WHITEPAPER

UNLOCKING POTENTIAL

Using LED Grow Lights for Better Cannabis Yields

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GE current
a Daintree company

Traditionally, cannabis growers have relied on high pressure sodium (HPS) systems for their lighting needs. Advancements in LED technology, coupled with increased demand and the need to reduce expenses, accelerate turns and save energy, make LED fixtures a viable replacement. Despite their advantages, there is a learning curve as you change from HPS to LED and several things to consider. This guide will walk you through things to keep in mind, as well as detail the benefits of LED growth.

EXECUTIVE SUMMARY

When moving from older technologies to LED lighting, the amount of light and proper light spectrum must be top of mind. These are instrumental elements for crop performance and, ultimately, commercial success.

HPS has a single, fixed spectrum that cannot be changed to encourage the promotion of distinct traits at certain crop stages. The HPS spectrum also includes a significant amount of infrared (heat generating) radiation. In cooler climates and during winter months, this heat can be leveraged to the grower's benefit, but more often than not it becomes an energy load that must be removed from the growing facility to prevent excessive heat at the crop level.

This guide will dive into two of the principal advantages of growing cannabis under LED:

- Exponential energy savings
- The ability to steer crop profile

KEY TERMS DEFINED

PAR
Photosynthetically Active Radiation describes the range of radiation that the plant uses to convert light energy to plant biomass. PAR is defined as the radiation between 400-700 nm and mostly falls within the visible range of light. The unit to quantify radiation in the PAR range is µmol m^{-2} s^{-1}.

µmols/Watt-second (µmols/Joule)
This unit defines fixture efficiency of light output to the amount of electrical input. A higher number means greater efficiency.

Canopy
The above portion of the crop that, once established, forms a continuous layer of foliage. This is the targeted site of crop photosynthesis and illumination.

DLI
The Daily Light Integral describes the amount of PAR radiation received for a given area in a 24-hour period. Simply put, it informs the grower if they have hit their targeted or recommended amount of light on a daily basis. By combining the hours of illumination and light intensity you get DLI. DLI is measured in moles of light per day (mols d^{-1}).

DID YOU KNOW?

Use different spectrums at different crop stages. The optimal spectrum for each stage can increase yield and improve crop value.

ENERGY SAVINGS

Electrical energy inputs are a significant cost component of any indoor operation. Lighting, heating, and cooling costs make up the bulk of your energy input. For large-scale operations, limited availability of grid power can also limit your farm potential if not using LEDs. Having your power switched off by the grid provider at peak times is not unheard of, and affects your bottom line.

Typically the inefficiency of any lighting technology that is not delivering radiation within the PAR range results in excess heat that must be managed. This results in two penalties to the grower: higher electrical lighting costs and higher cooling costs (or reduced heating efficiency, since lamps are inefficient as heating units). For example, HPS fixtures emit a large amount of heat in the form of infrared radiation, rather than just emitting PAR. This translates into reduced efficiency. Currently, LED fixture efficiency can reach 3.0 µmols of light per Watt·second (aka, µmols/joule), while HPS fixtures are only able to reach optimal efficiencies of 1.7 µmols/joule. By switching 100 lamps in a one-half acre, single layer, indoor farm from HPS to LED, you can save $30,400 in electrical costs after 6,000 hours of illumination (calculated over a one-year period, assuming a price of 11¢/kW·h).

Regardless of seasonality, growers need a larger HVAC system to compensate for the additional heat load generated by HPS during the warmer months. Remember, as one environmental factor/input changes in your farm, other environmental factors, such as temperature, relative humidity, air flow, and CO2 also change, requiring proactive adjustment. For example, the infrared radiation of HPS fixtures can increase canopy temperature by 2°C [1]. When retrofitting HPS with LED, the HVAC system may be used to more efficiently make up that temperature difference.

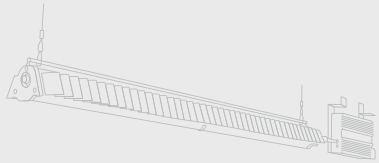
MEET THE WORLD'S MOST ADVANCED GROW LIGHT

Current has developed the industry's first **one-to-one LED replacement** option for double-ended, 1,000-watt HPS fixtures. We worked closely with growers to design a top light with efficacy levels up to 3.5 micromoles per joule—making the Arize Element™ L1000 the most efficient and flexible grow light available. The L1000 supports universal installation, enabling users to grow more crops and consume less energy in any type of facility.

TYPES OF

LED Grow Lights

LED grow lights come in many output configurations to meet different crop stage needs:



ARIZE ELEMENT

The workhorse of your greenhouse or indoor farm, the Arize Element L1000 is perfect for vegetative & flowering growth

ARIZE LYNK

A light bar that fits neatly in growth chambers, grow racks and vertical farms, tailored for healthy propagation

STEERING CROP GROWTH WITH LED

Ultimately, growers want to optimize yield relative to their inputs. For cannabis growers, this means producing the highest amount of quality flowers with the right amounts of cannabinoids, terpenes, and other phytochemicals. LED fixtures are a path to maximizing your lighting investment and pushing crop production to the next level.

DID YOU KNOW?

Light quality plays a key role in final yield and cannabinoid content.

OPTIMIZE YIELDS

To optimize yields, growers must achieve strong, robust growth by focusing on biomass production. This provides the plant with an increased amount of resources and a robust framework to optimize yields when harvested. Light intensity and DLI are key to success when focusing on biomass production. Cannabis is a high light species and can use up to 2,000 µmol m^{-2} s^{-1} of light, but typically light levels of 500-1,000 µmol m^{-2} s^{-1} are used. LEDs are easily dimmable and versatile in usage compared to HPS, allowing the grower to adjust the light intensity as needed.

Light spectrum is another consideration that impacts yield. The wavelengths in focus here are blue and red, as these wavelengths enable optimal photosynthesis, thus allowing rapid biomass accumulation. This spectrum application also coincides with the propagation and vegetative stages of cannabis production, where focus on immediate secondary metabolite synthesis is reduced since the main goals of these stages are to increase foliage and photosynthetic surface area.

Once the right plant sizing is obtained at the vegetative stage, plants are then shifted to the reproductive or flowering stage. Here, lighting management plays a large role in shifting the plant from a biological vegetative state to one of flowering. Reducing photoperiod to a period of 12 hours is used to trigger this switch. As the plant approaches harvest, photoperiod and light intensity can be increased, resulting in a larger DLI. The light increase can make secondary metabolite (cannabinoid and terpene) production more pronounced.

CANNABINOID CONTENT

Cannabinoids are a key indicator of quality. Higher cannabinoid content in flower trichomes (plant hairs rich in phytochemicals) leads to a higher market selling price for the grower. Depending on the strain and intended market, the cannabinoid profile can be notably different. Some of the target cannabinoids are THC, CBD, CBG, CBC, CBN, CBGM, and THCV. As mentioned earlier, increased light intensity can increase cannabinoid content. Aside from this, light spectrum can play a large role in cannabinoid profile. By triggering photoreceptors with special wavelengths of blue, green (better known as 'white' in horticulture parlance), and red, a grower can increase the amount of cannabinoids by using the right ratio of these spectrums. Adding green or white to the typical red and blue LED spectrum can increase cannabinoid content. There is a limit to the benefit of green, though. Levels of green above 50% can penalize the grower on yields and electrical efficiency.

TERPENE CONTENT

Terpene flower content is much lower when compared to flower cannabinoid content but plays a large role in flower quality. Terpenes are a diverse group of aromatic compounds found within the flower trichomes. There are hundreds of terpenes and each have their own distinct aroma. Their inclusion complements the cannabinoid profile, both therapeutically and on the sensory side. Medically, these compounds are used for stress relief and have anti-microbial properties. A few of the commonly noted terpenes are Myrcene, Terpinolene, Limonene, Pinene, Caryophyllene, and Linalool.
Light is one environmental factor that can increase the amount of Terpenes. There are two ways of improving terpene profile through lighting: increasing light intensity and optimizing light quality. Simply by increasing light intensity during flowering, the grower can increase synthesis of terpene precursors that lead to increased terpene content. We recommend increasing intensity right before harvest. Light quality can also improve the terpene profile. By adding a white light component to your spectrum, terpene content can be increased when compared to just using blue and red light[2].

LOOKING FORWARD

The scientific world and grower community alike are learning more and more every day about the role spectrum optimization plays in improving cannabis production. Growing under LEDs is a path to increased yields, quality, and market value of your crop. Current is excited to help growers navigate the LED revolution, optimize production and drive costs down with LED-lit operations.

OUR ADVANTAGE

GE Current, a Daintree company, connects indoor growers to relevant lighting products with their unique interests in mind. Leveraging decades of LED expertise and lighting technology innovation, we support CEA by delivering highly efficient solutions.

REFERENCES

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