outdoors" (33%), with another third reporting "greenhouse with lighting" (31%). "Greenhouse without lighting" was reported by 13% of commercial grower participants for 2025, down 6 percentage points from 2024.

The research indicates, however, that many of those growers cultivate in various combinations of facility types. Forty-four percent of commercial growers grow indoors *only*, per the research, while 11% cultivate outdoors *only*, and 11% cultivate in greenhouses *only* (8% of those grow in greenhouses with supplemental lighting and 3% without supplemental lighting).

When it comes to those growing in multiple facility types, the most common combination includes both indoor facilities and greenhouses with lighting, used by 16% of growers as part of their overall setup. Six percent of research participants report cultivating using all four facility types: indoor, outdoor, greenhouse with lighting, and greenhouse without lighting.

YIELDS

57%

The percentage of commercial cultivators reporting average yields across all genetics of **80 GRAMS OR MORE PER SQUARE FOOT** (vs. 14% in 2023).

14%

The percentage of commercial cultivators reporting average yields across all genetics of **130 GRAMS OR MORE PER SQUARE FOOT.**

VERTICAL FARMING – VEGETATION & FLOWERING

USING VERTICAL RACK SYSTEMS IN VEG *(not including propagation)*

2017: **31%**

2025: **46%**

Percentage-point growth: **15%**

USING VERTICAL RACK SYSTEMS IN FLOWER

2017: **13%**

2025: **26%**

Percentage-point growth: **13%**

Base: Commercial growers who grow cannabis in indoor facilities or greenhouses with lighting: 76. No answer: 1%.

ABOUT THE RESEARCH & PARTICIPANTS

Independent research firm Readex Research conducted the study and compiled the data for the 2025 "State of the Cannabis Lighting Market" report. During July and August 2025, a research questionnaire was sent to all emailable *Cannabis Business Times* subscribers in the U.S. and Canada. A total of 185 cultivators participated in the study. To provide data-based insights most relevant to cannabis cultivators, this report focuses on the 143 research participants who cultivate cannabis for a commercial operation, for personal use/hobby or both. Results were then refined to exclude non-commercial operations. Unless otherwise indicated, the data reflects participants who grow cannabis commercially indoors and/or in greenhouses, with or without supplemental lighting.

The margin of error for percentages based on the 185 participants who reported they currently own or work for an operation that cultivates cannabis in an indoor and/or greenhouse facility is ±7.2 percentage points at the 95% confidence level.

The geographic breakdown of commercial cultivators who participated in this study is: Northeast U.S. (23%); Midwest U.S. (35%); Southern U.S. (18%); Western U.S. (32%); Canada (11%) and other* (14%). (*Only cultivators with U.S. or Canadian operations were included in the research. However, participants could select "all that apply," so their operations may be in one or more regions of the U.S. and/or Canada, plus a location outside the U.S. and/or Canada.)

DYNAMIC LIGHTING *Demystified*

BY **JOLENE HANSEN**

ABOVE Dynamic lighting in action.

How to integrate science and practical application to leverage new lighting technology to maximize your grow's—and your business's—potential.

The 10th annual "State of the Cannabis Lighting Market" study asked two new questions: Participants were asked how familiar they are with tunable spectrum/dynamic lighting. They were also asked what was most important for them to achieve with tunable spectrum/dynamic lighting.

The answers confirmed that dynamic lighting is putting the "buzz" in buzzword this year: 85% of research participants were either actively engaged in exploring tunable spectrum/dynamic lighting or interested in learning more. But, despite that interest, half of those individuals reported they aren't really familiar with this lighting technology.

Those research results won't surprise Fluence Principal Scientist David Hawley, Ph.D., or Fluence Cultivation Advisor Taylor Kirk. Both Hawley and Kirk (who also owns and operates 4K Pharm, a Texas craft hemp farm) regularly encounter misconceptions about dynamic lighting.

They spoke with *Cannabis Business Times* to demystify dynamic lighting and answer the questions in many cultivators' minds—from the research behind the technology to practical applications in the grow.

What Exactly Is Dynamic Lighting?

You may have heard that dynamic lighting is just dimming your light intensity. Manipulating light intensity can be part of that equation, but Hawley points out it's much broader than that. Even so, it's not complicated. "Dynamic lighting just means changing something about your light over time. It's as simple as that," he says.

While dynamic lighting encompasses many as-

FLUENCE PRINCIPAL SCIENTIST
DAVID HAWLEY, PH.D.

FLUENCE CULTIVATION ADVISOR
TAYLOR KIRK

PHOTOS COURTESY FLUENCE

> **EVERY GROWER IS TRYING TO MAXIMIZE THE BOTTOM LINE.** AND IF THEY CAN MANIPULATE ANYTHING IN THEIR GROW TO REDUCE OPERATIONAL COSTS WHILE MAINTAINING ... OR IMPROVING QUALITY AND YIELD, **THEY'RE GOING TO DO IT WITH LIGHTING."**
>
> FLUENCE PRINCIPAL SCIENTIST
> **DAVID HAWLEY, PH.D**

ABOVE
A flower room at Clade[9]

pects of lighting manipulation, Hawley says most conversations about dynamic lighting today revolve around dynamic spectrum. "That's changing the light spectrum throughout the day or throughout the crop cycle or based on the time of year," he says.

Why Should Growers Care About Dynamic Lighting?

The potential impact of dynamic lighting technology on a grow is as fundamental as it gets. "Every grower is trying to maximize the bottom line," Hawley says. "And if they can manipulate anything in their grow to reduce operational costs while maintaining quality or improving quality and yield, they're going to do it with lighting."

Examples of dynamic lighting applications include dimming supplemental lighting in a greenhouse environment when nature provides sufficient sunlight. Similarly, someone might manipulate their spectrum to enhance the quality and market value of their product or reduce operational cost.

Kirk notes that growers are looking for "that silver bullet" to produce the perfect crop. And, while dynamic lighting alone isn't that bullet, most growers interested in dynamic lighting are focused on changing the spectrum of their lighting fixture.

"They're looking for a competitive edge, and dynamic spectrum holds that promise," Kirk says. "We [at Fluence] see the need to help growers produce premium-quality crops at the lowest cost to help them succeed in their business. That's what we see in dynamic lighting."

Four Pillars of Opportunity for Dynamic Impact

Hawley says that cultivators have an opportunity to improve their businesses through lighting with four pillars: yield, morphology (aspects of the plant's shape, form and structure), quality, and economics.

When it comes to economics, dynamic lighting and tunable spectrum are opening new avenues for growers to improve

A flowering cannabis plant at Peninsula Gardens

production costs and profit margins.

Hawley explains, "We've really seen an opportunity in a dynamic red and white spectrum, because red photons are cheaper to produce. But if you use too many red photons, then you negatively impact plant quality by way of inducing photobleaching or white tips. So, we now believe that the optimal way to produce cannabis is with a dynamic red and white solution."

Put into practice, this translates to the ability to use a higher red spectrum—and save money—during periods when the plant is less sensitive to red photons and won't photobleach. "But during developmental stages when the plant is more sensitive to red, you can dial that red down and use a more white spectrum to avoid photobleaching, albeit at a higher operational cost," Hawley adds.

Dynamic lighting and tunable spectrum make that possible.

What the Research Shows

As different dynamic lighting solutions with different spectra enter the market, knowing what spectrum to choose can be confusing. Kirk invokes Fluence's slogan "LED by Science" as he explains that belief in red and white spectrum over other color channels is based on research, not anecdotal narratives or lack of technology.

"We support growers with confidence, because we've done the science, and we know how to guide them to the right products for their applications and their needs," Kirk explains. "That doesn't mean we won't come out with a different type of dynamic product in the future, but we have not seen the specific use cases—backed by science—to justify other parts of the spectrum."

Hawley reiterates the focus on improvement across the four pillars. And the choice of red and white versus other color channels in dynamic lighting hits the fourth pillar, economics, head on.

"Our research has not yet identified clear value-adding use cases for other parts of the spectrum that you'd want to manipulate," Hawley says. But why not put those other channels on there if you can? Start with these two reasons:

1. Certain parts of the spectrum can significantly reduce product value. As an example, Hawley and Kirk point to UVB. "The UVB research that we've done so far has found that UVB significantly inhibits yield and reduces quality," Hawley says, noting that growers could harm their crops with UVB.

2. Diodes cost money. Noting less publicized parts of the spectrum, like blue, cyan, green or amber, Hawley says, "They're expensive diodes to be purchasing and then having on your light fixture and hanging up in the ceiling if it's not actually adding any value to your crop."

While other channels such as green will drive photosynthesis, they do it much less efficiently—and more expensively—than diodes that are more mechanically optimized. "For instance, white and red diodes have a much higher system efficacy than something like a green diode. You can use green diodes, but it just costs you a lot more money to operate," Hawley adds.

Just How 'Tunable' Is Tunable Spectrum?

For growers exploring dynamic lighting, Kirk explains it's important to understand how much flexibility and tunability a fixture truly provides. Fluence's RAPTR 2 toplight series offers three spectrum options, but only one—the T48 spectrum—delivers full dynamic control.

"The RAPTR 2 with the T48 spectrum is a dual-channel solution that allows growers to adjust the red content from roughly 40% to 80%," Kirk says. "T48 stands for 'tunable,' with red between 40 and 80." Using proprietary Fluence software, growers can fine-tune the spectrum anywhere within that range to match plant needs at each growth stage.

As with any evolving technology, not all manufacturers define "tunable" or "dynamic" the same way. Some fixtures are limited to preset points, while others—like Fluence's RAPTR 2 T48—enable continuous, precise adjustments. Understanding a fixture's capabilities and how to apply them is key to realizing the full benefits of tunable dynamic lighting and tailored light recipes.

LEFT
Inside Light Sky Farms

> WE JUST WANT TO GET SMARTER AND SMARTER WITH OUR APPLICATION OF THE TOOLS. **THAT WILL BE THE FUTURE.**
>
> FLUENCE PRINCIPAL SCIENTIST
> **DAVID HAWLEY, PH.D.**

How Do You Know What Lighting Recipe to Use?

Knowing when to choose a high red or low red spectrum (or anything in between) doesn't have to be trial or error when there's research and technical support to guide your choice.

"Over the years of researching photobleaching thresholds or white tip thresholds, we've developed a couple recipes that we think are really optimal for different production objectives," Hawley explains. Though he and Kirk reserve specific recipes for their customer base, there are research-backed starting-point recipes for growing for flower or for extract or other end goals.

Based on Fluence research, Hawley and Kirk say growers switching to dynamic lighting (with appropriate recipes for their growing goals) typically realize 19% to 20% OPEX savings compared to a static white top light.

Dynamic spectrum provides the "keys to the system" to create your own recipes for cultivars that aren't sensitive to red light, for example, or when you're growing for extract and high red risks such as photobleaching don't matter.

How Can I Optimize My Use of Dynamic Lighting?

While Kirk and Hawley work with growers on grow-specific, genetics-specific lighting recipes, some general strategies on using tunable spectrum can help. More red for veg and more broad white for flower is one example, Kirk says.

"At a high level, utilizing more red light during your vegetative period and more nuanced spectral tuning for your flower period is a much more defined growing strategy. This strategy provides the most efficient way to apply the light that the plant would need at the right time," Kirk says. "And with light intensities you're using during these stages of growth, you're not at a point that you risk the crop damage that we've seen at higher light intensity during flower, for example."

Circling back to Hawley's simple definition of dynamic lighting, Kirk emphasizes that optimizing your lighting use extends beyond the spectral component, back to the basics.

"Don't discredit dynamic lighting components such as photo acclimation, proper photoperiod and DLI [daily light interval] management in greenhouses. That would all be encompassed under dynamic lighting because you're changing the way you're managing your lighting systems," he says.

Reflecting on LED technology, Hawley and Kirk talk about the parallel development of technology and the intelligence to use it. "This is kind of the final evolution of LED efficacy," Kirk says. "You have an efficient light now. How can you use that efficient light more efficiently? Part of it is through this dynamic lighting strategy."

With dynamic lighting, growers can take further advantage of the lighting technology that is available today and focus on various ways to apply that technology to impact all four pillars of opportunity for cannabis cultivators.

"We just want to get smarter and smarter with our application of the tools," Hawley says. "That will be the future." ●

PHOTO COURTESY FLUENCE

HOW TO TURN LED LIGHTING INTO A

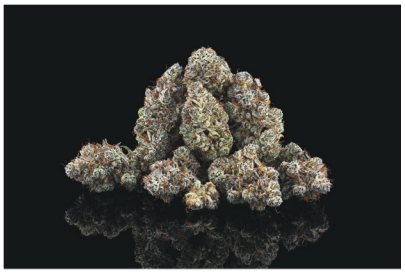
Strategic Cultivation Tool

BY **JOLENE HANSEN**

Cannara Biotech shares how it has gone beyond the norm in deploying LED technology.

Look back across the 10 editions of the *Cannabis Business Times* "State of the Cannabis Lighting Market" report, and you'll see that every report reveals major advances in research and cultivation practices involving LED lighting solutions. With technology pushed near its present-day limits, a new challenge exists: how to get even more out of your LED lighting.

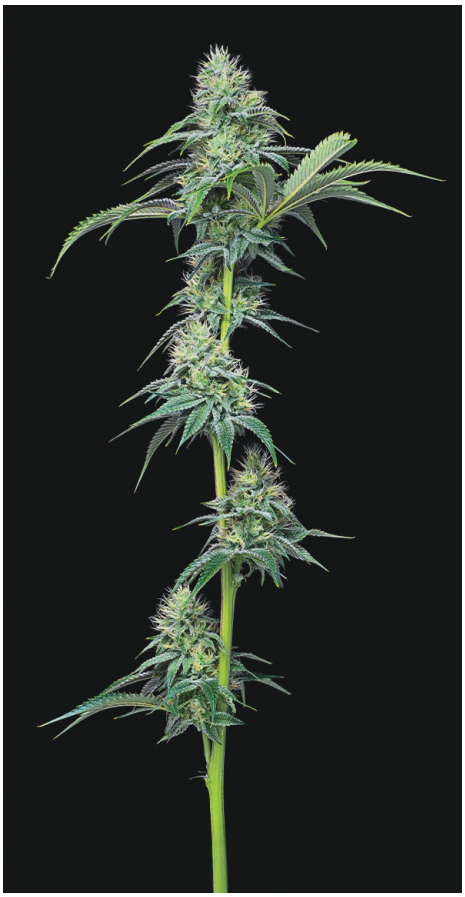
To paraphrase Fluence Horticulture Service Specialist Jason Matlock, Ph.D., the LED lighting narrative has covered efficiency, yields and quality. As the cannabis industry becomes more competitive, sophistication in operations is a major driver of success. As a result, as Fluence Director of Technical Services Chris Bezuyen adds, "Some lighting stories are bigger than lighting."



LEFT
Neon Sunshine flower grown by Cannara Biotech

RIGHT
Cannara VP of Production and Experimentation Issam Ben Moussa

PHOTOS COURTESY CANNARA BIOTECH



ABOVE
A Tribal Cuban Linx plant at Cannara

With that in mind, *Cannabis Business Times* turned to a cultivation operation that is using LED technology as part of that sophisticated recipe, to do things it couldn't do before: Canada-based cannabis producer Cannara Biotech. Cannara's story is certainly one that goes beyond the traditional "converting to LED lighting" thread and demonstrates how LED technology can push the boundaries of established practices and processes and help set the company up for a more fluid cultivation operation that can adapt in ways it couldn't previously.

The Quebec-based company, founded in 2018, is a vertically integrated producer of cannabis products cultivated in two mega facilities—one 625,000-square-foot indoor facility and another 1 million-square-foot site with 24 grow zones in a hybrid greenhouse. Cannara is focused on producing "high-grade cannabis at a low cost by leveraging its scale and advanced cultivation techniques," as its website explains. The company's product offerings include dried flower, pre-rolls, and cannabis oils for both the recreational and medical markets.

As Cannara's vice president of production and experimentation, Issam Ben Moussa, Ph.D., has overseen production and cultivation as well as research and development projects.

Retrofitting the greenhouse from HPS lighting to dimmable LED lighting has been a focus for the Cannara cultivation team as a key part of the company's goals to optimize production using the most advanced technologies available to them to offer its premium products at affordable prices for patients and consumers.

Ben Moussa says that three primary factors drove the decision to switch from HPS to LEDs. "One is the efficiency of energy. Second is the quality. The third is operational flexibility with the LED lighting," he says. "Flexibility is important at our scale."

As Cannara has evolved, the company's smaller, indoor facility has been adapted to support the larger area. Rooms that were previously used for flowering are now devoted to genetic selection and stock plants, where a transition from HPS to dimmable LED lighting had begun. Continuous R&D includes pheno-hunting, and 20,000 to 30,000 clones are propagated every week under the LED lights, then routed to the larger facility for cultivation.

To create the flexibility to use a room for whatever purpose it's needed—mother plants, veg and/or flower—Cannara is switching veg rooms over to dimmable LED lighting that can accommodate the range of possibilities the future may hold. Eight rooms have transitioned so far, while the goal is to have 18 rooms switched to LED by the end of FY2026.

"When you have stage-specific rooms dedicated

ABOUT CANNARA BIOTECH:

YEAR FOUNDED: 2018

LOCATION:
Saint-Laurent, Quebec, Canada

FACILITY TYPES:
One 625,000-square-foot indoor facility and one 1 million-square-foot site with 24 grow zones within a hybrid greenhouse

CANOPY SIZE:
~625,000 square feet

NUMBER OF EMPLOYEES:
575, with 170 in cultivation/post-harvest

PRODUCTS OFFERED:
dry flower, pre-rolls, infused pre-rolls, vapes, concentrates

WEBSITE: Cannara.ca

CONSUMER-FOCUSED BRAND WEBSITES:
tribal.ca, nugz.ca, orchidcbd.ca

"SOME LIGHTING STORIES ARE **BIGGER THAN LIGHTING.**"

for flowering or for veg/moms, it's a bit difficult to do rotation and renew stock plants without interrupting cloning activities," Ben Moussa says. "With HPS, you cannot use a flowering room for mother plants. However, if you switch to LED, you can."

He points out that flexibility is critical, allowing him to move his mother plants into a "flower room" if needed. "Because it has LED lighting, I can do cleaning, sanitary/maintenance checks, and conditioning after harvesting a commercial lot and use the room to renew mother plants—all of that without eliminating the existing moms," he says.

Where Cannara previously had to transfer plants from the clone room to veg and then to flower, they've saved a step. Eliminating the veg rooms is in process, so all plants will eventually veg and flower in one space.

"From the rooted clones, we transplant directly in the LED room. Because the LEDs are dimmable, you can dim and start your acclimation gradually," Ben Moussa explains. "We start veg there, then we flip the lights to 12-12, and we start the flowering cycle."

Bezuyen says that vegging in space is "kind of a new thing that's been happening in the building industry, where they are no longer moving plants area to area." In addition to allowing the operation greater flexibility, it also cuts labor costs and room-flipping time, among others.

Quality has also played a role in Cannara's move to LED lighting. As one example, Ben Moussa says the team can better control vapor pressure deficit (VPD)—not just the ambient, but also VPD on the leaf surface.

"With LED, we can have the desired light intensity and spectrum in an area, while avoiding extra heat generated by the HPS," he says. "This affects the yield, the quality of the flowers at the end. By better controlling the climate in the room, diseases such as powdery mildew are avoided."

With the transition to LED lighting in its early stages, Ben Moussa says he's still in the data collection stage, but he's seen energy efficiency savings of 25% to 30% so far.

With dimmable LED lighting that allows the company to veg and flower a crop in the same room, Cannara is future-proofing its facility for changes in methodology or growing strategy.

While the technology itself isn't new, Cannara's deployment of LEDs is another example of pushing through boundaries, expanding opportunities, and getting the most out of LED lighting technology. ●

BELOW
Plants being moved during post-harvest at Cannara.

BELOW
Inside a Cannara grow room. Eliminating veg rooms is in process, so all plants will soon veg and flower in place.

BUILT FOR GROWERS BACKED BY SCIENCE

SPYDR 3

VYPR 4

RAPTR 2

PYTHN

Purpose-built cannabis lighting solutions that maximize yield, quality, and consistency at scale

Since 2014, growers have turned to Fluence not just for cutting-edge lighting, but for steadfast support they can count on. While others come and go, Fluence remains a trusted partner, purpose-built to provide what growers need to thrive—whether it's maximizing yield, protecting quality, or scaling operations with confidence. With more than a decade of proven innovation and reliability, Fluence continues to back growers with solutions designed with intent and backed by science.

FLUENCE

HELPING THE WORLD GROW SMARTER

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