BY ERIK RUNKLE

Efficacy of Lamp Types at Controlling Flowering

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When the nights are long (the days are short), delivering low-intensity lighting can regulate flowering of photoperiodic ornamental plants. Incandescent lamps have been used for decades to successfully inhibit flowering of short-day plants and promote flowering of long-day plants. While the energy-inefficient incandescents have been phased out of production, more efficient ones are still available but at a higher price.

Several other lamp types have been developed that are increasingly more energy efficient, especially with advances in light-emitting diode (LED) technology. In most cases, lamps have been developed for human applications and so the lamps usually emit white light, which really is a combination of blue, green and red light. While white light is desirable for home, office and outdoor lighting, it isn't necessarily the best for plant applications.

It turns out that the spectrum emitted by an incandescent lamp — rich in red and far red radiation — is very effective at regulating flowering of plants. Research from the 1960s and 1970s showed that red light is what primarily regulates flowering of short-day plants while some long-day plants needed exposure to red and far-red radiation to maximally promote flowering. Those studies were relatively primitive given existing technologies, but recent research with LEDs at Michigan State University has confirmed these results and provided additional information on the efficacy of various lamp types and light wavebands at controlling flowering.

Basically, any lamp that emits a moderate to high percentage of red light should be effective at inhibiting flowering of short-day plants (Table 1). This includes fluorescents, high-intensity discharge (HID) lamps, white LEDs and LEDs developed specifically for flowering applications, such as the deep red/white GreenPower Flowering Lamp from Philips and TotalGrow's Night & Day Management Light. Whether a lamp also emits blue, green or far-red light has little or no effect on controlling flowering of short-day plants.

When using low-intensity lighting to accelerate flowering of long-day plants, lamps that emit both red and far-red radiation are often the most effective, especially when plants are grown under light-limiting conditions (for example, the average daily light integral is less than 10 $mol \cdot m^{-2} \cdot d^{-1}$). Thus, fluorescent lamps and white LEDs are generally not as effective because they emit little far-red radiation. In addition, LEDs that don't emit red light, such as blue or far-red lamps, have little or no effect on flowering.

Table 1. Summary of the effectiveness of low-intensity lighting from different lamp types at regulating flowering of a wide range of ornamental crops based primarily on research performed at Michigan State University. Exceptions exist on some crops, so perform your own small-scale experiment with new lamps before converting your entire operation.

Lamp type		Short-day plants	Long-day plants
Incandescent		X	X
Fluorescent (including CFLs)[1]		X	X[3]
Mix incandescent + CFL[1]		X	X
HID (HPS, MH, mercury, Beamflicker)[2]		X	X
LEDs	White	X	X[3]
	Red	X	X[3]
	Red + far-red	X	X
	Far-red	X	X
	Blue	X	X
	Green	X	X

[1]CFL = Compact fluorescent lamps.
[2]HPS = High-pressure sodium; MH = Metal halide.
[3]Effective on some crops, especially when the daily light integral is high.

The efficacy of lamps listed in Table 1 assumes the intensity delivered (from 400 to 800 nm) is low, between 1 and 5 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Some "specialty" LEDs are available that emit a single waveband of light, for example blue LEDs or green LEDs. When light from these bulbs is delivered at a low intensity, it typically is not perceived by plants and has no effect on flowering. However, at least for blue light, a higher intensity can regulate flowering. Therefore, there is an interaction between the spectrum of light and its intensity. Generally, with respect to flowering, the spectrum of light becomes less important as intensity increases. gpn