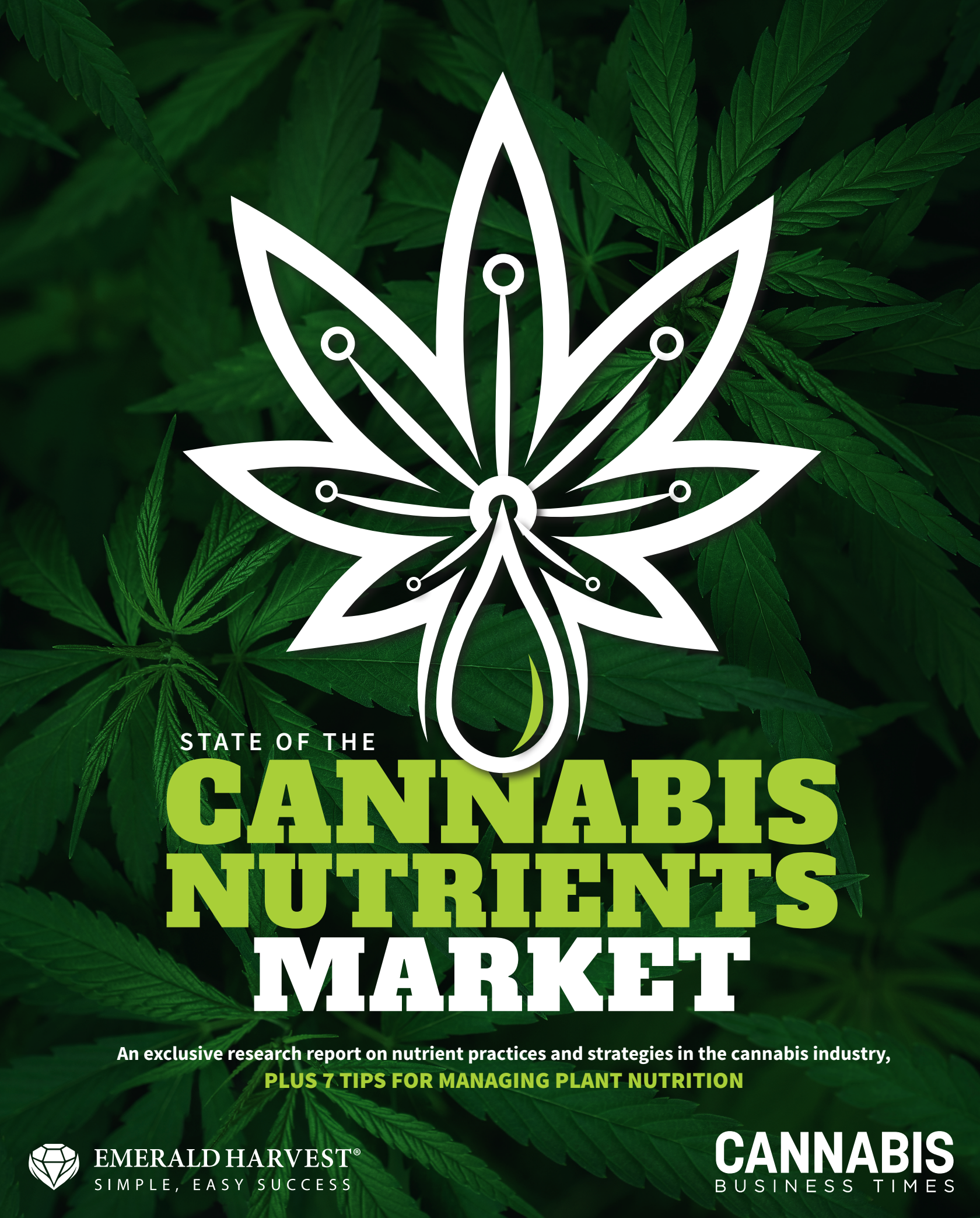

STATE OF THE

CANNABIS NUTRIENTS MARKET

An exclusive research report on nutrient practices and strategies in the cannabis industry,
PLUS 7 TIPS FOR MANAGING PLANT NUTRITION

EMERALD HARVEST®
SIMPLE, EASY SUCCESS

CANNABIS
BUSINESS TIMES

STATE OF THE NUTRIENTS MARKET

> **OUR MISSION AT EMERALD HARVEST IS TO HELP GROWERS ACHIEVE SIMPLE, EASY SUCCESS THROUGH OUR STREAMLINED PRODUCT LINE.**

Maximizing plant potential to grow your business

Cannabis cultivators sink enormous amounts of time, money and effort into their high-value crops. These investments require the right skills, techniques and inputs—light, CO_2, water and nutrients—to pay off.

In this report, you'll learn how professional growers use nutrients to maximize plant potential, and thereby grow their businesses, in three main ways:

- **Increasing yields.** We're talking volume here—scaling production for more sales. To achieve this, you can either grow more plants or make each plant more productive. Or, ideally, you can do both! A powerful bloom booster—in addition to the right lighting, CO_2 enrichment and other cultivation techniques—is crucial for getting the biggest yields possible, resulting in more dry weight per plant.
- **Improving quality.** You can demand top dollar *only* if you offer a product unequaled in the marketplace. Your customers value flavor, fragrance, color and, above all, potency. Once again, a superior bloom booster and other flowering supplements, including both a premium plant tonic and an aroma and resin enricher, are what you need. You also need a brand you can trust—nutrients low in heavy metals and other impurities.
- **Safeguarding against losses.** Your investment and care could get squandered without grow-room hygiene. The roots are especially vulnerable, so inoculate them! If beneficial microbes get a foothold early in your grow, they'll help to fight off the bad stuff. Other supplements can help your crops stand tall and fight off upper-plant diseases. Finally, deficiencies and burn must be guarded against.

Our mission at Emerald Harvest is to help growers achieve simple, easy success through our streamlined product line. To that end, we've positioned ourselves to know all we can about the industry, our products and growers' needs.

These efforts are made knowing that, in a changing industry, there's always more to learn. That's why we chose to support this original research by *Cannabis Business Times*. Emerald Harvest shares *CBT*'s mission of educating growers to help their gardens—and businesses—thrive.

We hope you'll find this report as interesting, informative and helpful as we have.

Our best wishes for your success!

ROBERT HIGGINS
CEO, Emerald Harvest

STATE OF THE NUTRIENTS MARKET

REFINING NUTRIENT GUIDELINES

DIETARY GUIDELINES ALWAYS SEEM TO BE IN FLUX. The food pyramid, once accepted as the gold standard for human health and wellness, has now been replaced with the very literal "MyPlate." The dish is divided with serving size suggestions for each food group, with an emphasis on vegetables instead of cereal and grains, once the foundational base of the ubiquitous pyramid.

Updating dietary guidelines is important because nutrients are fundamental to human health and development—so essential that the U.S. government reviews, modifies and publishes nutritional recommendations every five years. As cultivators know, nutrients are also an essential component not only to grow and maintain strong and healthy cannabis, but also to help fight disease. And, as they do with human nutrition, researchers continue to study and discover new findings about the best balance of essential nutrients for cannabis.

That's why for the past year, *Cannabis Business Times* has published findings from North Carolina State University researchers in a regular series called "Nutrient Matters," which covers everything from troubleshooting nutrient problems to balancing pH levels in a grow. Scientists are re-examining previous nutrient best practices as the cannabis industry continues to evolve.

Thanks to the generous support of Emerald Harvest, *CBT* has conducted new research among cannabis cultivators to find out how they manage nutrients in their cultivation facilities in *CBT*'s first-ever "State of the Cannabis Nutrients Market" report. Participants responded to questions to shed light on their ideal pH level for nutrient solutions, the most popular supplements and growing media used and what factors they find most important when selecting nutrients.

Findings from the study are published on the following pages, along with comparisons to an Emerald Harvest-supported 2017 research project conducted by *CBT*, which shows how cultivators' practices and priorities have changed in just two years. This exclusive report also includes insight from a cultivation director, who provides a detailed glimpse of the day-to-day challenges of operating a nutrient program and shares top tips for success.

AS THE INDUSTRY CONTINUES TO EVOLVE, *CBT* WILL CONTINUE TO EVOLVE, AND LEARN, WITH YOU.

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STATE OF THE NUTRIENTS MARKET

PHOTO BY MEL FRANK

STATE OF THE CANNABIS NUTRIENTS MARKET REPORT

Top Operational Hurdles: Regulations, Cultivation Management

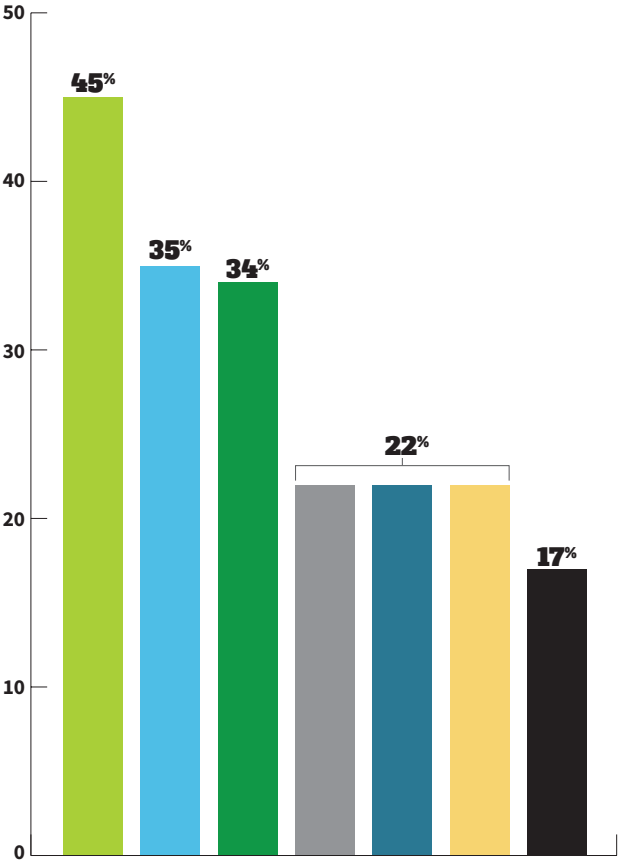
When cultivators launch operations, they often grapple with complex regulations, environmental factors and financial challenges. Growers participating in *Cannabis Business Times*' "State of the Cannabis Nutrients Market" study indicated that these issues were significant challenges during their start-up phase. Given the number of factors involved in running a successful growing operation, it's no surprise that cultivators also often struggle with effective cultivation management, which includes plant nutrition—a critical process that can determine crop yields, quality and, ultimately, profitability. In fact, 35% of research participants ranked "cultivation management" as their greatest operational challenge during the launch phase, second only to "regulation hurdles." Other notable challenges included "securing capital," "declining prices" and "disappointing crop yields." The top three challenges remain unchanged for cultivators when comparing hurdles during the launch phase to what these businesses struggle with today.

TOP 3 OPERATIONAL HURDLES

REGULATIONS | CULTIVATION MANAGEMENT | SECURING CAPITAL

Launch Challenges

What was your greatest operational challenge initially when you were *launching* your business?

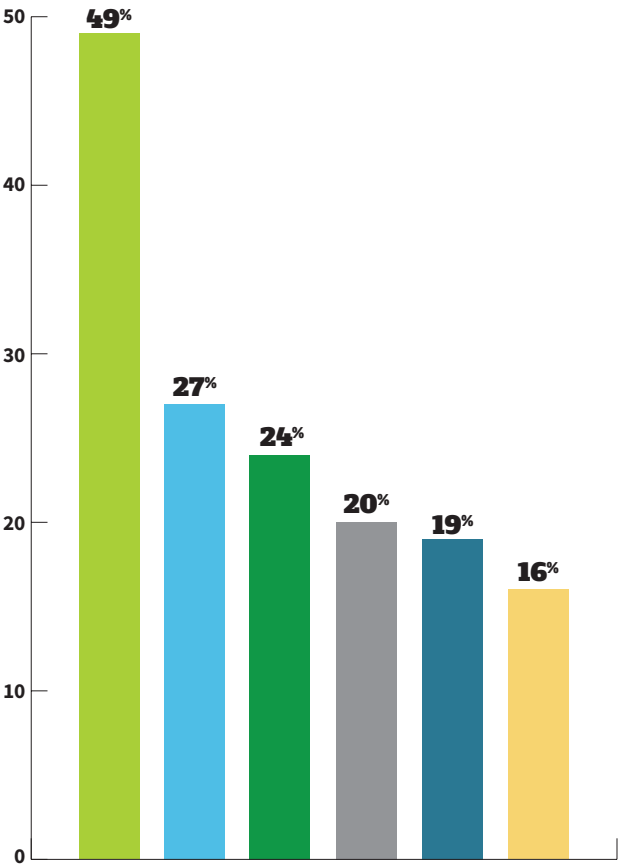


Note: Additional concerns noted were: distribution delays (10%); competition (8%); product shortages (7%); and oversupply (6%). 5% of participants said none of these were concerns, and 1% did not answer the question. Note: Totals exceed 100% because respondents could select all that apply .

- Regulation hurdles
- Cultivation management (i.e., plant nutrition, lighting, watering/ irrigation, humidity control, and/or pests/ disease prevention)
- Securing capital
- Declining prices
- Disappointing crop yields
- Financial management/ production costs
- Product consistency

Ongoing Challenges

What do you consider to be the most significant pain points in your organization *today*?



Note: Additional concerns noted were: product consistency (11%); competition (11%); oversupply (10%); disappointing crop yields (9%); and product shortages (5%). 7% of participants said none of these were the most significant pain points, and 2% did not answer the question. Note: Totals exceed 100% because respondents could select all that apply.

- Regulation hurdles
- Securing capital
- Cultivation management (i.e., plant nutrition, lighting, watering/irrigation, humidity control, and/or pests/disease prevention)
- Declining prices
- Financial management/ production costs
- Distribution delays

STATE OF THE NUTRIENTS MARKET

Nutrient Knowledge and Strategies

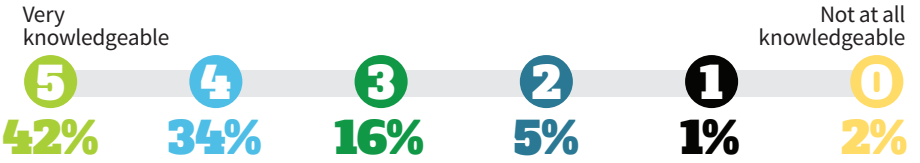
In the two years since *CBT*'s first nutrient report, also conducted in partnership with Emerald Harvest, study participants reported being slightly more knowledgeable about plant nutrition, as 42% indicated they feel "very knowledgeable" about it compared with 36% in 2017. Overall, more than three-fourths of participants rated their knowledge as 4 or 5 on a scale of "not at all knowledgeable" (0) to "very knowledgeable" (5) in the nutritional needs of their plants, which has not changed since *CBT* last conducted research of nutrient use among cannabis cultivators.

Despite cultivators' confidence, their approaches to nutrient programs are not consistent. For example, responses to whether cultivators use pre-mixed nutrient lines (29%), mix their own nutrients (29%) or do some combination of the two (39%) were fragmented. For those who do use pre-mixed nutrients, a majority (54%) said they use more than two nutrient brands.

Cultivators use a wide range of supplements, in addition to base nutrients, and the top 12 supplements used are included below. The most popular choices included "bloom enhancers/boosters" (48%), "humic/fulvic acid" (47%) and "kelp" (45%).

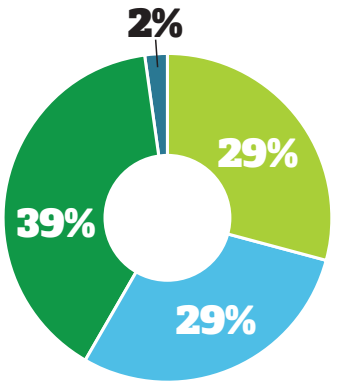
Nutrient Know-How

How knowledgeable do you feel about the nutritional needs of your plants?



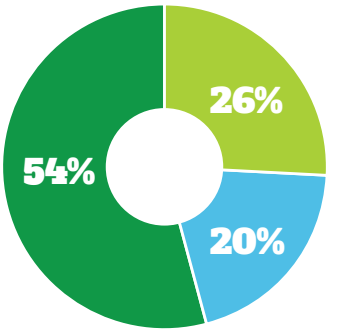
Nutrient Mixes

For plant nutrition, we use:



- One or more pre-mixed nutrient lines: 29%
- Mix our own nutrients: 29%
- A combination of pre-mixed nutrient lines and our own nutrient mix: 39%
- No answer: 2%

For those who *use pre-mixed nutrients*, which of the following do you use in your grow operation?

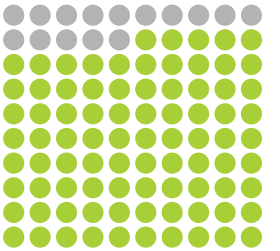


- Only one nutrient brand: 26%
- One base nutrient brand and a different supplement brand: 20%
- More than two brands: 54%
- No answer: 0%

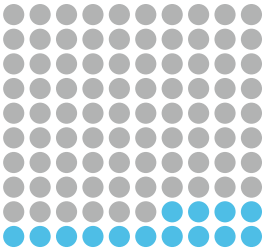
Base: those who own or work for a licensed operation that cultivates cannabis for sale and use pre-mixed nutrients (105 respondents)

Supplements

Do you use nutrient supplements in addition to a base nutrient?



Yes: 85%



No: 14%

No answer: 1%

Which of the following supplements do you use, in addition to a base nutrient? (Top 12 used)

Bloom enhancers/ boosters	48%
Humic/fulvic acid	47%
Kelp	45%
Worm castings	36%
Molasses	32%
Guano	30%
Silica	30%
Compost	28%
Probiotic teas	28%
Inoculants	28%
Potassium silicate	25%
Organic residuals	23%

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

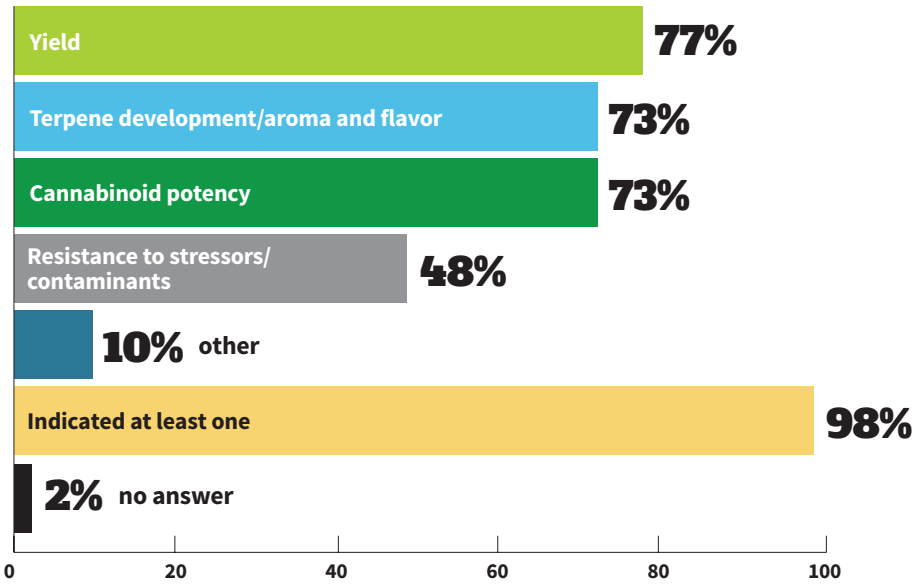
Performance Expectations, Reasons for Buying Evolving

The number of cultivators seeking nutrients that can impact cannabinoid potency has increased dramatically since the last study in 2017; this year, 73% indicated it was among the top three factors they considered, compared with less than 10% two years ago. Other key priorities cited by this year's participants include "yield" (77%) and "terpene development/aroma and flavor" (73%).

The selection criteria cultivators use to choose nutrient lines has also changed since the last report. A plurality of respondents relied on "recommendations from other growers" (45%) in 2017. This year, 26% used those endorsements as a guide. The majority (76%) indicated "results/performance" was of top importance when determining what to feed their plants. When looking at other highly ranked options, it seems growers value information and transparency from nutrient manufacturers, as "ingredients" (64%) and "certificates of analysis" (40%) ranked as the second- and third-most selected choices. Price remains important for cultivators—55% of research participants noted cost as 4 or 5 on a scale of "not at all important" (0) to "extremely important" (5) when looking for a nutrient. But when compared with other factors, 39% said price is among the most important when selecting a nutrient line.

Desired Nutrient Impact

Which of the following do you look for in nutrients to impact in your crops?



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

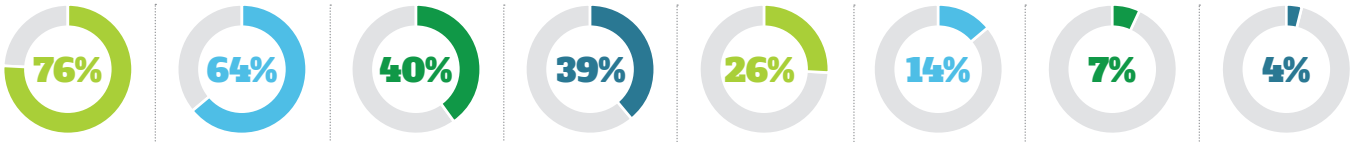
Price Priority

How important is cost to you when looking for a nutrient?

No answer: 0%

Selection Criteria

Which of the following are most important to you when selecting a nutrient line?



No Answer: 0%

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

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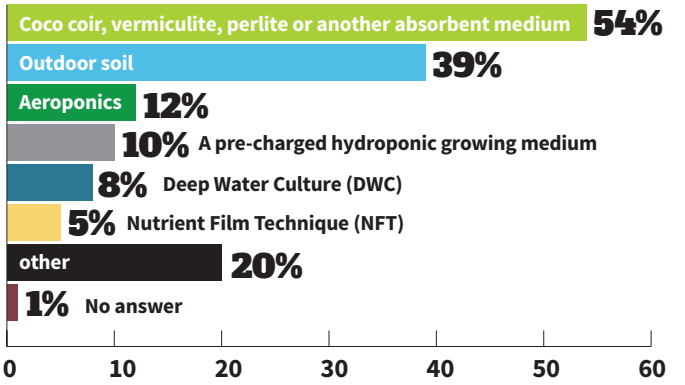
STATE OF THE NUTRIENTS MARKET

Growing Medium: The Foundation

More than half (54%) of cultivators who participated in the nutrient study indicated they use “coco coir, vermiculite, perlite or another absorbent medium” as a growing medium, while 39% said they use “outdoor soil.”

Growing Media

What growing medium do you use?



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

MORE THAN

3/4 OF PARTICIPANTS

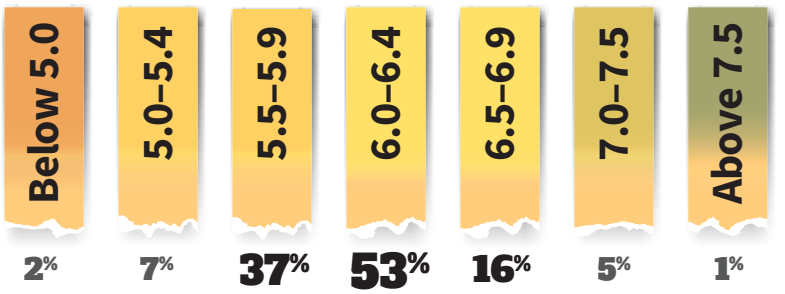
FEEL CONFIDENT IN THE NUTRITIONAL NEEDS OF THEIR CANNABIS CROPS.

Science and Nutrition

In this year’s study, slightly more respondents indicated they measure nutrient pH (89%) compared to the 2017 report (85%). Most respondents (90%) aim for nutrient pH levels between 5.5 and 6.4, with the majority (53%) targeting the 6.0-6.4 range.

pH Levels

What pH level do you aim for in your nutrient solution?



Indicated at least one	I do not check pH levels	No answer
89%	9%	2%

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PARTS PER MILLION (PPM) LEVELS

What ppm levels do you target for the following critical nutrients?

Magnesium (Mg)

More than 25 ppm	23%
20-25 ppm	6%
15-19 ppm	12%
10-14 ppm	18%
5-9 ppm	26%
1-4 ppm	16%

Phosphorus (P)

More than 25 ppm	30%
20-25 ppm	1%
15-19 ppm	13%
10-14 ppm	23%
5-9 ppm	22%
1-4 ppm	12%

Nitrogen (N)

More than 25 ppm	31%
20-25 ppm	10%
15-19 ppm	14%
10-14 ppm	17%
5-9 ppm	19%
1-4 ppm	9%

Calcium (Ca)

More than 25 ppm	27%
20-25 ppm	5%
15-19 ppm	9%
10-14 ppm	20%
5-9 ppm	27%
1-4 ppm	12%

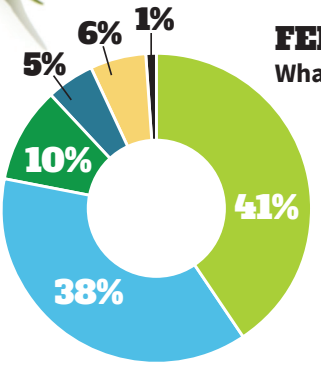
Potassium (K)

More than 25 ppm	33%
20-25 ppm	3%
15-19 ppm	15%
10-14 ppm	17%
5-9 ppm	22%
1-4 ppm	11%

**Note: 33% to 35% of research participants did not answer these questions.*

FEEDING CHARTS

What feeding charts do you use?



- The manufacturers', but adapted to our needs
- My own design
- The manufacturers'
- Other
- I do not use a feeding chart
- No answer

About the Research and Participants

Third-party researcher Readex Research conducted the study and compiled the data for the 2019 "State of the Cannabis Nutrients Market" report. *Cannabis Business Times* sent the questionnaire to subscribers with known email addresses and/or e-newsletter subscribers located in the U.S., Canada or other (unknown) North American locations in October and November 2019. The survey link was also included in regular e-newsletters and in social media posts.

Results are based on 153 respondents who indicated they own or work for a licensed operation that cultivates cannabis for sale. The margin of error for percentages based on the 153 respondents who indicated they work for a cultivation operation that cultivates cannabis for sale is approximately ±7.8 percentage points at the 95% confidence level.

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STATE OF THE NUTRIENTS MARKET

Grow Op Farms operates a 90,000-square-foot plant canopy that includes nine greenhouses.

7 TIPS FOR GROWING HEALTHIER CANNABIS

Grow Op Farms' head of cultivation shares top strategies and common pitfalls to avoid when managing a nutrient program. **BY MICHELLE SIMAKIS**

As most cannabis cultivators will attest, managing a successful growing operation requires monitoring several variables and tracking each closely. The key is achieving a constant balance; even just a few degrees in temperature, too much water or too little of an essential nutrient can throw an otherwise healthy plant off course.

"Besides genetics and environment, there is no other greater controlling factor than nutrients," says Mojave Morelli, director and head of cultivation for Washington-based Grow Op Farms, also known as Phat Panda. "Without regular additions of bioavailable macronutrients N-P-K, you are guaranteed to produce a less vigorous plant yielding far less mass than a plant that has a constant source of food."

And yield is the most important metric to growers when selecting a nutrient line for their cannabis cultivation operation, according to data from the 2019 "State of the Cannabis Nutrients Market" study. Morelli says he's seen yield increases of 5% with effective nutrient programs.

In addition to yield, Morelli says the correct balance of nutrients can result in increases in carbohydrates, electrolytes and resin production, in addition to more powerful aromas and a boost in the amount of extractable oil.

Morelli manages Grow Op Farms' 90,000-square-foot canopy, which includes nine greenhouses, 52 bloom rooms and 140 production strains. Tracking, testing and carefully recording this data is essential for a grower of any size, but especially when working with a large facility with multiple genetics. Ensuring the plants have the food they need is priority No. 1.

Here, Morelli shares seven tips for managing a successful nutrient program, including how to sidestep factors that can derail cultivation operations and how to avoid the most common pitfalls even seasoned growers face.

PHOTOS BY J. CRAIG SWEAT PHOTOGRAPHY

1. Establish and maintain a clean environment for your cannabis crops. In order for a nutrient program to succeed, cultivators and staff must start with standard operating procedures (SOPs) for proper grow-room hygiene. "The majority of sites we visit have deficits in grow room sanitation," Morelli says. These include staff wearing outside shoes and clothing in grow rooms and not properly washing their hands when entering and exiting the facility.

Keeping floors swept and free of debris is important, but light fixtures, fans and HVAC systems also must be kept clean and dust-free. "The biggest problems I see across the board are cultivators not building systems for killing harmful bacteria like *E. coli*, listeria, salmonella, bile-tolerant bacteria, yeast and molds. We also see a lot of air handling equipment and duct work that isn't being cleaned, ever, nor deodorized."

2. Choose your nutrient supplier carefully and do your homework. Ask potential companies to provide information about purity, ingredient sourcing, manufacturing practices, shipping and storing practices, Morelli says. Make sure they are using only the highest quality inputs and providing consistent solutions.

"We do a lot of fertilizer trials at Phat Panda, and I can attest to the inconsistency of particular formulas being sold on the market. The last thing a cultivator should be doing is having to worry if they are giving their plants a complete dietary package."

If growers aren't sure what an ingredient is, Morelli advises to ask the supplier and do background research. Also, investigate what grade of raw inputs are being used. "Try and find products that use the highest-grade pharmaceutical or equivalent materials," he says.

3. Use a nutrient with a balanced ratio of inputs. Morelli says though price is important, consider other factors, including ingredients, inputs and the company's track record. "Don't just go with a nutrient line because of the price point or [because the company offers] new-to-the-market products," he says. "We see lots of reformulations after products are released onto the market. Stick with manufacturers who have experience and a proven track record of delivering high-quality inputs."

4. Mix and apply nutrients and supplements correctly. "I see a lot of growers brewing teas with bat guano and other manures incorrectly," Morelli says. "These concoctions are watered into the soil and often sprayed on the plant itself. Once product is sprayed, it can be a hotbed for bad bacteria [such as those listed earlier.] These bacteria, which are harmful to humans, can persist from a vegetative stage through the end of flowering and even remaining after drying and curing."

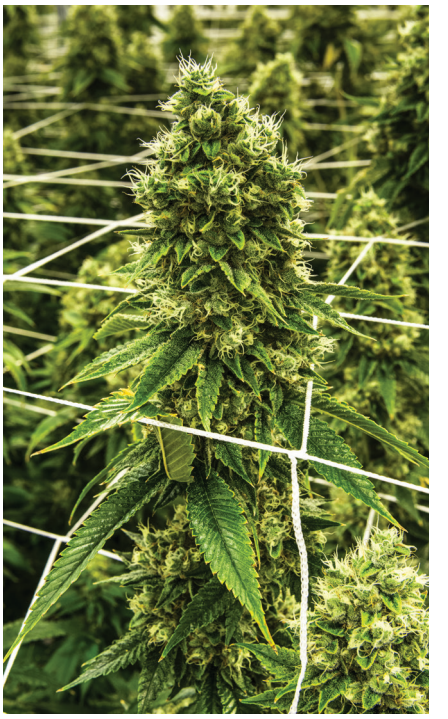
5. When problems arise, diagnose and simplify. When cannabis shows signs of stress, it's often something other than nutrients affecting crop performance, Morelli says. Many problems stem from imbalances in environmental conditions or improper irrigation. Check lighting, temperature, relative humidity, vapor pressure deficit and CO_2 first before investigating a nutrient program, and keep detailed cultivation records.

"Never make too many [nutrient] changes cycle to cycle," Morelli says. "The fewer number of variables you have to sort through [the better] when diagnosing plant issues and getting your genetics dialed in. Preventing these issues requires a diligent eye in the garden. Constant contact with the plants will enable you to make quick, corrective decisions to lessen any stress points that can have lasting effects."

In addition, new plants should be quarantined off-site for two weeks before being introduced into the growing operation.

6. Maintain a healthy root zone. Unfortunately, it's often difficult to discern whether plant pathology is a result of root-zone failures or nutrient problems, Morelli says, so getting ahead of any problems is key. If the root zone fails, the plant stops functioning and will produce a "dismal crop of mediocre flower at best," Morelli says.

"Inoculate and don't over or under water. Use strain-specific microbes and



bacteria, as these products often have higher [colony-forming units] than large complex biopacks."

7. Don't overcorrect for pH. A proper pH balance is essential because it affects nutrient availability. Because growers know how crucial this factor is, Morelli says many overcorrect when they see any slight changes in levels. "One of the biggest mistakes [that] new and old growers alike [make] is chasing incoming pH and outgoing pH," Morelli says. "We've found that we grow a much healthier, happier plant when we allow our nutrient solution to move a few points in either direction without correction over a 24-hour period. Reading runoff and adjusting according to the results is also problematic as it can be difficult to discern what the results actually mean."

Plants can readjust their own pH if they aren't getting the right balance of macro and micronutrients, he adds. Correcting the situation before plants have a chance to adapt can lead to problems, such as nutrient lock out. ●

Michelle Simakis is editor of *Cannabis Business Times* and sister publication *Cannabis Dispensary*.

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