 | BY ERIK RUNKLE

Supplemental lighting: Common pitfalls and practical solutions

Greenhouse growers are increasingly purchasing and installing light-emitting diodes (LEDs) to deliver low-intensity photoperiodic or high-intensity supplemental lighting.

There are many potential advantages of LEDs compared with conventional lighting fixtures, including energy efficiency, longevity and spectra that inhibit extension growth, leading to more compact plants (Figure 1).

However, sometimes growers aren't fully realizing the potential benefits of LEDs. This article discusses some of the pitfalls of supplemental lighting and opportunities to more effectively utilize LED (or conventional) lighting.

Figure 1. Supplemental lighting from LEDs is especially useful during propagation, but its efficacy depends, in part, on a proper control system. *Photo courtesy of Erik Runkle.*

LACK OF LIGHTING CONTROLS

One of the most common pitfalls I observe inside greenhouses is the lack of proper lighting controls. It may be obvious, but the value of electric lighting is greatest when:

- It is dark outside (cloudy and at night);
- The average daily light integral (DLI) is low;
- The rate of electricity is not at its peak price;
- Plants are growing underneath the fixtures.

To optimize the use of lighting, a grower needs at least a moderately sophisticated environmental control system that is integrated with the lighting controls. Ideally, a grower would have at least one quantum sensor inside the greenhouse, positioned at crop height and near the middle of the growing area.

If there are different kinds of greenhouses at the same operation with a meaningfully different light transmission (for example, with different glazing or shading materials), then quantum sensors should be inside each.

The next best option is to measure light intensity outside of the greenhouse, but that does not consider shading from the greenhouse structure, overhead obstructions and shading screens or compounds.

Quantum sensors should control operation of the fixtures throughout the day (and possibly part of the night), turning the lights on only when light inside the greenhouse is low. Since the lifespan of LEDs is not affected by on/off cycles, there is no need for a deadband; they can be controlled using a single setpoint for switching on and off. In contrast, high-pressure sodium fixtures should include a deadband, with the turn-off point set above the turn-on setpoint, to reduce frequent cycling and extend bulb life.

For most ornamental crops, as well as vegetable transplants and culinary herbs, the benefit of electric lighting diminishes once the average DLI inside the greenhouse is greater than 10 or 12 $mol \cdot m^{-2} \cdot d^{-1}$. Therefore, if the average DLI over a 3- to 5-day period is more than the target, there is little (economic) value of supplemental lighting.

It's not uncommon to see lights turned on during sunny conditions or in areas where there are no plants. There can be valid reasons for the latter, such as when lighting zones are large and only partially occupied by plants, making the lamp usage appear inefficient even though it's a limitation of the lighting setup. Another reasonable explanation is that plants were recently moved or shipped, and new plants will soon occupy that space.

DELIVERING TOO MUCH SUPPLEMENTAL LIGHTING

The economic value of supplemental lighting is usually the greatest when growing seedlings and rooting cuttings, partly because its cost on a per-plant basis is small. However, when propagating plants from cuttings or tissue culture, sometimes too much electric lighting can create production challenges.

For example, the leaves of some cultivars of petunia, begonia and others turn purple when the intensity of LED lighting is too high and when the greenhouse temperature is too low. In these cases, a lower supplemental light intensity may be merited, for example 60-75 $\mu mol \cdot m^{-2} \cdot s^{-1}$.

USING PHOTOPERIODIC LIGHTING FOR SUPPLEMENTAL LIGHTING

Low-intensity lighting can be effective at inhibiting flowering of short-day plants and promoting flowering of long-day plants. Plants are sensitive to very low intensities of light, so only 1 to 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of light is needed to regulate flowering. LEDs are replacing incandescent and screw-in fluorescent bulbs and consume much less electricity, but the intensity delivered is meaningless from a photosynthesis perspective. There can be an indirect effect of photoperiodic lighting on plant growth — for example, to inhibit dormancy — but photoperiodic lighting is not a substitute for supplemental lighting.

MIXING LIGHTING FIXTURES

Growers who installed supplemental LED lighting more than five years ago — or especially more than 10 years ago — are likely using fixtures that are relatively inefficient by today's standards. With the purchase of new fixtures, it can be tempting to incorporate older fixtures with newer ones. However, because LED fixtures vary widely in light output and spectrum, combining different types of LEDs or mixing them with high-pressure sodium lamps can lead to inconsistent lighting conditions.

Variability in light intensity and spectrum results in nonuniform plant growth. A lighting professional can potentially design a lighting plan with different fixture types, but in the absence of that, mixing fixture types is generally not recommended.

KEY TAKEAWAYS

To optimize supplemental lighting, fixtures should operate based on both the instantaneous light intensity and the short-term average daily light integral. If too much light is delivered during propagation, sensitive plants may not acclimate well or leaves could turn a purplish color. If too little light is delivered, the rate of root and shoot growth is slow, which can increase propagation time and delay flowering. Finally, avoid mixing different kinds of lighting fixtures; a variable light intensity and spectrum will lead to variable crop growth. gpn

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