BY ERIK RUNKLE

Does Light QUANTITY Trump Light QUALITY?

Erik Runkle is professor and floriculture Extension specialist in the department of horticulture at Michigan State University. He can be reached at runkleer@msu.edu.

When we think about lighting of plants, the different dimensions we consider are light quantity (intensity), light quality (spectrum), photoperiod (hours of light per day) and uniformity. Usually, we think of these four parameters independently, but we know that they interact with each other to regulate plant growth and development. Therefore, when considering photoperiodic or supplemental greenhouse lighting, we should consider these factors simultaneously. Here's a brief summary of these two lighting applications.

Photoperiodic lighting. Typically, low-intensity lighting (1 to 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$) is delivered by a variety of lamp types, including incandescents, compact fluorescents, high-pressure sodium lamps (spaced far apart or with a rotating reflector), or light-emitting diodes (LEDs). After years of research, we know that when the intensity delivered at plant height is very low (1 to 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$), the spectrum matters. To inhibit flowering of short-day plants, red light (600 to 700 nm) is the most effective, which means that white LEDs are also usually effective because white includes red light. For long-day plants, red alone is effective on some crops, but for others, red and far red (700 to 800 nm) combined is most effective. For both short- and long-day plants, low-intensity blue or far red are not effective.

There are at least a few cases in which light quantity overrides light quality, especially in long-day plants. As mentioned above, blue light alone at 1 to 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ does not regulate flowering, but when intensity is increased to 15 to 30 $\mu mol \cdot m^{-2} \cdot s^{-1}$, it becomes effective. We've seen similar results with far-red radiation; at a high intensity, it can inhibit flowering of poinsettia. In a second scenario, we know that flowering of a wide range of long-day plants is promoted most when the spectrum includes red and far red. However, we also learned that's not necessarily true when the photosynthetic daily light integral (DLI) is high. When the DLI exceeds around 12 to 15 $mol \cdot m^{-2} \cdot d^{-1}$, red light alone is as effective as red and far red combined. Thus, light quantity trumped light quality.

Supplemental lighting. To increase growth and plant quality, high-intensity lighting (50 to 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for ornamentals) is delivered primarily by high-pressure sodium lamps or LEDs. Because LEDs come in a wide range spectral distributions, we are learning much more about how individual colors of light influence various growth and flowering responses.

In research performed in 2014-2016 at Michigan State University with different ratios of blue, green and red light, we observed few effects of the light spectrum on plant growth. This research was performed under a moderately low DLI from the sun (7 to 9 $mol \cdot m^{-2} \cdot d^{-1}$). However, when my colleague Roberto Lopez's group performed somewhat similar research in 2016-2017, the solar DLI was lower (4 to 7 $mol \cdot m^{-2} \cdot d^{-1}$) and there was a greater effect of the supplemental lighting spectrum on plant growth. Once again, light quality was important when light intensity was low, but its effects diminished as the amount of sunlight increased. In other words, light quantity trumped light quality.

Why is this important? When making lighting investments, what's appropriate for one grower isn't necessarily the same for another. For growers in low-light regions, such as the upper third of the U.S. and Canada, the light spectrum should be considered with light intensity. In regions with higher light levels, the light spectrum is less important and in some cases, may play no meaningful role in the production of greenhouse crops.

We know much less about how light intensity and quality interact when lighting plants indoors, such as in vertical farms. However, some of our recent research confirms that light quality (such as the ratio or red to far red) has a greater effect on plant growth when light intensity is low than when it is high. It is likely that with indoor lighting, the spectrum of light will remain important, but less important as light intensity is increased. gpn