GROWERTALKS

Features

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Charting a Course for LEDs

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Light in the greenhouse during peak winter and spring production is arguably the last major environmental factor that growers struggle to control over most of North America. Whether for use in plug, liner or finished production, to increase total light levels and/or for photoperiod manipulation, the benefits of greenhouse lighting have been well documented. While supplemental lighting has been available for years, widespread use has been somewhat restricted due to the high-energy consumption costs, limited spectral composition and other challenges with legacy technologies.

With the current proliferation of compound semiconductor-based LED technology, growers now have many more choices to meet their crops' light demands. But how does a grower sort through the plethora of LED fixture choices to find the best option to optimize production and drive their financial performance? Let's delve into key terms and factors for consideration, discover the importance of comparing "apples to apples" and look at the key derived benefits to production.

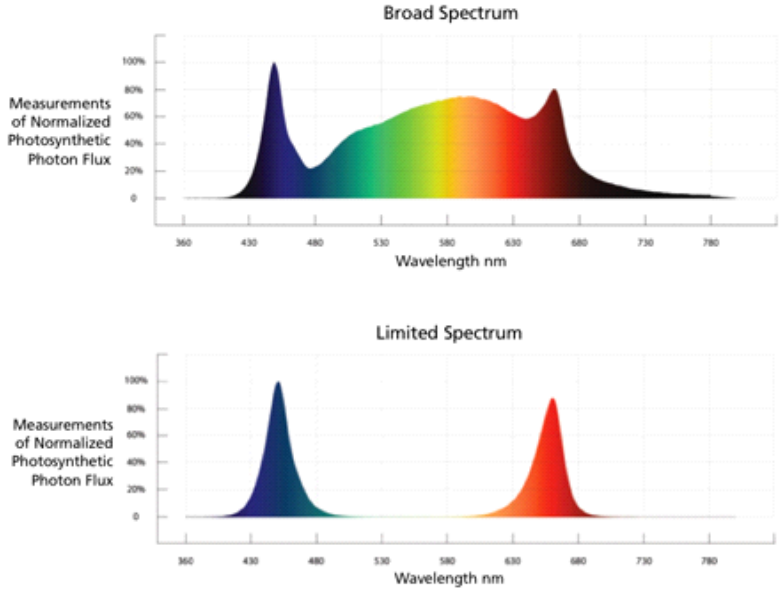

Figure 1. Examples of broad-spectrum lighting (top) and limited-spectrum lighting (bottom).

Correct lighting terms

While growers may be familiar with older lighting terms like foot candles and lumens, those are more relative to the way people perceive light and not relevant to plant photosynthesis. To properly compare greenhouse lighting choices, understanding the following terms is helpful.

* Photosynthetically Active Radiation (PAR): PAR defines the region of the electromagnetic spectrum (400 to 700 nanometers), which is needed for photosynthesis.

* Photosynthetic Photon Flux (PPF): The total amount of PAR (photons) emitted by a light fixture each second. Measured in micromoles per second (µmol/s).

* Photosynthetic Photon Flux Density (PPFD): The total PAR (photons) that reaches the plant canopy each second. Measured in micromoles per square meter per second (µmol/m2/s).

* Daily Light Integral (DLI): A cumulative measurement of the total amount of PAR (photons) that reach the plant canopy during the photoperiod/day. Measured in moles per square meter per day (mol/m2/d).

Comparing spectra and other factors

Growers are often confused by the fact that different fixtures emit different spectra. Research shows that a broad spectrum, one that more closely resembles sunlight in which plants naturally evolved, can be most beneficial to maximize photosynthesis and developing balanced plant growth where total light (DLI) enhancement is the goal. However, some research has been conducted, especially on monoculture crops like lettuce, that indicates a more limited spectrum can also be effective in achieving specific goals (Figure 1). Given that ornamental growers produce such a wide variety of plants, a broad spectrum is generally the best option.

For night break interruption photoperiod manipulation with LED lighting, a broad-spectrum option can be used as well if it includes sufficient far-red light. The objective is to trigger the plant's photoperiod response without causing any negative plant response, such as stretch.

There are human advantages to utilizing a broad-spectrum option as well. A broad spectrum appears white to the eye, while a limited-spectrum usually looks pink or purple. Growers may more easily scout for insects, disease, foliar nutritional and phytotoxicity symptoms on plants with broad spectrum "white" light, like sunlight, as opposed to pink/purple, which gives the plants an unnatural appearance. To accurately compare fixtures, know the spectra.

Besides spectrum, there are other factors to consider. Each fixture's spec sheet should include the PPF. This reflects the amount of photons emitting from the fixture within the PAR wavelengths from 400nm to 700nm. For example, a fixture with a PPF of 1,100 µmol/s would have significantly more PAR light output compared to a PPF of 550 µmol/s. Depending on use, generally the higher the fixture's PPF the better, especially if mounted at quite a distance from the plant canopy.

The lighting manufacturer or supplier should provide the grower with the recommended mounting height, spacing and placement of the fixtures specific to their greenhouse and the crops that they grow. There's no "one size fits all" approach to this. This design should provide the grower with the average PPFD and

uniformity of photons/light across the crop. Pay special attention to any areas in the design where PPFD levels drop off significantly across the greenhouse, as this will cause non-uniformity in the crop. The goal is to provide a uniform “blanket of photons” across the plants.

With the average PPFD determined, the manufacturer should also indicate how many moles of light will be added to the grower’s natural sunlight DLI based on the number of hours they plan to operate the fixtures. The longer the fixtures run, the greater the crop’s DLI.

LED technology is more energy efficient compared to older technologies like high pressure sodium (HPS). The intention is to produce more light and less heat from the electricity input. The term used to describe this is efficacy and is measured in micromoles per Joule (µmol/J); or in laymen’s terms, photons/watt. Efficacy over 2.0 µmol/J is considered good for “white” light. (Note that spectral output of the fixture affects efficacy.) A fixture emitting mostly red light may have a higher efficacy, but that wouldn’t necessarily be the best option to achieve balanced plant growth. For proper “apples to apples” efficacy comparisons, both fixtures need to have a similar spectrum.

The role of fixture design

There are clear differences in LED fixture design and in their intended application. Some are primarily used as “toplighting,” hung several feet/meters above the crop. Others may be designed to be deployed much closer to the plant canopy—for example, mounted on an irrigation boom for use in night break interruption. Identify your intended use before evaluating fixtures.

Inquire if the fixture is passively cooled or if it requires an internal fan or water system to remove the heat generated during use. Generally, passively cooled fixtures have greater energy efficiency and may be more trouble-free, lacking moving components, which may be susceptible to breakage.

How large is the fixture? The larger or more box-like the fixture, the greater the potential for shading the crop below from sunlight coming into the greenhouse. There are slim profile fixtures available on the market that fit under greenhouse trusses and don’t cause additional shading.

Is the fixture dimmable? While you normally want to maximize light output (PPF), there may be situations where you want the ability to dim the light intensity.

Fixture wiring is another factor to consider. When fixtures are hard-wired in a line down a greenhouse bay, what happens if one fixture would need to be removed for some reason—would the entire bay of lights be inoperable until the missing fixture was replaced? Are the fixtures assembled in North America or overseas? What type of technical support does the company offer before, during and after purchase? What is the fixture warranty and the expected useable life?

Fixture and installation cost

When comparing different fixture costs, always consider the number of fixtures it will take to achieve equal coverage (PPFD and uniformity). For example, “FIXTURE A” is less expensive than “FIXTURE B,” but you need twice as many of “FIXTURE A” to generate the same PPFD and uniformity as one of “FIXTURE B.” Having to buy twice as many of “FIXTURE A” may also double your electrical installation costs.

Inquire about volume discounts before deciding on the exact number of fixtures to purchase. Does the supplier sell direct or through a broker? Buying through a broker may add to the cost. Besides outright purchase, does the supplier offer a fixture leasing or other extended payment option? A leasing option may appeal to a grower who doesn't want to make the capital investment all at once. Is there a fixture shipping charge? In many areas, there are power company incentive rebates for replacing and/or installing energy-efficient LED fixtures. Can your supplier assist in that rebate application process?

Also, is your salesperson knowledgeable about greenhouse lighting and how it relates to the grower's individual production techniques? What's the lead time from order placement to fixture delivery? Can the supplier provide customer testimonials relevant to the grower's particular business? Does the manufacturer work with floriculture university professors in their R&D process?

Benefits to crop production investment considerations

Lighting solutions can be incorporated into grower production regardless of size. Given that plug and liner production is often started during the darkest time of year with the shortest days (lowest DLI), that production often sees the greatest benefit. As part of plug and liner lighting financial analyses, consider the following possible benefits: faster turns, quicker callus/root development and overall better root systems, less loss in propagation, more accurate scheduling, less PGR application, less chemical/labor application costs, and an overall more compact, sturdy, resilient starter plant.

Finished production will benefit as well. If lighting after transplant, consider the following possible enhanced metrics to drive financial performance: better scheduling control, faster bench turns, faster flowering, better space utilization via a higher plant density, less PGR application and less loss/shrinkage. A powerful opportunity may apply with LED fixtures mounted below hanging basket level to significantly improve production on the benches and floor below.

Remember, over much of North America, LED lighting is useful beyond just the winter months. It's useful during the shoulder seasons as well.

In summary, as the greenhouse industry embraces LED solutions to reap the benefits of additional supplemental lighting options, there are a series of factors to consider. As a grower considers their key financial drivers, they should take into consideration the fixture and installation costs, the income/savings through the added benefits to the crop, electricity savings, rebate incentives, the number of hours per year you plan to use the fixtures and the expected life of the fixture. **GT**

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