SPECIAL REPORT: STATE OF THE LIGHTING MARKET

Light Intensity Benefits and Boundaries

Researchers and growers are experimenting with photosynthetically active radiation to determine just how much they can boost yield and cannabinoid content.

Jolene Hansen

Flowering bay at The Green Organic Dutchman's (TGOD) Ancaster, Ontario, facility. Photo by David Bernard-Perron

Of all the components that go into a world-class cannabis cultivation facility, lighting is one aspect that gets the most attention. As lighting research and technologies advance, the cannabis industry seeks an increased understanding of how light and cannabis interact. Light intensity is a crucial factor in that quest.

Utah State University professor and researcher Dr. Bruce Bugbee, Ph.D., notes that lighting discussions often focus on color, but he suggests that emphasis is misplaced. "Intensity is more important than colors. It's significantly more important," Bugbee says. A better understanding of light intensity and how to optimize it is key to lighting success.

Setting a Standard

When considering lighting for homes and offices, most laypeople equate intensity to lumens or even foot candles. But those measurements fall short when considering horticultural lighting systems to influence plant growth.

Bugbee explains that photosynthetic photon flux density (PPFD) is the standard unit of measurement for light intensity in horticultural settings. Measured in micromoles of photons per square meter per second (μmol/m2/s), PPFD reveals the amount of photosynthetically active radiation (PAR) reaching the leaf surface.

More than half of cannabis cultivators measure PPFD, according to 2020 data from the "State of the Lighting Market" research (p. 56), as 55% indicated they track this metric.

David Bernard-Perron, vice president of growing operations for The Green Organic Dutchman (https://www.tgod.ca) (TGOD), compares PPFD to the flow rate of water when trying to fill a cup. The higher the PPFD, the greater the flow. But instead of a cup capturing water, the leaf surface of the plant captures light to fuel plant growth.

In Bugbee's opinion, the biggest misconception about light intensity is that it is easily quantified by the human eye. "You may think your eyes can tell light intensity, but they cannot," he says. "Some less experienced growers don't realize how critical it is to measure the light intensity, so they've never measured it." When growers use light meters to measure intensity properly, epiphanies occur. And once light is measured, it can be controlled.

Bugbee says that the most important concept growers should understand about intensity is simple: "The more light that's given, the faster the plants will grow." He adds that many growers could enjoy significantly higher yields by increasing the lighting in their grows. (Editor's note: Environmental conditions may need to be adjusted to account for the additional light.)

Plants in TGOD's propagation room. When increasing light intensity, it's important to examine other inputs plants receive, as well, says TGOD's David Bernard-Perron. Photo by Amer Nakuti

Balance Natural and Supplemental Light

Bernard-Perron likens TGOD's Ancaster, Ontario, hybrid greenhouse to a warehouse with a glass roof. Lit primarily by natural light, the 150,000-square-foot facility is outfitted with 800 PPFD of all-LED supplemental lighting. Although the capital expenditure for LEDs is higher compared to other lighting types, Bernard-Perron believes the return on investment for LEDs is "absolutely there."

The natural light captured by the greenhouse can reach 1,400 to 1,600 PPFD on sunny days. Bernard- Perron says TGOD typically reserves the supplemental 800 PPFD for cloudy days or short winter days with limited natural light.

"In winter, the lights are on all the time," he says. "Depending on if the plants are in a flowering cycle—so a short-day cycle—or if they're in a vegetative cycle—a long-day cycle—we're going to give them the 800 PPFD of light."

Bernard-Perron ties his PPFD-cup analogy to the notion of daily light integral, the amount of PAR a plant receives each day as a function of light intensity and duration. Along with the water's flow rate comes the consideration of how much water the cup can or should hold.

"When is your cup going to start to overflow? When is it going to create damage to the cup itself? Cannabis is a plant that you can push a lot of light into, but there's still a maximum amount," he says. "Then at some point, if light is no longer your limiting factor in your environment, is it CO2? Is it environmental conditions? Is it nutrients?"

Bernard-Perron's internal R&D focuses on answering those questions and more. "We've really just harnessed the tools that we have and started working with notions of daily light and varying light intensities over time," he says. One example is pushing more light into plants the day before a cloudy day is forecast, so daily light integrals are met through averaging during the week.

TGOD also is exploring light quality and UV light's effect on plant morphology and secondary metabolites. "A really good metric to think about is the milligrams of secondary metabolites per [square foot] per year that you're producing, and light is one of the key drivers to that," Bernard-Perron shares.

"There's still so much to learn about this crop and what we're doing," he says. "We're doing a lot of intensive work with photoperiod and the light duration, the light quality and all that, but nothing that has been yet deployed at scale."

Compassionate Cultivation based in Austin, Texas, is growing cannabis under different light intensities and examining how that impacts yield and plant quality. Photo Courtesy of Fluence

Intensity Ceilings and Effects

As head grower for Austin, Texas-based Compassionate Cultivation (https://texasorignal.com/), Jason Sanders has a front-row seat to cannabis research illuminating light intensity and its effects. In May, the medical cannabis company announced it was conducting lighting research (https://www.cannabisbusinesstimes.com/article/fluence-expands-photobiology-research-program/), and it now devotes a significant amount of its 2,000 square feet of indoor cultivation space to trials.

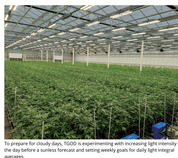
The trials take place in portions of three 500-square-foot flower rooms, with one experiment per room. Each room is divided into four sections. One section serves as a control while three sections introduce different variables.

The light-intensity study, now in its second go-round, explores the impact of light treatments ranging from 1,000 to well above 2,000 micromoles of PAR. (In comparison, Bugbee says field-grown plants receive 2,000 micromoles from the sun at mid-day on a sunny day.)

Sanders says the study's goal is to identify the ceiling for light intensity in cannabis cultivation. Yield levels at different light intensities also are of concern. While it's still too early to quantify results, Sanders says the team has been "amazed" at how much light cannabis can handle and the higher yields tied to higher light.

Additional studies focus on spectra and the hypothesis that broad-spectrum light will create higher yields. "We're learning a lot right now on what spectrum is producing the best," Sanders shares. The team also is exploring the effect of ultraviolet B (UVB) light incorporated at various intervals during flowering.

For every study, the team analyzes yield, cannabinoid levels, and terpene levels and profiles. Results are expected to be released in early 2021.



To prepare for cloudy days, TGOD is experimenting with increasing light intensity the day before a sunless forecast and setting weekly goals for daily light integral averages.
Photo by David Bernard-Perron

The Benefits of Mixing

Many cultivators use a variety of lighting types for their grows. "Historically, we've always looked at vegetative rooms needing more blue lights, whether it be ceramic metal halide or even the T5 (fluorescents). Then as we go into flower, we go towards a warmer light or reds and oranges, so we've gone to HPS," Sanders shares. "I think what we're learning is that we still like a broad spectrum, even in veg."

Prior to starting LED research, Compassionate used double-ended HPS bulbs. "We were running under 1,000 micromoles with HPS, and now we're well above that with LEDs. We're seeing a dramatic plant response with that—increased yield, better vigor, actually shorter plants," Sanders says.

Bernard-Perron explains that HPS or MH lights are less energy-efficient than LEDs because more energy ends up as radiant heat. But from a grower's perspective, that can be a positive thing: Plants respond to a warmer leaf surface with evapotranspiration, which in turn drives nutrient uptake. It can also be a benefit in some cold climates.

TGOD mixes HPS and LED lighting in its facility in Valleyfield, Quebec, where the climate is colder and electricity prices are significantly lower than in Ontario. "We get free heat from the HPS for the environment in the winter, while maintaining this full transpiration drive in the plants," Bernard-Perron says. He reminds growers to keep the effect on room temperature in mind when switching between lighting types.

Stay Focused on the Whole

Bernard-Perron advises growers to consider all environmental conditions: While lighting is a big piece of the puzzle, it's still just one piece. "Everything ties in together," he says. "Good light quality is important, but also pay attention to what's going on in your grow room."

Bugbee points out two common errors: In one scenario, plants lack sufficient light and grow poorly, but growers suspect a fertilizer problem or something else. In the second, plants struggle under high light, and lights get blamed. But other factors—such as fertilizer or water not optimized for high light—might be at fault. "Bright lights are important for cannabis. That's the take-home message," he says.

Sanders advises growers to run their own small trials and do side-by-side comparisons before making any sweeping lighting change.

Bernard-Perron echoes this, advocating running small R&D trials to make sure your hunches work at scale without jeopardizing your investment—or adding stress. "We manage the stress on the plant, but we also have to manage the stress on ourselves sometimes because it's never ending," he says. "It's good to try new things, but in a way that we make sure it's going to be successful."

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Note: This article is part of the 2020 State of the Cannabis Lighting Market report. Find more articles from the report below.

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