GROWERTALKS

Features

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Measuring the Efficacy of LEDs

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Many important greenhouse floriculture crops are long-day plants, meaning they require long days and short nights (usually less than eight to 10 hours of darkness) to produce flowers early. In areas where winters have short days and long nights, flowering of long-day plants grown during that time is delayed or inhibited.

To shorten long nights and promote flowering of long-day plants, growers can use dim photoperiodic lighting at the end of the day (day-extension lighting) or in the middle of the night (night-break or night-interruption lighting). Previous research suggests that 16-hour days created from day-extension lighting or four hours of night-break lighting are generally sufficient to achieve complete flowering of long-day plants.

In the past decade, “flowering” LED lamps with custom light spectra including red (R) + far-red (FR) light have been commercially available for flowering applications, albeit at higher prices. A more affordable option may be white LED lamps, which are mass-produced for general use. Developed for human vision, white LED lamps emit mostly visible red, green and blue light, but little FR light.

Figure 1. Greenhouse setup of white and red + far-red lighting treatments.

There are pros and cons to both, in addition to cost considerations. “Flowering” LED lamps with FR light can result in rapid flowering of some crops like petunias, but may also cause undesired stretching. White LED lamps may be less effective at promoting flowering than LED lamps with FR light, but may produce plants that are more compact.

Experimental design

Classic photoperiod studies suggest that plants can be sensitive to R or FR light during different parts of the night, so timing may also play a role in how effective white LED lamps can be at controlling flowering.

To investigate the efficacy and optimal timing of white versus R+FR LED lamps, we performed, and then repeated, an experiment on four long-day plants: Coreopsis Early Sunrise, Snapdragon Liberty Classic Yellow, Petunia Easy Wave Burgundy Star and Petunia Wave Purple Improved. We transplanted seedlings into 4-in. pots filled with peat-perlite media and grew them in a greenhouse under nine lighting treatments (Figure 1).

We grew plants under eight-hour short days (control, truncated with black cloth) with or without white or R+FR (1:1) LED lamps operating for eight hours after dusk, eight hours before dawn, four hours after dusk, plus four hours before dawn or four hours as a night break (Figure 2). A digital timer controlled the timing of each lighting treatment. We used layers of aluminum mesh to cover the R+FR LED lamps so that light intensity was similar across all white and R+FR lighting treatments at around 2 μmol·m−2·s−1 with all colors included.

Results

Coreopsis Easy Sunrise: Plants did not flower under short days, but flowered similarly under all lighting treatments (Figure 3). At flowering, plants grown under white LED lamps were 18% to 19% shorter than those grown under R+FR LED lamps.

Snapdragon Liberty Classic Yellow: Compared to short days, both white and R+FR LED lamps promoted flowering. For eight-hour after-dusk and/or before-dawn lighting, flowering was 10 to 20 days later under white LED lamps than under R+FR LED lamps (Figure 3). However, for four-hour night-break lighting, flowering was similar under the two lamp types. White LED lamps were most effective as eight-hour before-dawn lighting.

Flowering under R+FR LED lamps was 12 days earlier under eight-hour after-dusk and/or before-dawn lighting than under four-hour night-break lighting. At flowering, plants were 15% to 23% taller under white LED lamps than under R+FR LED lamps, when delivered as eight-hour after-dusk or before-dawn lighting. The greater extension growth at flowering under white LED lamps was due to delayed flowering. White LED lamps increased lateral branching by 30% to 122% compared to R+FR LED lamps no matter the timing.

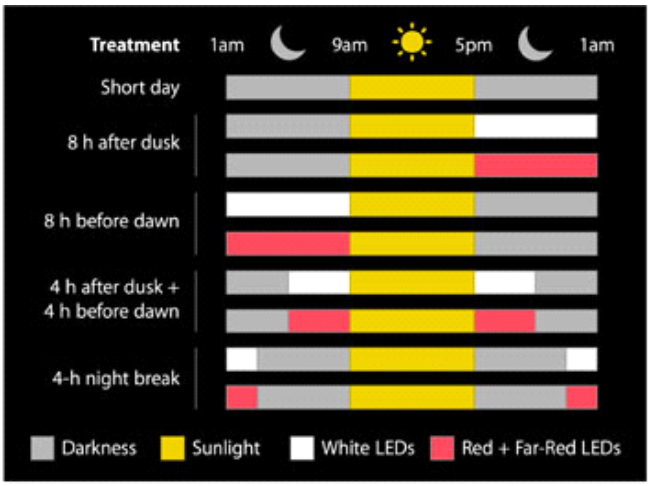

Figure 2. Nine photoperiodic lighting treatments.

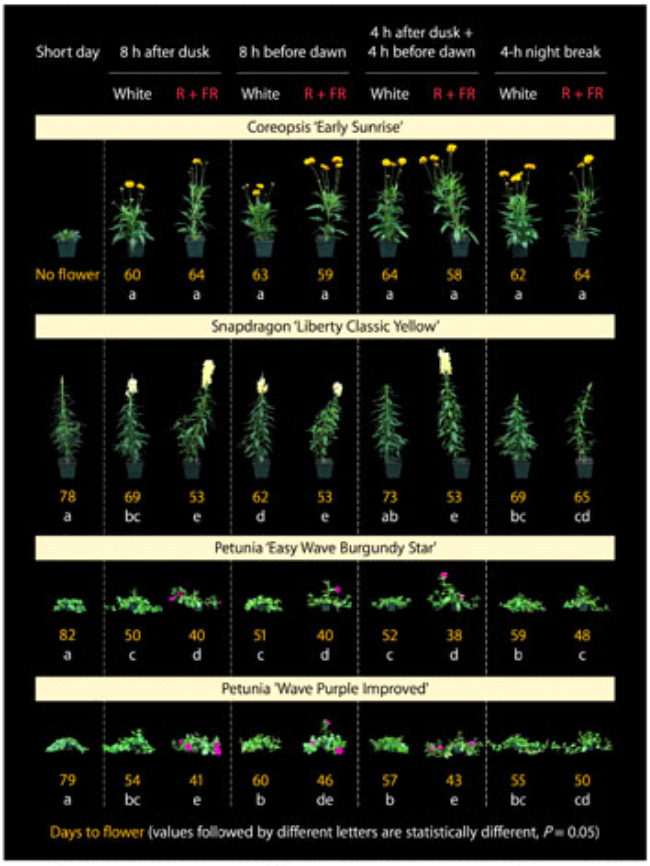

Figure 3. Flowering responses of four long-day plants under nine lighting treatments.

Petunia Easy Wave Burgundy Star: All lighting treatments promoted flowering compared to short days. Flowering was 10 to 15 days later under white LED lamps than under R+FR LED lamps (Figure 3). For both lamp types, flowering was six to 10 days earlier under eight-hour after-dusk and/or before-dawn lighting than under four-hour night-break lighting. At flowering, the length of the stem with the first open flower was similar between the two lamp types at any timing.

For eight-hour after-dusk and/or before-dawn lighting, plants grown under white LED lamps had 54% to 86% more lateral branches at flowering than those grown under R+FR LED lamps.

Petunia Wave Purple Improved: Plants flowered earlier under all lighting treatments compared to short days. For eight-hour after-dusk and/or before-dawn lighting, plants grown under white LED lamps flowered 13 to 14 days later compared to R+FR LED lamps (Figure 3). However, flowering was similar under both lamp types, when delivered as four-hour night-break lighting.

For white LED lamps, the light timing didn't matter, however, under R+FR LED lamps, flowering was four to nine days earlier under eight-hour after-dusk lighting than under four-hour night-break lighting. At flowering, neither the light spectrum nor timing affected the length of the stem with the first open flower. Lateral branching was similar under all lighting treatments.

Takeaways

For coreopsis, white LED lamps were as effective as R+FR LED lamps at promoting flowering while improving plant compactness. Therefore, they may be a cost-effective photoperiodic lighting option for FR-insensitive crops such as coreopsis. For FR-sensitive crops (snapdragon and petunia), white LED lamps delayed flowering and did not inhibit extension growth at flowering, when compared to R+FR LED lamps. However, white LED lamps showed the potential to improve lateral branching.

As for the optimal timing of the two lamp types, we found that for white LED lamps, flowering of all crops was earliest when operated for eight hours before dawn. For R+FR LED lamps, eight-hour after-dusk and/or before-dawn lighting was generally more effective than four-hour night-break lighting. **GT**

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