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+ SIZE MATTERS: THE CASE FOR SHORT PLANTS

JANUARY/FEBRUARY 2024

CANNABIS

BUSINESS TIMES

QUICK TIPS:

IMPROVE YOUR MOTHER ROOM MANAGEMENT



INTERCANOPY LIGHTING:

CAN IT BOOST YIELD AND QUALITY?

LUME'S RAPID RISE

How Lume Cannabis Co. has flourished—growing from \$2 million to nearly \$200 million in revenue in four years—amid Michigan's plunging retail prices and other challenges.

◀ Kevin Kuethe,
Chief Cultivation Officer,
Lume Cannabis Co.



Lume.

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ADULT USE IN
COLORADO:
BY THE NUMBERS

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LUME'S RAPID RISE

How Lume Cannabis Co. has flourished—growing from \$2 million to nearly \$200 million in revenue in four years—amid Michigan’s plunging retail prices and other challenges.

BY JOLENE HANSEN
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COVER AND CONTENTS PHOTO OF KEVIN KUETHE; BRYAN ESLER

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By Kenneth Morrow



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'CHALLENGE OUR OWN THINKING'



IN DECEMBER 2023, I had the opportunity to visit two cultivation operations headquartered in Akron, Ohio, just down the road from where *Cannabis Business Times* is based. I had asked the cultivation directors, Christine DeJesus of Galenas and Mike Lentz of Klutch Cannabis, for insights on mother plant and room management for an article about best practices for maintaining these critical spaces housing prized genetics and plants that will produce the next generation of crops. (Read more on this topic in Quick Tips on p. 10).

Though they both have their own cultivation practices and styles, something that resonated with me during each visit was how both DeJesus and Lentz are continuously fine-tuning their operations and searching for ways to improve. Before sharing a tip or suggestion, they noted that they used to do things differently—for example, DeJesus used to grow mother plants in larger containers and keep them longer—but they've since changed that.

Although they have close to two decades of commercial cannabis cultivation experience between them, they never stop questioning if they can do things differently—and better.

Albert Einstein once said, "The whole of science is nothing more than a refinement of everyday thinking." Throughout the articles in *CBT's* first print issue of 2024, you'll find many examples of experts in the field doing just that, fine-tuning their craft and generously sharing what they've learned with *CBT*.

This includes university researchers. On p. 12, the team from North Carolina State University, led by Brian Whipker, Ph.D., details findings from a study of how nutrients in pre-charged substrates affect plant growth, and how growers can adjust protocols to account for this.

Lighting is another area growers and researchers continue to explore. Travis Higginbotham, VP of Cultivation for StateHouse, based in Salinas, Calif., explains why the company embarked on intercanopy lighting research, and the basis for its hypothesis that having fixtures surrounding plants can improve both yields and quality (p. 20.)

Lume Cannabis Co. Chief Cultivation Officer

Kevin Kuethe, who is featured on the cover, dedicated an entire space in the company's Evart, Mich., grow facility for research and development, specifically around mechanical infrastructure and environmental control technology. The results were so successful that it was used as the foundation for the facility's expansion. The story of Lume's journey in the Michigan market starts on p. 26.

And *CBT* columnist and industry pioneer Kenneth Morrow, who has been growing cannabis for more than 30 years, explains why commercial growers may want to consider growing shorter plants, starting on p. 36. While he used to believe growing massive plants would produce the largest yields, he says he has learned through his experience that is not the case.

As Higginbotham writes in this issue: "Commercial cannabis growers face an ever-evolving market and constant uncertainty. As a result, we must continually challenge our own thinking and build upon what we think we already know about growing. ... It is essential to explore ways to build awareness and encourage the sharing of scientifically valid and commercially proven information within the cannabis community and industry to further advance the market as a whole."

And *Cannabis Business Times* will continue to be a resource where that information is gathered, vetted and shared, on our website, at our annual Cannabis Business Times Conference, and within the pages of each issue. ✨

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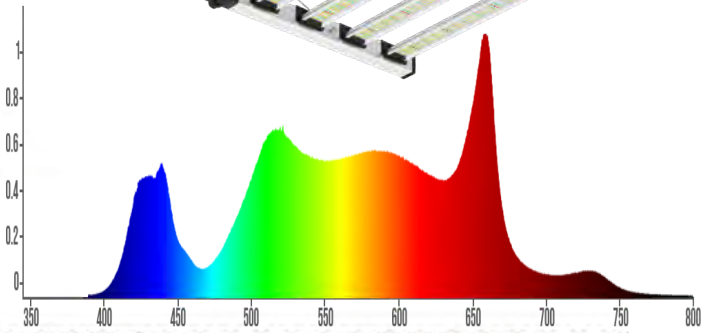
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WITHIN THE PAGES OF THIS ISSUE, you will find insights, tips, words of wisdom and even personal tales from some of the brightest minds in the industry and some of the best journalists around. We're pleased to introduce you to our contributors.



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CULTIVATION MATTERS, P. 12



TRAVIS HIGGINBOTHAM

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LIGHTING FEATURE, P. 20



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CULTIVATION MATTERS, P. 12



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COVER STORY, P. 26



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CULTIVATION MATTERS, P. 12



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TOMORROW IN CANNABIS, P. 36



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THEN & NOW: COLORADO MARKS 10 YEARS

Key metrics provide a glimpse of how the pioneering adult-use cannabis market has fared a decade after launch.

SALES TOTAL SINCE LAUNCH → **\$15.4 BILLION**



NUMBER OF MEDICAL RETAIL LICENSES

2014
502
2024
350

NUMBER OF ADULT-USE RETAIL LICENSES

2014
305
2024
686

NUMBER OF CULTIVATION LICENSES (MEDICAL + ADULT-USE COMBINED)

2014
1,112
738 medical +
374 adult-use
2024
924
304 medical +
620 adult-use

AVERAGE MARKET RATE PER POUND, RETAIL BUD*

2014
Jan.:
\$1,867
2024
Jan.:
\$750

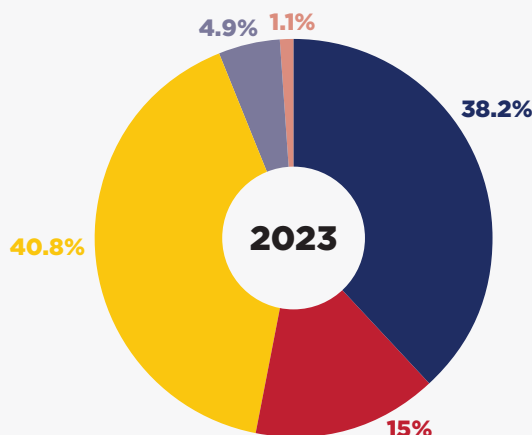
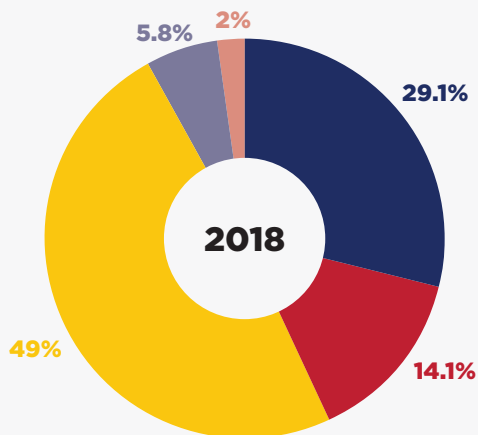
SALES REVENUE

2014
\$683.5 MILLION
2023
(Jan. - Nov. available)
\$1.41 BILLION
(Lowest since 2016)



SHARE OF ANNUAL ADULT-USE SALES BY PRODUCT

● CONCENTRATE ● EDIBLES ● FLOWER ● SHAKE/TRIM ● OTHER



TAX REVENUES

2014
(Feb. - Dec.)
\$67.6 MILLION
2023
(Jan.-Dec.)
\$274.1 MILLION
represents lowest tax collection since 2018

Source: Data courtesy of The Colorado Department of Revenue and Colorado's MED Dashboard, maintained by Colorado University Business Research Division. *More information on how average market rates are calculated is available here: tax.colorado.gov/average-market-rate

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Tiffany, 24 (Michigan - Cannabis Connoisseur)

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Price

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5

TIPS FOR
MANAGING
MOTHER PLANTS

Cultivation directors share their best practices and advice for maintaining an optimal environment for mother plants to thrive.



BY MICHELLE
SIMAKIS

For many cannabis cultivators, the mother room is the heart of the company.

Until plants make their way through the roughly two-month grow cycle, they are cared for in mother rooms. Typically smaller areas of a grow, they are arguably the most important spaces in many operations, where genetics are maintained, preserved and strategically pruned to produce the strongest clones possible to create a new generation of crops.

Two cultivation directors of leading indoor cannabis grow facilities in Akron, Ohio, welcomed *Cannabis Business Times* to explore their operations and offered guidance and best practices for mother room manage-

ment based on years of fine-tuning. Here, Christine DeJesus, cultivation director at Galenas, and Mike Lentz, cultivation and processing director at Klutch Cannabis, offer advice and key care tips for mother plants.

1. Minimize staff working in the mother room.

"We have some pretty tight, strict protocols in here," says DeJesus, standing in the mother room at Galenas' grow facility, which operates 3,000 square feet of canopy. "Try and isolate employee movement so that generally the only people working in the mother rooms are the people that are in charge of those rooms."

Basic sanitation practices in other areas of the

grow apply to the mother room as well—and DeJesus suggests ensuring employees wear gloves (and change them between plants) and keep dedicated clothes and shoes only worn at the grow.

2. Assign a pruning shear to each plant.

With about 60 mother plants, keeping individual pruning shears for each mother can be an investment, but one well worth it to Galenas to prevent outbreaks and ensure if there is a pest or pathogen that develops, that it is isolated to as few plants as possible.

3. Rotate out mother plants every three to six months.

Most mother plants at Galenas are kept for 100 days or less. At Klutch, they make sure they get new moms every four to six months.

"As plants age, they definitely become more susceptible to disease," DeJesus says. "Every year, we go through and delete some of our library so that we can maintain the health of everything."

"What happens as a plant ages is that it lignifies. So, this plant's getting a little old, and you can see the stems are starting

to get more woody," DeJesus says. "And so those types of stems don't root as well as plants that are soft and green like these. This is still nice and soft and supple and green, and it'll root faster."

Older stems can rot before they root, she adds.

4. Keep mother plants in medium-sized pots.

Since DeJesus started at Galenas in 2019, they've been fine-tuning production, and one big change they made was moving mothers down to 4- to 7-gallon containers, which works well in their two-tier mother room, from 10-gallon to 20-gallon pots, in some cases. "We find that the teenager-size plants seem to give us the highest quality clones," DeJesus says, adding that they produce ideal node spacing. "If the plants are too big and too old, then rooting takes a bit longer. If they're too small, you don't get enough clones off them. Somewhere in that mid-range is where we found the best of both worlds."

Klutch also keeps its mothers in 7-gallon containers, finding that to be the sweet spot when it comes to managing plant size and irrigation.

5. Consider hand-watering mother plants.

Although Klutch automates irrigation and fertigation in veg and flower, all mother plants are hand watered and checked daily.

"Overwatering can be a big issue, especially when you're dealing with a bunch of different plant ages," Lentz says. "When you have so many different ages and sizes and when you lop a plant down, you have to understand it's not going to have the same irrigation strategy as it did when it had 50 pounds of biomass on it."

At Galenas, DeJesus finds that hand watering every three days helps optimize plant growth, development and health.

"If you water more frequently and in lesser amounts, lots of times you have more issues with soilborne pests like fungus gnats. You can get root diseases, rot and things like that from just having too much moisture for too long within the soil." ✨

Read the full article for more tips at bit.ly/cbt-mother-plants.

Michelle Simakis is editor-in-chief for *Cannabis Business Times*.



Klutch's cultivation facility in Akron includes 3,600 square feet of space exclusively for mother plants.

Save the Date & Meet the Board

Join us this August at Cannabis Business Times Conference

Most everyone working in cannabis today understands that the market is far too challenging to navigate it alone. Cannabis Business Times Conference has become known as the place for plant-touching cannabis professionals to unite, where they can share their biggest trials and triumphs among peers who understand what it takes to operate a business in this dynamic yet difficult industry.

Celebrating its eighth year, Cannabis Business Times Conference **will take place Aug. 20-22**, at Paris Las Vegas, and will once again bring together cultivators, retailers, brands, manufacturers, suppliers, scientists, researchers, professors and other leaders from across the industry and around the world. The event has become known for its unmatched educational program that provides solutions and

actionable takeaways, in addition to collaborative cultivation roundtables, grow and retail launch workshops, and many networking opportunities.

Cannabis Business Times editors consult a board of leading experts in the field to craft relevant, thought-provoking sessions led by the best in the business to ensure that attendees walk away with resources and information to succeed and thrive. The Cannabis Business Times Conference Advisory Board (*below*) represents some of the most knowledgeable, genuine and generous people working in the industry.

Registration opens Feb. 15, and opening rates will save you hundreds of dollars. Join us and invest in your success this August, where you'll find support and strategies that could change the trajectory of your business and career. ✨



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Figure 1. Excessive substrate electrical conductivity levels can result in girdling of the young transplant.

TAKE 'CHARGE' OF PLANT FERTILITY

How to adjust production protocols when using pre-charged substrates to ensure plants are getting optimal nutrients

BY PATRICK VEAZIE, PAUL CÔCKSON
AND BRIAN E. WHIPKER

Many retail-focused, commercially available substrates advertise increased plant and root growth compared to their competitors. Often, this is a result of organic and/or nonorganic pre-plant fertilizer charges that are included in the substrate to supply longer-term fertilizer requirements to the plant.

While home growers can generally operate as usual with these substrates, commercial growers need to understand how these season-long pre-plant charges impact the chemical properties of the substrate, and what production system adjustments are needed when using these products. Although the substrates examined generally target home and

ALL IMAGES: BRIAN WHIPKER



IF ADEQUATE FERTILIZER IS PRESENT IN THE SUBSTRATE AND FERTILIZATION BEGINS, OVER-FERTILIZING OR FERTILIZER WASTE CAN RESULT.



Substrate Blends: No Fertilizer Added

Figure 2. Growth comparison of 5-week-old plants (four weeks vegetative growth plus one week of reproductive growth) when plants were grown in 15 different substrate mixes and were not supplied with additional fertilizers. The plants with higher pre-plant fertilization are green, while those formulated without any additional fertilizer turned yellow, as expected.

small commercial growers, some are used by larger commercial growers. Commercial substrates still generally have a pre-plant starter charge, as well. While it tends to be smaller, it still needs to be considered, as it can impact chemical properties over time.

UNDERSTANDING PRE-PLANT CHARGES

A pre-plant fertilizer charge is included during the manufacturing process and is intended to provide nutrients to the crop immediately following transplant. There are many formulations and strategies to pre-plant charges that can

impact a commercial operator's fertility planning and the overall season-long benefits to plants. For example, substrate manufacturers supply a pre-plant starter charge when adjusting the substrate pH during the blending process. In contrast, some blends are designed to provide a season-long supply of nutrients. The length of time that a pre-plant fertilizer charge lasts can vary based on rate of initial charge, substrate leaching and plant uptake.

Pre-plant charges can take the form of inorganic and/or organic granular nutrients, or of organic matter, including compost. Each formulation of fertilizer

and fertilizer input will have varying impacts on the plant's growth and your fertility program.

If nutrients from the pre-plant charge are inadequate before additional fertilizer is provided, transplants can become stunted and weak. If adequate fertilizer is present in the substrate and fertilization begins, over-fertilizing or fertilizer waste can result. Thus, knowing your pre-plant charge will allow your transplants to thrive, help avoid fertilizer waste, and keep operations at peak economic efficiency.

Growers generally supply plants with fertilizer after transplant. Post-

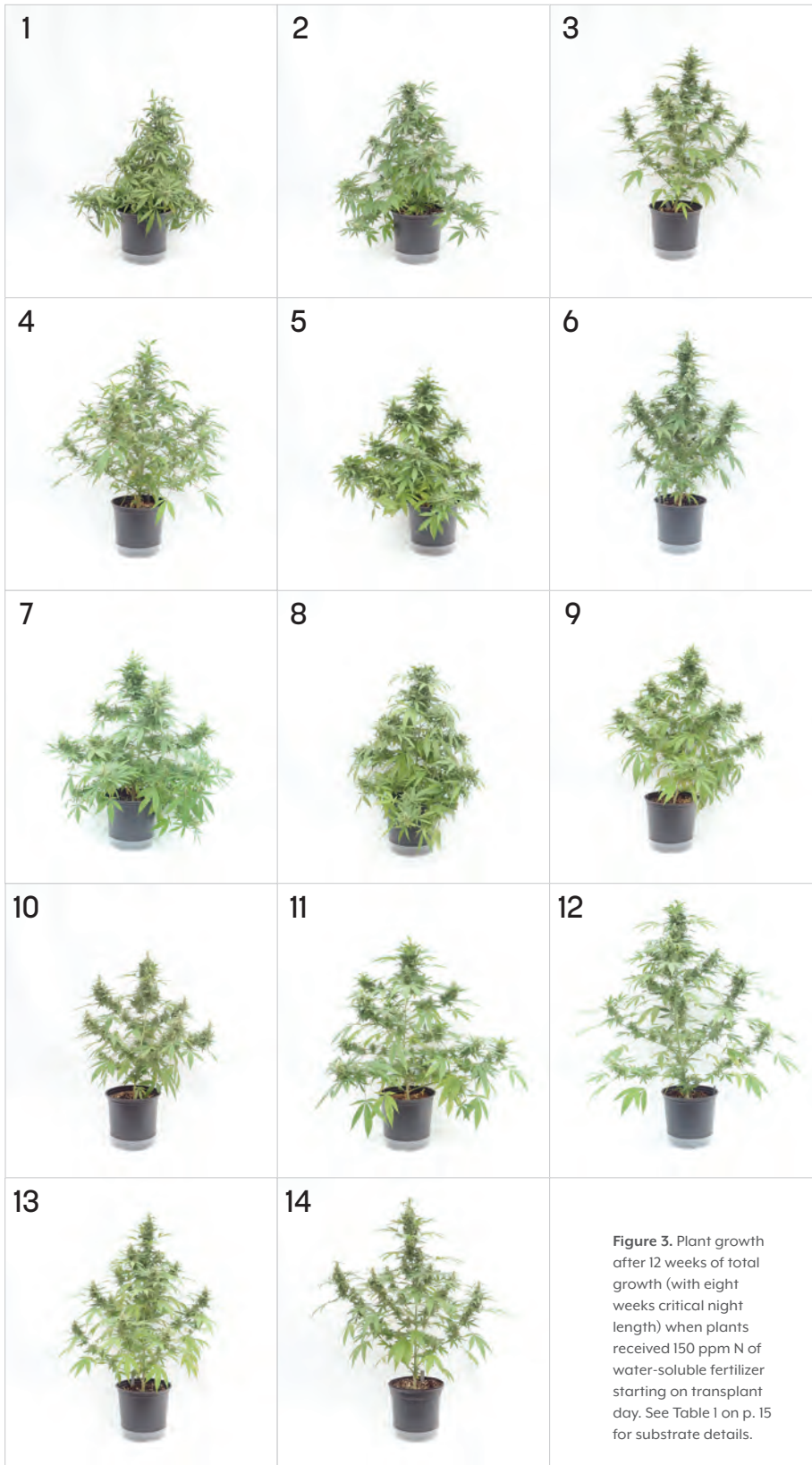


Figure 3. Plant growth after 12 weeks of total growth (with eight weeks critical night length) when plants received 150 ppm N of water-soluble fertilizer starting on transplant day. See Table 1 on p. 15 for substrate details.



WHEN PLANTS WERE NOT PROVIDED ADDITIONAL FERTILITY, SUBSTRATES WITH A LOW INITIAL EC EXHIBITED STUNTED GROWTH AND CHLOROSIS THREE WEEKS AFTER TRANSPLANT.

plant fertilizer comes in many forms, ranging from water-soluble fertilizers to controlled-release or slow-release fertilizers. Growers can utilize a combination of these two strategies: A pre-plant fertilizer charge to help encourage plant growth initially, followed by post-plant fertilization. This is why growers should test the chemical properties of their substrate to optimize their fertilization program if pre-plant charges are included.

ADJUSTING POST-PLANT FERTILIZATION

At North Carolina State University (NC SU), we examined the effects of 14 different retail-focused, peat-based substrates' pre-plant charge on the substrate pH, electrical conductivity (EC) and plant growth, both with and without additional fertilizers. (Some substrates incorporated coco coir and wood fiber.) Understanding which nutrients are in a substrate can help

growers customize their fertility regime to optimize yield.

When looking at the substrate pH and EC across the different blends, there were large differences observed with pH, ranging from 4.56 to 7 and EC from 0.14 to 4.39 (Table 1). The nitrogen (N) concentration supplied by the pre-plant charge is most commonly in the form of nitrate ($\text{NO}_3\text{-N}$) as opposed to ammoniacal ($\text{NH}_4\text{-N}$) or urea ($\text{CO}(\text{NH}_2)_2$) nitrogen. This allows for a slower decrease in substrate pH compared to high ammoniacal or urea pre-plant charges. Additionally, the substrates that included a nitrate pre-plant charge also contained increased potassium, calcium, magnesium and sulfur in the substrate.

When plants were not pro-

Table 1: Comparison of 14 retail substrates initial electrical conductivity (EC), pH, nitrogen, and phosphorus concentrations prior to transplant.

Substrate	EC	pH	Nitrate (NO_3^-)	Ammonium ($\text{NH}_4\text{-N}$)	Urea-N ($\text{CO}(\text{NH}_2)_2$)	Total N	P
1	1.67	5.13	142.42	55.83	0	198.25	33.97
2	1.7	6.43	69.65	15.86	0.01	85.52	3.64
3	0.25	6.79	0.31	0	0	0.31	1.54
4	0.38	6.75	0.3	0	0	0.3	1.85
5	1.77	6.46	124.99	0.25	0	125.24	16.11
6	3.09	5.68	211.19	0.62	0.1	211.91	9.63
7	4.06	4.78	356.66	11.9	0	368.56	25.86
8	4.39	6.23	222.86	0	0.05	222.91	8.38
9	0.14	6.46	0.87	0	0.42	1.29	0.86
10	2.22	7	22.49	0.34	0	22.83	2.49
11	3.07	4.68	249.54	1.32	0.12	250.98	36.13
12	3.25	4.56	316.33	74.48	0.05	390.86	59.2
13	0.75	6.43	1.62	0.35	0	1.97	0.21
14	0.4	6.14	0.53	0	0	0.53	2.89

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THE MOST COMMON NUTRIENT DISORDER OBSERVED ACROSS ALL SUBSTRATES AFTER FIVE WEEKS OF GROWTH WAS NITROGEN DEFICIENCY.

vided additional fertility, substrates with a low initial EC exhibited stunted growth and chlorosis three weeks after transplant. Additionally, substrates that initially exhibited a greater EC yielded larger plants after five weeks of growth

when compared to plants that had a lower initial EC (Fig. 2, p. 13). However, when EC is excessive for young plants, stunted growth or girdling at the soil line can occur (Fig. 1, p. 12).

growth normalized (Fig. 3, p. 14).

Plants grown in the substrates with pre-plant charges of fertilizer to jump-start growth perform best with continual fertilization—that was what they were designed for. In contrast, substrates supplied with pre-plant fertility to carry the crop during the entire growth season accumulated excessive nutrients when supplemental fertilizer was also supplied.

The results of this trial show substrates with a total-season supply of nutrients in the bag from the start and ones that rely upon the grower to provide fertilizer performed well. The key to success is to ensure the substrate and fertilization program match up to fulfill the plant's needs. ✨



**PATRICK
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The most common nutrient disorder observed across all substrates after five weeks of growth was nitrogen deficiency. Nitrogen deficiency is first observed as chlorosis of the lower foliage, which advances into entire leaves turning yellow and, in severe cases, necrosis and leaf abscission. However, when 150 ppm N (13-2-13 N-P-K) water-soluble fertilizer was supplied to all substrates, plant

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Can Growers Optimize Light Capture

Cultivators form research group to investigate if intercanopy lighting can improve yields and flower quality.

BY TRAVIS HIGGINBOTHAM



Are?

Commercial cannabis growers face an ever-evolving market and constant uncertainty. As a result, we must continually challenge our own thinking and build upon what we think we already know about growing. Across the industry, a primary objective is to reduce cost per pound while increasing quality and yield, to generate more revenue per square foot, per turn and per year. But how we pursue that goal will be essential to survival and success.

In the past, cannabis activists pushed for information sharing regarding cultivation practices, but growers are hesitant with the commercialization of cannabis and everyone thinking they have hit the goldmine with a special secret sauce.

Nowadays, there is still a lack of solid commercial data from growers about successful, cost-effective and progressive cultivation practices that could help all cultivators as a group. It is essential to explore ways to build awareness and encourage the sharing of scientifically valid and commercially proven information within the cannabis community and industry to further advance the market as a whole.

With that said, Statehouse, a California-focused, vertically integrated cannabis company, would like to share an innovative approach to optimizing cannabis yields by improving photon conversion efficiency while potentially reducing total energy use required per gram of biomass produced.

PHOTOSYNTHESIS FUNDAMENTALS

As a grower myself, I've come to believe that channeling energy directly to cannabis flowers during production—what we at StateHouse now call Flower Direct Cannabis Cultivation (FDC²)—may hold great potential for the goals we aspire to achieve.

While lighting is just one aspect of cultivation, optimizing light is crucial to FDC² success. Understanding some funda-

mentals of photosynthesis is key to implementing this new growing approach.

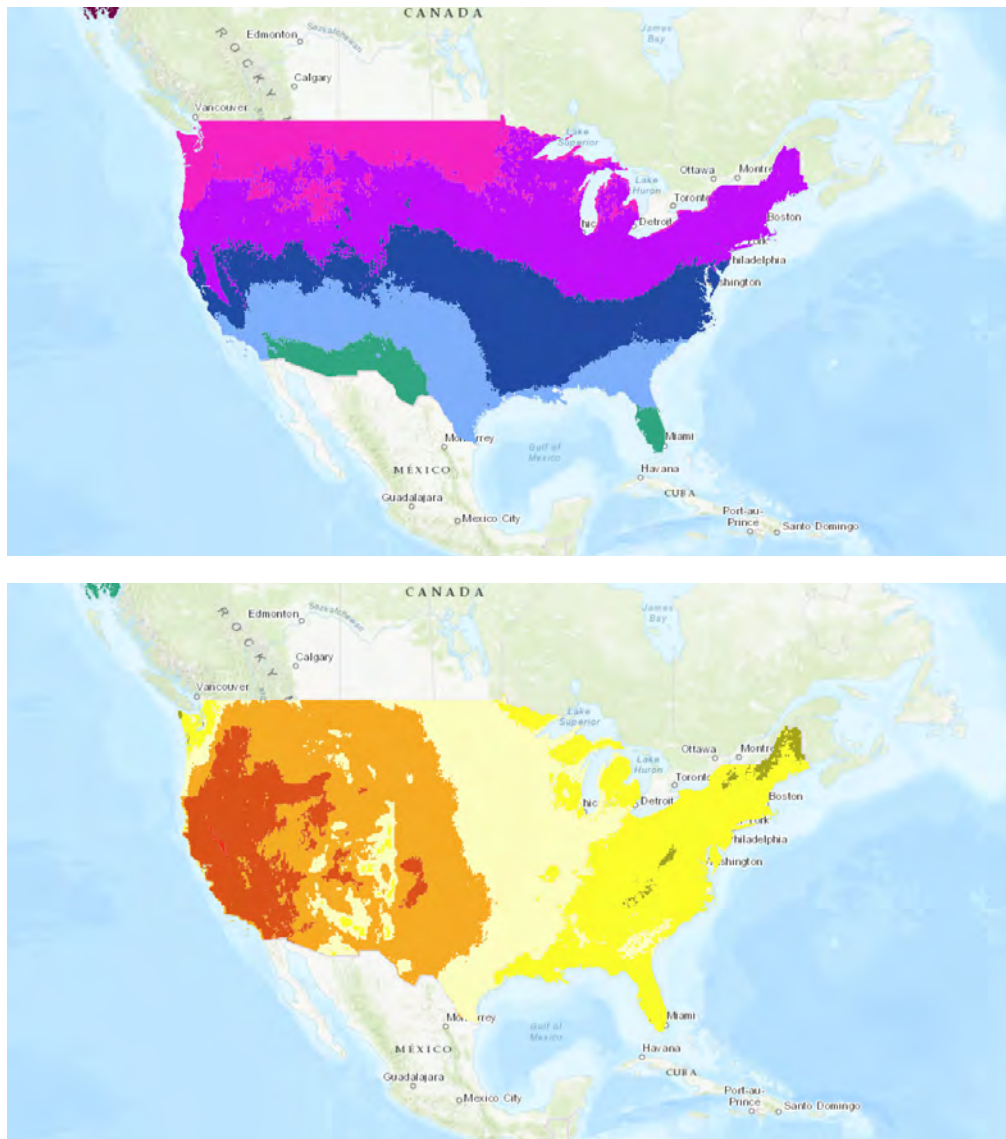
There's been a lot of attention given to the relationship between light and yield—specifically the commonly cited metric that 1% more light equals 1% more yield. This is widely assumed not only in cannabis but also in other crops, including commercial tomato, cucumber and leafy green production. This rule is a good baseline, but the linear relationship of light to yield is not exactly that simple. That's where understanding photosynthesis comes in.

Photosynthesis is the process by which green plants and other organisms convert photosynthetically active radiation (PAR) energy from the sun into chemical energy in the form of organic compounds, mainly glucose. During photosynthesis, carbon dioxide (CO₂) from the atmosphere is combined with water to form glucose, which can then be used by the plant for energy and growth.

In that process, the carbon in CO₂ is partitioned into the glucose molecules produced. The glucose can be used immediately for energy, or it can be stored in the form of starch or other complex carbohydrates for later use. These carbohydrates serve as the building blocks for biomass and yield in cannabis production.

Once we appreciate the fundamentals of photosynthesis (light + CO₂ + H₂O), we can work to optimize the growing environment's impact on it. This involves examining cultivation performance via key environmental measurement metrics, including daily light integral (DLI), photon conversion efficiency (PCE) and leaf area index (LAI), along with other FDC² metrics. Being able to calculate these metrics and compare them against yields clearly conveys both the facility infrastructure's latent yield potential or capabilities and, separately, a grower's performance.





MOL/M²/DAY

- 60-65
- 55-60
- 50-55
- 45-50
- 40-45
- 35-40
- 30-35
- 25-30
- 20-25
- 15-20
- 10-15
- 5-10
- 0-5

Fig. 1: U.S. DLI Levels, January (top) and July (bottom). Both maps based on solar radiation data from 1998 to 2012. Screenshot of maps courtesy of American Floral Endowment. The interactive map can be found here: <https://endowment.org/dlimaps/>

KEY METRICS FOR OPTIMIZING FDC²

Two well-known adages are fitting here: “You can’t manage what you don’t measure” and “Don’t be lazy in learning.” Keeping the simplicity, relevance and importance of these two quotes in mind can help as we examine light-related metrics and look at new opportunities to maximize yields in cannabis flower production systems.

THE OPTIMAL DAILY LIGHT INTEGRAL (DLI)

In partnership with the American Flower Endowment, Dr. Jim Faust and Dr. Joanne Logan (from Clemson University and University of Tennessee, respectively) created interactive daily light integral (DLI) maps and explained DLI this way: “Daily Light Integral represents the total

photosynthetically active radiation (PAR) accumulated over one day (24 hours). Since plants are accumulators of solar radiation, this measurement is extremely useful when describing solar radiation as it affects plant growth. Daily light integral has become a familiar measurement for plant scientists and commercial growers.”

Photosynthetic photon flux density (PPFD) is light intensity or instantaneous light measured in micromoles per square meter per second ($\mu\text{mol}/\text{m}^2/\text{s}$). In contrast, DLI is a cumulative measure, a function of both light intensity and duration, measured as moles per square meter per day ($\text{mol}/\text{m}^2/\text{day}$).

It’s important to note that natural DLI is tied not only to the sun’s seasonal intensity but also to your natural day length as it changes throughout the year.

Keep in mind this addition or loss of light throughout the year directly impacts photosynthesis and yields as discussed earlier. When growing in a greenhouse, this is especially critical to understand.

Research out of Utah State University’s Crop Physiology Laboratory (note: StateHouse is a funding partner for the USU Lab) shows that cannabis can be continually productive up to DLIs as high as 70 and potentially above. However, DLIs in the United States do not reach this level naturally, even during peak summer, and most indoor growers shoot for between 51 and 55 moles per day or approximately 1,200 $\mu\text{mol}/\text{m}^2/\text{s}$.

As growers, our goals are not always aligned with Mother Nature. To achieve the highest yields possible year-round, growing indoors or in a greenhouse with

supplemental artificial lighting is necessary to achieve those DLIs.

The maps on p. 22, created by Drs. Faust and Logan, reflect the variation in DLI based on U.S. geography and seasons. January is on the top, and July is below. The brightest reds on the July map represent DLIs of 55 to 65, while the pinks and purple on the winter map correspond to 5 to 15 mol/m²/day. Depending on your location, your natural DLI can change by 40% to 65% throughout the year—having a significant impact on cultivation performance.

StateHouse's cultivation facility in Salinas, Calif., is in a region with some of the highest DLIs in the United States, but the change between summer and winter is significant. The natural DLI outside the greenhouse changes by 60% throughout the year. At StateHouse, we use 60 moles as a practical, cost-effective target for optimization of yields, and even in California, we have opportunities to improve light capture and utilization.

Let's say you're a commercial greenhouse grower growing under glass in a tall Venlo greenhouse. When adding supplemental LED top lighting to optimize your grow, there are many considerations—including fixture form factor, fixture efficiency and spectra. But focusing on DLI as a function of light intensity you want to make sure your crop never receives a DLI less than 30 mol/m²/day at any given time of the year—not including your natural ambient light conditions. This means you would need to outfit your greenhouse with no less than 700 μmol/m²/s of supplemental LED top lighting when growing under a flowering photoperiod (approximately 12-hour day length).

PHOTON CONVERSION EFFICIENCY (PCE)

Photon conversion efficiency is another important parameter to consider and measure when trying to maximize yield with light, as it directly affects the efficiency of a growing system and therefore should be considered a new key cultivation performance indicator/metric. Photon conversion efficiency (PCE) reflects the efficiency with which light energy is converted into biomass. More specifically, it's the ratio of the number of photons

absorbed to the number of photons converted into useful energy.

A higher PCE means that more of your light energy is producing useful energy, which leads to higher overall system efficiency and yield. In photosynthetic systems, a higher PCE means more of the absorbed photons are being utilized to drive the photosynthetic process. This results in a higher rate of biomass production from the same amount of light energy.

When discussing cannabis flower production or biomass yield in general, the unit of measure for PCE is grams per mole (g/mole) of photosynthetically active radiation (PAR) light. You can apply this to a single square foot, cycle or year (g/mole/ft²/cycle). To maximize yield with light, it is important to design photosynthetic systems that have high photon conversion efficiency. This can be achieved by optimizing the system's materials, structure, light design, defoliation techniques, crop density and other operating conditions.

Currently, most growers only apply lighting from above the crop—and most commercial lighting is designed for that application. Obviously, this approach is due to plants being naturally adapted to capture light from the sun. But upper

leaves are not the only surfaces that can drive photosynthesis. Again, when thinking about crop production systems, our goals as growers are not always the same as Mother Nature.

LEAF AREA INDEX (LAI)

LAI is a key metric used in many fields, including ecology, agriculture, forestry and climate science, to provide valuable information about plant canopy structure, plant growth and ecosystem functioning. For cannabis growers, LAI is a critical tool in optimizing photon capture during production.

Typically expressed as a ratio, LAI quantifies the amount of foliage or leaf surface area present in a defined area. More specifically, LAI is the ratio of total leaf surface area—including both the upper (adaxial) and lower (abaxial) surfaces of leaves—to the ground (or bench) surface area.

Whether they know it or not, cannabis growers use this metric when filling in their canopy space during flowering. But there are many different approaches to maximizing canopy area. Although different approaches may achieve the same "total" yield result, they come with extremely different costs, system



▲ Intercanopy lighting research at StateHouse's cultivation facility in Salinas, Calif.

efficiencies gained or lost, and varying quality results.

For example, one way to fill in your growing area is to place more plants at it. Many assume you can increase yields easily by adding more plants. However, in some systems, labor cost has a 1 to 1 relationship with plant count, along with other direct costs, like materials (pots, substrate, fertilizer, water, etc.). More plants can require more handling; more defoliation contributes to additional labor and other costs. More plants also mean additional total wet weight going into drying, so a grower must remove more water from non-flower biomass. This poses many challenges, especially when growers have fixed and limited drying space, limited water removal capacity and limited dry time.

From an efficient drying and quality-ensuring perspective, growers can try to implement strategies that reduce total wet weight being introduced into drying at one time, enabling more precise control over the drying process. There are operators with systems as high as 1 plant per 1 square foot (1p/ft²) with the same yield as 1 plant per 3 square feet (.3p/ft²)—with the exact same crop time and schedule, but with vastly different finished flower quality, biomass category ratios, PCEs and costs per pound. In other words, less, i.e., fewer plants, can be more—and more efficient.

FLOWER DIRECT CANNABIS CULTIVATION STRATEGIES

As growers understand and appreciate daily light integral, photon conversion efficiency and leaf area index, the bigger question becomes how we can optimize these metrics to maximize



TRAVIS HIGGINBOTHAM

As VP of cultivation for StateHouse, Travis Higginbotham oversees a 230,000-square-foot cannabis greenhouse operation, running all cultivation, postharvest and bulk sales.

production, while also minimizing cost per pound. This is where FDC² strategies and technologies, like those that follow here, come into play.

LIGHT DIFFUSION

In lighting, diffusion refers to the

NATURAL DLI IS TIED NOT ONLY TO THE SUN'S SEASONAL INTENSITY BUT ALSO TO YOUR NATURAL DAY LENGTH AS IT CHANGES THROUGHOUT THE YEAR.

process of scattering or softening light rays to reduce harsh shadows and create a more even and uniform distribution of light. Greenhouses are subject to shading and, as the sun rises and sets, growing areas receive varying amounts of light throughout the day. By diffusing the light, the crop/growing area can receive more consistent light levels throughout the day while possibly accumulating more total light (DLI) during a single day.

Light diffusion also can help with temperature/heat management issues caused when wasted light concentrates on non-plant surfaces and contributes to radiant heat levels. With that said, light diffusion is also why most indoor grow rooms are white. *Flat* white can reflect and diffuse up to 85% of light, ensuring the same benefits seen when growers deploy proper light diffusion strategies in a greenhouse. The same is not true for gloss white, which can reduce uniform light diffusion compared to flat white by up to 50%. These small details matter.

While this may sound new to some growers, the proven strategy of maximizing diffusion and increasing light accumulation in plants in a single day—increasing single-day DLIs—has been integrated into traditional greenhouse production system designs for more than a decade. Understanding the benefits of diffusion, we can appreciate the possibilities when plants are able to absorb photons from all angles, not just from above.

MOVING BEYOND TOP LIGHTING

Chlorophyll, the pigment that gives plants their green color, is present in the chloroplasts of plants, algae and some

bacteria. It is essential for photosynthesis. In fact, the importance of chlorophyll in photosynthesis *cannot* be overstated.

Chlorophyll is the molecule responsible for capturing light energy and transferring it to other molecules in the photosynthetic pathway. Without chlorophyll, plants and other photosynthetic organisms would not be able to produce the energy they need to survive nor convert that energy into biomass.

Knowing the importance of the role of chlorophyll in photosynthesis and its direct impact on plant growth/biomass production, it's also critical to acknowledge that cannabis flowers are *green*. Yes, photosynthesis in fruits and flowers is also significant, not just leaves; green tomatoes are just one example. This principle may be crucial to maximizing your PCE during cannabis flower production.

It's time to now ask the question: Would applying light directly to all flowers on a single plant (throughout the whole vertical and horizontal profile) increase photon capture, therefore increasing photosynthesis, resulting in increased PCE and greater yields? Here at StateHouse, we think it does.

Dr. Bruce Bugbee at Utah State University's Crop Physiology Laboratory offers additional support for this idea, including research by USU Ph.D. Candidate and Graduate Research Assistant Mitchell Westmoreland.

"Cannabis flower photosynthesis is proportional to chlorophyll and surface area of the flowers. Mitch has data indicating that the flowers contribute up to 30% of the total photosynthesis at

harvest. This is based on canopy photosynthetic measurements after removal of the leaves,” Bugbee says. Consider that again: Flowers contribute up to 30% of the total photosynthesis at harvest.

To date, much of the research exploring more direct application of light to cannabis flowers, central to Flower Direct Cannabis Cultivation, has focused on supplementing top lights with intercanopy lighting (ICL), sometimes called *intra*canopy lighting, which places supplemental lighting into the canopy itself. Bugbee’s lab is not alone in acknowledging ICL’s potential for improving plant growth and yield.

Many other universities have also studied this promising lighting technique, including the University of Arizona’s Controlled Environment Agriculture Center; Wageningen University & Research (Netherlands); University of California, Davis, Department of Plant Sciences; Michigan State University’s Department of Horticulture; and Purdue University’s Department of Horticulture and Landscape Architecture. The latter three have also developed numerous lighting systems now being used in commercial greenhouse operations.

RESEARCH: INTERCANOPY LIGHTING VALIDATION GROUP (ICLVG)

Based on StateHouse’s own robust internal experiments and data from related research, the company, partnering with the Cannabis Research Coalition, explored FDC² lighting principles through the application of a specialized form factor of lighting fixture designed specifically for cannabis production.

The specialized fixtures have two levels and surround the crop while also sitting on the bench, enabling trellis connection and bracing of the plants. These fixtures create



Close up of intercanopy lighting technology used at StateHouse.

a three-dimensional cube around the crop.

As the crop grows, a grower can tweak the placement and direction of the light to channel directly on the flowers of the crop.

The objective of the study was to determine the impact of redistributing the same DLI (same amount of energy used) between top lighting alone versus

the combined application of top lighting plus the surround canopy fixture on cannabis crop biomass yield, biomass category ratio and finished flower quality. Read more details about the study and the findings, published in *Cannabis Business Times*, here: bit.ly/cbt-intercanopy-lighting-research ✨

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Kevin Kuethe,
Chief Cultivation Officer

LUME'S RAPID RISE

How Lume Cannabis Co. has flourished—growing from \$2 million to nearly \$200 million in revenue in four years—amid Michigan’s plunging retail prices and other challenges.

BY JOLENE HANSEN

PHOTOS BY BRYAN ESLER

Anyone following the cannabis industry's ups and downs has Michigan on their radar. Since adult-use sales launched in December 2019, the state climbed to No. 2 in sales nationally, eclipsing \$3 billion in 2023. But—and this is a big but—the state endured unprecedented price compression. As *Cannabis Business Times* reported in December 2023, Michigan's average adult-use retail flower prices plunged 78% in four years. However, there are bright spots that exist here. In just four years, vertically integrated Lume Cannabis Co. grew sales from \$2 million to closing in on \$200 million, thanks to investments in technology and automation that cut production costs by 50%, and an engaged and experienced team. With a solid foundation in the Midwest, the company is planning to expand to the Sunshine State.

A VISION BUILT TO LAST

You won't hear grumbling about Michigan's challenges from Lume Chief Cultivation Officer Kevin Kuethe. Instead, you'll hear optimism and confidence from a seasoned cannabis industry veteran (and 2021 *CBT* Cannabis Leadership Awards winner) whose cannabis industry experience spans a range of responsibilities and perspectives.

His cannabis career dates back to 2010, when he left Montana for Arizona as its medical market launched. As one of three co-founders and chief operating officer, he helped Bloom quickly become one of Arizona's highest-grossing cannabis companies. From there, he moved on to newer markets—including Colorado, Oregon and California—before landing in Las Vegas as chief operating officer of Gb Sciences.

Kuethe joined the Lume team in late 2017, before the company technically existed. "It was still an idea. But we had a vision of what we wanted it to be," he recalls. That vision was to build something of ultra-high quality that would last. He acknowledges that funding challenges often make such dreams difficult. But Lume was different. Initial capital came from the original founders and a network of friends, but the company has funded recent capital expenditures with revenue from ongoing operations. Now it's "marijuana's best-kept secret," he says.

"The main attraction for me was that I believed that we could do that here. We had good partners and good funding. We had a vision, and everybody was on the same page," he says. "And I'll tell you what, nothing stopped. Nobody ever went back on what they said, and we were able to create and build our first cultivation facility here."

Lume Chief Operating Officer and President Doug Hellyar came on board in early 2019, after working more than a decade with Lume founder and CEO, lacrosse legend Dave Morrow of Warrior Sports fame.

"It was a pretty simple call for Dave and I to make the switch over [to cannabis] because we saw this huge market potential," says Hellyar, who had multiple leadership positions at Warrior. While the entrepreneurial duo didn't anticipate all the challenges, the appeal of building something from scratch was irresistible. They set out to make Lume Michigan's leading brand.

Hellyar says vertical integration and the team have been crucial to growth: "To grow from \$2 million in revenues in 2019 to approaching \$200 million in 2023 is rapid growth. We would not have been able to do that unless we controlled our own destiny in terms of our operations and our retail scale-up ... and we put together an incredible team."

LESSONS FROM GROW ROOM 10

Today, Kuethe sits in Lume's 2020-2021 expansion in Ewart, Mich. (population 1,700). The 250,000-square-foot indoor facility houses 60,000 square feet of flowering canopy, two labs for solventless and hydrocarbon extraction, a 3,000-square-foot walk-in freezer, a fully automated gummy line pumping out 10,000 units an hour, an in-house tissue culture lab complete with internal qPCR (quantitative polymerase chain reaction) and HPLC (high performance liquid chromatography), and more.

About a year into the original facility, Kuethe started working with an engineer who had worked with U.S. automakers and whose expertise surpassed others he's known. For Kuethe, who's been part of the design, build and operations on 16 commercial grows, the year-long collaboration pushed the pair to new levels of performance, efficiency and technology.

"We designed a cultivation room we thought could outperform everything else and also cost us a lot less to operate it," he says. They sold the partners on the technology and built "an incubator"—aptly christened Grow Room 10—off the original nine-grow-room facility.

Grow Room 10's first yield set company records—82 grams per square foot. Then it got better—102 grams per square foot. Realizing it was something special, they got a process patent on the mechanical infrastructure and environmental control technology. After four or five harvests, the partners approved the expansion.

The expanded facility was built around the newly discovered technology. "It's been amazing here," Kuethe shares. "We have just been on such a tear with our harvest. We've had about 330 harvests so far, and we've never had a failed harvest. We never lost a room."

Lume also has robust in-house tissue culture and breeding programs. The indoor facility typically runs 150 genetics in tissue culture and flowers 20 to 30 at any given point. While many people think high-quality, high-testing cultivars equate to lower yields, it's the opposite at Lume, says Kuethe.

"Our highest-testing strains are also our highest yielding strains," Kuethe says, noting one tested over 50% total cannabinoids. "It's almost like growing a concentrate. It's

IN JUST
FOUR
YEARS, THE
COMPANY
GREW
SALES
FROM \$2
MILLION
TO
NEARLY
\$200
MILLION.





Clockwise from left: Lume Cannabis Co. typically runs 150 genetics in tissue culture at any given time; the company grows in tiers at its indoor facility in Ewart, Mich.; Lume's Extraction Manager Sviatoslav "Stan" Gourentchik in the hydrocarbon lab; the team bucks freshly dried flower.



LIVE. LOVE. LUME. IT'S A MOTTO WE HAVE THAT REFLECTS OUR COMPANY'S ETHOS AND

- KEVIN KUETHE (SEE PHOTO ON PAGE 32)



Lume has 1,000 employees across its cultivation and retail operations in Michigan, including 300 people at the Evart facility, some of whom are pictured here.

outrageous. It's also one of our highest yields." Giving a shoutout to Scott Reach of Rare Dankness's Jenny Kush, he urges growers not to settle when it comes to genetics: "Continue to hunt until you have the absolute winners that are high testers and high yielders. They exist."

AUTOMATION ADVANTAGE

A key factor in Lume's success is its attitude toward automation. Related savings and advantages have been integral to staying solvent during Michigan's wild price ride. But reducing operating costs was Lume's goal since day one—not a reaction—enabling the company to "bob and weave with the market" and come out on top, Kuethe says.

With 14 years in operations, Kuethe says he's always known you have to be a low-cost producer, and that's impossible without facilities to support it. When Lume's expansion was designed, the market had yet to make its downturn. But when adult-use retail prices started crashing—from more than \$400 an ounce in 2020 down to \$92 in 2023, as he points out—Lume didn't rest on its infrastructure laurels.

Instead, the team sought automation for everything that

aligned with consistent high quality. "When you're in the face of a declining market like that, you have to be able to automate things to lower your cost to produce. For us, it was essential at our volume and scale to be able to get automation that worked with our infrastructure," Kuethe says. He describes the result as "a stunning showcase of a premier grow and quality and consistency in automation" with minimum human intervention that allowed Lume to continue to compete.

"Automatically over the course of the grow cycle, light intensity and spectrum will change, irrigation recipes and volumes will change, temperature and humidity will change," Kuethe says. "The rooms are even capable of monitoring and adapting the set points based on how the room is performing."

Automation continues in post-harvest processing, where there are machines for trimming and grinding, vape cartridge filling, gummy manufacturing and packaging, pre-roll manufacturing and infusion, and printing and labeling.

Kuethe adds that willingness to invest in infrastructure to deliver higher quality products sets Lume apart: "We'll pay the money to have something that will help us in the long run for quality and consistency every single time. There will never be an argument."

ON THE WALL D SPIRIT.”

What's the biggest challenge in launching or maintaining a cannabis business?

“There are so many challenges! I think one of the biggest challenges is dealing with the consistent rule changes. There's a rule change every day and a half or something in the cannabis industry. So, staying on top of that, making sure that you are being efficient and following the rules, and also translating that to your employees because it takes new training and comprehension every time something like that happens.

“I always say if you can operate successfully in the cannabis industry, you could probably run any business because there are more regulatory changes and operational changes that happen than any other industry. And it's consistent because they're still learning as we go.”

What's something that would surprise most people about running a cannabis business?

“How difficult it is. I think a lot of people think ‘Oh, it's a marijuana grow. Those guys are probably hanging out walking around inside in board shorts and flip-flops and smoking doobies.’ It's not like that. It's not like that whatsoever. It's like a hospital, mixed with a surgery center and a science lab. And, for the regulatory side and the cash side, it's almost like a casino. To be able to function and operate, you have to be on point at all times. And the larger your company is, the more difficult that can be because all of that stuff has to be translated to the employees as well.”

What keeps you up at night?

“Nothing anymore. I have my second in charge, my right-hand man. His name is Marlon Mallas. He worked for me in Las Vegas as well, and he was my general manager there. He's now my general manager here, so we've worked together for years now. He is as sharp as they come and as reliable as they come. So, I sleep well at night having him by my side and helping me to operate and run these facilities. And I'd be lying if I didn't say the rest of the team as well.

“We have such a quality team here that's dependable. We've been through so many scenarios already. When something bad happens and they're able to solve

it in the same way that you would have solved it, that's priceless. And to be able to sleep at night, I know that any major issue that's going on, it will be handled, and it'll be okay. So, I think having the right team helps you avoid sleepless nights.”

I think you just answered this one: What helps you sleep at night?

“That's it!”

Any advice for others considering a cannabis business?

“I think your team is everything. I look at my partners here at Lume and the guys

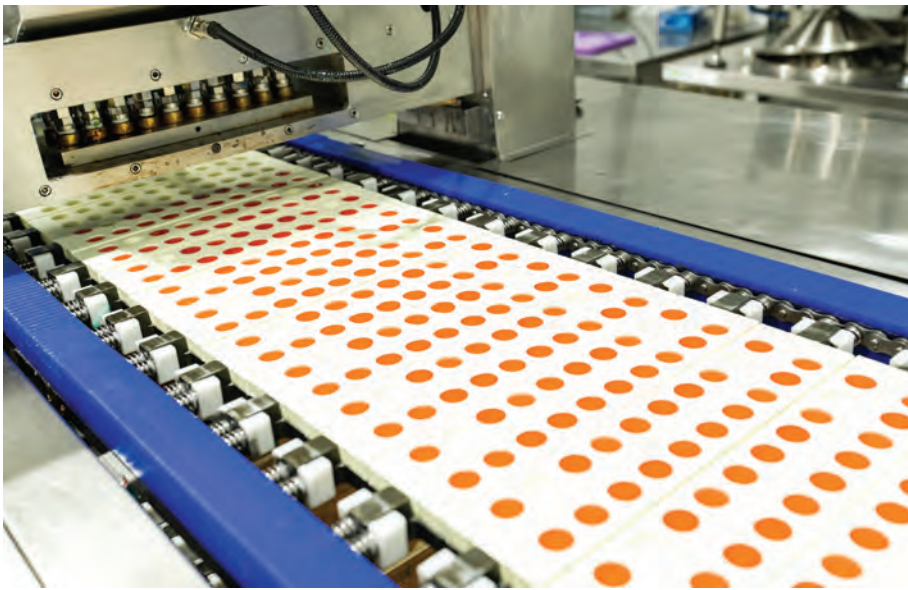
that I started out with here, and I wouldn't have done it if they weren't here. So, surrounding yourself with able people that have experience. Proven experience, not just people that say, ‘Oh, I can do that. We're going to do this. It'll be huge. It'll be great.’ But people that actually have proven experience in this industry or other industries and know business.

“I think the industry has developed enough to require a standard of high-quality business practices— professionalism, kindness, consistency—to be able to be successful. I think that really is the most important thing, to me.”

FAST TAKE WITH KEVIN KUETHE

CHIEF
CULTIVATION
OFFICER





With automation added to infrastructure and state-of-the-art technology that enabled Lume to double yields, Kuethe says Lume's production costs have dropped "well over" 50%. Hellyar adds that automation is essential to production at Lume's scale, and they've just touched the surface.

Now the focus is improving what's there, like a move from hand packaging ounces to an automated bagging system. From 40 pounds per eight-hour shift, they now do 300 pounds per shift—with two people instead of eight.

OUTDOOR? IN MICHIGAN?

Indoor expansion isn't the only thing fueling Lume's growth. Colorado hemp experience bolstered Kuethe's confidence in Michigan's outdoor cultivation potential. The first outdoor test run three years ago was 20 acres, aiming for oil.

The team discovered, to their surprise, the outdoor "extraction" crop produced some high-quality smokeable flower as well. Confidence grew and so did the grow. Hellyar says, "We had a very strong first year, and we've continued to build on that. It's a very, very large component of our growth strategy now." Dramatically lower outdoor production costs and Lume's ability to control its own destiny have been crucial to outdoor gains.

Top: While Lume has automated much of its trimming, they still hand-trim premium flower. Bottom: Lume's automated edibles production

"There's really an insatiable demand for outdoor-cultivated flower that passes the compliance tests mandated by the state of Michigan," Hellyar says. "It's really hard to pass the [microbial] test with outdoor smokeable flower. We've been able to do it each year in larger and larger quantities." Lume markets the in-demand product as "Lume SunK-issed—farm-to-rolling-table flower from the Northern Michigan sun."

In 2023, the outdoor grow had 36,000 plants for 70 acres of canopy. For 2024, the outdoor canopy is being bumped to 120 acres. The site is also home to a fully automated hybrid indoor-greenhouse, 16 hoop house tunnels and as much automation as possible for an outdoor farm of this scale. Planting, harvesting, drying, trimming, packaging—it's all automated.

"I haven't seen an outdoor farm with as much automation as we've employed there. But with such large scale, you have to invest in the automation infrastructure to be able to have acceptable costs," Kuethe says.

"One of my strengths has always been being able to compete commercially in cannabis on a quality and consistency level, but also just as importantly on a cost-to-produce level. The outdoor farm

obviously achieved several of those things. By not having to pay for lighting and environmental controls, you save on the infrastructure requirements necessary to grow indoors," he adds.

Lume's total 2023 indoor and outdoor production hovered around 100,000 pounds. Kuethe estimates they'll hit 150,000 pounds with 2024's outdoor expansion. But that still falls short of the quantities needed to supply Lume's flourishing retail arm.

Along with "Lume Cultivated" cannabis, the stores offer "Lume Curated" cannabis sourced from a select, carefully vetted cultivator network from throughout Michigan. Hellyar puts the current breakdown at about 45% Lume-grown and 55% from "the best and brightest, most passionate growers of excellent quality curated flower."

RETAIL AND EMPLOYEE SUPPORT

Lume's origin plans called for retail in every Michigan town that opted-in for cannabis. That turned out to be far fewer than expected, Hellyar says. (Seventy-three percent of the state's municipalities have opted out of allowing adult-use sales, according to ClickOnDetroit.com, the city's NBC affiliate.) Plus, requirements and restrictions in towns that did opt-in further hampered plans. Even so, Lume has 38 retail stores across Michigan—including six launched in 2023's tough market.

"The No. 1 plan for this year is to optimize the footprint that we have within Michigan, the 38 locations. No. 2, we have a few



Clockwise from top left: Lume has automated filling vape cartridges; Grow Manager James Holthaus examines plants in flower; a team performs quality checks on gummies; Lume's flower accounts for about 45% of what it sells at its 38 stores, the rest comes from partner vendors.



additional stores that are in the planning process right now,” Hellyar says. “And No. 3, we are looking for any type of acquisition that we can make—a retailer that has an excellent location where perhaps they’ve decided after five years in the cannabis market, it’s not for them. We’re looking for those types of opportunities.”

With 1,000 total employees, Lume’s workforce could constitute a town. The Evert facility’s 300 employees include tissue culture lab techs; dedicated propagation, vegetative and grow teams; harvest crews; trimmers; packagers; facility maintenance; back office and janitorial teams.

At a time when agriculture and horticulture businesses struggle to find labor, Lume hasn’t. Kuethe credits the work environment. “People want to work here,” he says. “We embrace the culture.”

Lume employees get two free things 24/7: coffee and ice cream. There’s also a 5-foot disco ball in the packaging room, with an on-off switch wired to Kuethe’s office. Add in events, parties, catering and the occasional massage therapist for on-the-job massages. “We try to keep it light and fun. Cannabis is supposed to be that way,” Kuethe adds.

Kuethe notes that Lume is one of the largest private cannabis companies in the country, and possibly the world, with an exec team that goes above and beyond for employees. “The volume of product that we move, we were able to stay private and keep the quality high in all these things. Without your employees, there’s nothing there,” he says.

Lume employees get full medical, dental, vision and pet insurance, plus incentive pay—and product samples. When employees had bank accounts closed and loans threatened because they worked in cannabis, one of the partners found a local credit union. Now Lume employees get preferred rates for home and vehicle loans, checking accounts and more.

“That all comes from people being passionate and trying to source things to help make the employees’ lives better. And at the end of the day, it just makes us better,” Kuethe says.

MULTISTATE ASPIRATIONS

While continuing to dial in Michigan, the Lume team has eyes on Florida. The company has applied for a Florida medical license and invested heavily in the Sunshine State. Hellyar notes that Florida, with double Michigan’s population, offers the opportunity to capitalize on Lume’s strengths: growing cannabis and operating retail. “We’ve made a multimillion-dollar investment in operations, so we’re going to be good to go,” he says. But it looks like licensing is still months away, according to a presentation



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from the state’s Office of Medical Marijuana Use Director, Christopher Kimball, who said in December he hoped the timeline for the new round of applicants would be within the next six months.

“We have a fully ready-to-operate indoor and greenhouse facility there ready to go,” Kuethe says. “One of the nuances of the Florida license is you have to get your cultivation authorization and start growing within 60 days of being awarded the li-



cense. You can’t just wait to get the license and then build something. You have to be ready to go. So we are.”

It will be Lume’s first move toward MSO status. “For us, it’s the perfect state to expand into,” Kuethe says. “That’ll make us a multi-state operator, but the regulation in Florida allows for vertically operated businesses to thrive. They don’t allow wholesale there, so you have to produce everything yourself. That’s our bread and butter. That’s what we’re good at. That’s what we do. So, the market and the regulatory side fits perfectly with our company.”

In the meantime, Hellyar says Michigan’s importance remains: “The state of Michigan’s market is going to be over \$3 billion [for 2023], so we still have a small percentage. There’s a lot to be done here, and that’s really what the team is focused on.”

If Florida licensing comes through, the Lume team is confident they’ll replicate their success. “The Lume team has proven we can thrive in the most competitive marketplace. We can compete with anybody because we’ve done it in Michigan,” Hellyar says. “Everybody in the country that understands cannabis knows the price compression that happened in Michigan is unlike any other price decline in the country, and it continues to be the most competitive market. That is our strength.” *

Top: Lume operates a tissue culture lab at its Evert facility.
Bottom: Prerolls in Lume-branded packaging

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SIZE MATTERS: THE CASE FOR SHORT PLANTS



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WHY TALL PLANTS COULD BE HURTING YOUR BOTTOM LINE, AND 3 TIPS TO KEEP CROPS SHORT.

Short plants can be easier to access and maintain, minimizing labor time and costs.

As I was learning and teaching myself proper horticultural practices early in my cultivation career, my goal was to grow the largest plants possible, thinking “the larger the plant, the larger the yield.”

This notion is one shared by many first-time growers, especially novice outdoor farmers. Growing 10-foot-tall (or more) trees can without a doubt impress friends and team members.

However, my experience ultimately taught me that the time, resources and energy required to grow and maintain very large plants was not worth it.

THE TROUBLE WITH TALL PLANTS

To grow tall cannabis plants, growers must extend the vegetative cycle to grow thicker stalks and more branches. And during longer vegetative cycles, there will inevitably be more resources utilized.

Cannabis remains in its vegetative state when photoperiods exceed 12 hours per day, which means indoor growers must keep lights on for longer periods, increasing production costs. Similarly, greenhouse growers will need to rely more heavily on supplemental lighting during darker winter and spring months to allow the vegetating plants to grow to their colossal size. Outdoor growers might need to start plants earlier in the season in a greenhouse or indoors to get plants large enough before planting them in their fields come spring, thus increasing production costs.

Maintaining taller plants can also be an

issue for employees. Defoliating tall plants might require cultivation team members to climb ladders, slowing down the process and increasing the risk of accidents. Because of their increased biomass, large plants require much more support in the form of trellising than medium or small plants, which again can become an arduous task when it needs to be done on a ladder or from a cherry-picker.

When grown outdoors, large plants are also more susceptible to having broken branches—or worse, destroyed main stems—during inclement weather, as the bigger branches weigh down the plant in later growth stages. Similar to trellising, covering large plants during storms can create havoc for cultivation staff. Leaving large plants poorly covered can lead to moisture-related health issues, including bud rot, botrytis and/or powdery mildew.

While growing larger plants in larger containers might save on watering (a larger volume of growing media will generally hold more water, thus reducing watering frequency) there is also a spacing consideration: How much usable biomass are you getting out of your large pot compared to having multiple pots covering the same area that require the same inputs? With most cultivars, three stocky 3-foot plants can yield as much, if not more, usable biomass than a 9-foot plant. Larger plants will have more wasted biomass due to the larger number and size of stems, branches and stalks.

While large plants will typically produce huge buds, it will be difficult to get those to

WHAT ABOUT MOTHER PLANTS?

The philosophy of growing more smaller plants rather than having a few massive trees extends to mother plants from which some growers take clones or tissue cultures. Large mother plants are difficult to keep virus-free, even when utilizing UV sterilizing lights, because, similarly to grow lights, it is difficult for the sterilizing light to reach all surfaces of the plant if the plant is large and has a lot of foliage. To keep a large mother sterile and free from viral infections such as tobacco mosaic virus, (TMV) all surfaces of the plant must have UV rays in direct contact.

I prefer small- or medium-sized mother plants as they are easier to keep “clean.” I also prefer to rotate my mother plants often, so there is always a relatively fresh and clean clone/tissue culture sources. I realize a good mother plant can be perpetually sourced from for years on end, but I still prefer to periodically rotate out old mother plants and replace them with new clean stock out of an abundance of caution.

For more tips on mother plant management, read Quick Tips on p. 10.



Keeping cannabis plants shorter can minimize the layers of trellis needed to support the stalks and branches.

consumers. Huge, beautiful buds will certainly impress even the most novice customer, but they are more difficult to package. Growers are often forced to break down those massive colas to fit into retail packaging, wasting all the time and resources spent growing them.

THE BENEFITS OF SMALLER PLANTS

Short and medium plants are easier to defoliate and maintain, as they are closer to regular working height and require less structural support—often, only two or three layers of trellis are required to support the plant and branches—and are more resilient against inclement weather.

Smaller containers are also easier for both employees and machines to work with and move around, helping with facility workflow. And they can be stacked on multi-level racks to maximize the use of available floor space. While a larger plant may yield more than a single small plant, by stacking smaller plants vertically and increasing density, yield per

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square foot figures can dramatically increase.

From an input perspective, smaller plants will require less supplemental and side lighting (in both greenhouse and indoor environments), as there is not as much foliage through which light needs to navigate. They also will require less frequent and intense defoliating, as even lower and deeper bud structures will receive enough light compared to similarly positioned buds on large plants. Not only will they require less supplemental lighting, short plants also will require less vegetating time, thus saving electricity and other input costs.

Additionally, shorter vegetation cycles will allow greenhouse and indoor growers to get more harvests in their year, and the harvests will be quicker, as there is less unusable biomass to sort through. Ask yourself: are you growing buds? Or stems and stalks? Because, last I checked, the stems and stalks have little-to-no value. I would rather focus on maximizing the productivity and quality of the usable buds rather than growing fibrous material.

3 TIPS TO KEEP PLANTS SHORT

Tip 1: Minimize veg time. To optimize production, ideally plants will grow 24 to 36 inches indoors and 48 to 60 inches outdoors. To keep crops at targeted heights, growers can short-cycle plants, which minimizes cultivation time spent in vegetation. Vegetation should run no more than the length of time it takes for a given cultivar to reach the target size and have strong root development, which some achieve in as little as two to three weeks in tiered indoor grows and up to eight weeks in single level grows.

Beyond adjusting size, short-cycling also reduces the risk of disease or pathogens infecting crops—the quicker the plants are harvested, the less time problems have to manifest. More frequent harvests will also equate to more frequent room decontaminations, again minimizing the risk of critical crop failures or diseases that seep through the entire facility and become systemic. If pathogens do infect a crop, it's easier to recover

from a shorter plant cycle and start anew rather than see six months of vegetation work go up in smoke (and not in a good way).

Indoors growers can more easily dictate the final height of the finished plant by decreasing the amount of light the plant receives earlier in the growth cycle before inducing flowering.

By manipulating the photoperiod and intensity in the vegetation period, growers can ensure that plants are the ideal size by the end of flowering. Often, at the end of the flowering cycle, the plants will be taller than desired and may get too close to light fixtures, which can cause photobleaching or tip burn. Understanding your specific cultivars and their growth patterns is a must, and until cultivar information becomes more widely available, this can only be learned through experience—and trials.

Tip 2: Plant seedlings later in the growing season. Outdoors, the easiest method



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possible to produce medium-sized plants rather than large ones is to plant seedlings slightly later in the growing season, leaving less vegetative time before the flowering cycle. A shorter vegetative cycle in midsummer can produce very nice medium-sized plants with a stalk infrastructure that only requires two or three levels of trellis for

supporting flowering branches, rather than scaffolding-type supports that are sometimes required for supporting very large plants.

(Relatedly, I've seen many home growers who want to grow large plants purchase clones from their local dispensary and immediately place them in a media outside, only to have them immediately begin to flower

because they are now receiving less light than what is required for vegetative growth. Likewise, the clones' growth would be stunted because they have been thrust in a cooler environment than they were propagated in.)

The key to short-cycling outdoors is understanding the outdoor environment—more specifically, seasonal temperatures and light levels—so one can predict when it is best to place plants outdoors or germinate seeds to place outdoors to minimize overgrowth.

If temperatures are still low at night, a simple collapsible hoop house can be placed over young plants outdoors to prevent stunting (no different than what many backyard tomato growers do and have done for decades).

Interestingly, in some latitudes, such as Hawaii, cannabis plants immediately begin to flower when placed outdoors, regardless of what time of year crops are planted. Some home growers choose to vegetate their plants in a greenhouse with supplemental lighting, or do so in an indoor facility, and place the plant outdoors when the plant has reached the target vegetative height. This way, they end up with a plant that is the desired height at the end of the flowering cycle.

Tip 3: Consider autoflowering varieties.

Another way to manage plant height is to employ autoflowering plants from seed. Autoflowering plants typically stay very short, between 24 to 36 inches, but it is not unusual for a 48-inch autoflowering plant to appear. The structure of an auto-flowering plant naturally has less lateral side branching and typically yields a large apical or primary bud with short to very short side branches. Autoflowering plants are also conducive to shorter cycles because plants naturally transition to flower 14 to 21 days after germination.

Growing cannabis plants as tall as your living room ceiling might be a fun side project,



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but, from a commercial perspective, these mammoths present too many challenges to effectively overcome. If growers do want to grow monsters, it's likely best to do so in the comfort of their own backyards—if nothing else, the shade will be nice. ✨



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THE LAST WORD

A conversation with an industry leader, before you go

'FOCUS ON THE DOWN THAT'S AT HAND'

In this exclusive interview with *CBT*, **TRULIEVE CEO KIM RIVERS** explains why the company is 'laser focused' on Florida and reclaiming 280E taxes paid.

INTERVIEW BY **NOELLE SKODZINSKI AND MICHELLE SIMAKIS**

IN NOVEMBER, *Cannabis Business Times* sat down in Las Vegas with Trulieve CEO Kim Rivers to discuss some of the company's most important endeavors in 2023 and top priorities for 2024. In this conversation, Rivers explains the motivation behind Trulieve—one of the largest multistate cannabis companies in the country—filing an amended tax return and its effort to recover 280E money paid to the IRS and which markets are most important for the company in 2024.

1 **Noelle Skodzinski:** Can you talk about the amended tax filing and the strategy behind claiming you do not owe 280E taxes?
Kim Rivers: We filed in October amended tax returns for 2019, 2020 and 2021, and we had to file by that date, or we would've lost the ability to claim basically a refund for 2019. And so it was a straight refund claim. You're just basically saying, "We don't believe that we owe you this money. We made an error in our filing, so please send us back \$143 million. Please and thank you." [Laughs]

Just to be clear, up until this point, we have made all estimated tax payments, fully loaded, is how we're characterizing it, with 280E and our regular tax payments all the way through the second quarter of 2023.

Then when 2023 becomes due, we will have paid partial fully loaded payments for 2023, we'll file that return and say, "Hey, by the way, we're not paying these last two quarters of estimated payments because we don't believe we owe you." And so then this will really hit in 2024, right when we file that return, and we'll be filing that return saying, again, we're taking the position that we do not owe 280E taxes.

So, best case scenario, the IRS says, "Oh my gosh, thank you for bringing this to our attention. We agree with you. Here are checks, and we're going to start sending you money."

Second scenario would be IRS says, "No, we disagree with you. We believe that you owe it." To which point we would then roll out our legal strategy and take it to court. At that point in time ... everybody will be able to see exactly the specifics in terms of what is behind the claim.

2 **NS:** So you're not sharing that rationale now?

KR: There's no reason for us to do that, and it would not be to our advantage from a positioning perspective—we don't want to harm our chances of success ultimately by doing that.

3 **Michelle Simakis:** Looking ahead to 2024, are there any markets you feel are most favorable to expansion or that you're most excited about?

KR: I think for us, we are very, very, very focused on Florida and then Pennsylvania. When you look at those two markets combined for us, we have 150 stores that we need to flip [to adult-use if a bill or ballot initiative passes], which is not nothin' as we sit here today.

I mean, I think when you look at other medical programs that have transitioned into adult use, I think that the most anyone had in their portfolio at the time was less than 20.

I'm a big Florida State Seminoles fan. We have the ball at the 10, and you want the touchdown. You don't want to have to settle for the extra points, and you dang sure don't want to fumble the ball. Right? What causes fumbles a lot of times is you're thinking about the next play. You're not focused on the down that's at hand, and we have to focus on the down that's at hand.

4 **MS:** How are you preparing for the potential of adult-use expansion?

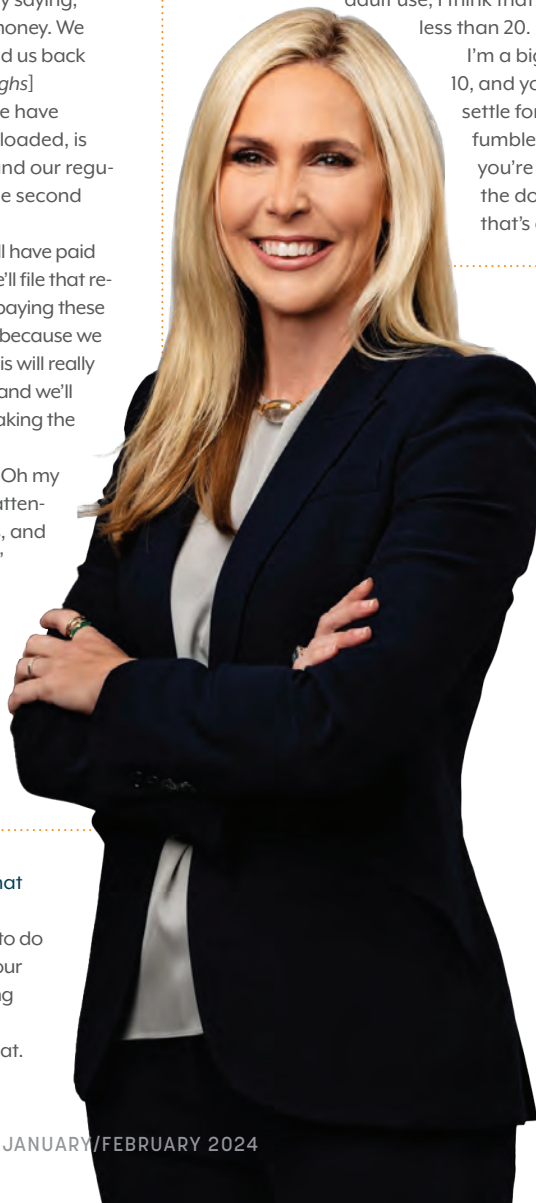
KR: We need to optimize and make sure that our retail platform is in the best posture that it can be to service the customer in the current environment, but then of course, in an increased demand environment, as well.

We're about to launch a new website. We're about to launch a new loyalty program. We're looking at our tech stack and our communications channels to consumers. ... Making sure that our systems can handle that at a different level of scale. And then all the way back through our demand planning and how is our forecasting model going to change. It's a soup to nuts effort that has already kicked off.

And again, by the way, that benefits our business regardless of what happens with adult use. And it benefits our business, not just in Florida, but across the country. Finding those opportunities where we can make investments and we can lean in in a "regardless" situation is something that we continue to be focused on. ✨

This conversation has been edited for length, style and clarity. Read the full conversation here: bit.ly/cbt-kim-rivers

Noelle Skodzinski is editorial director and Michelle Simakis is editor-in-chief for *Cannabis Business Times*.



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