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# Special Research Report #529
# Production Technology: Using Light-Emitting Diodes (LEDs) for Photoperiodic Lighting

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## BACKGROUND

Flowering of many floriculture crops is dependent on the day and night length, and lighting is often used to control flower induction. Light quality in plants is perceived by several receptors, including phytochrome. Phytochromes exist in red (R; 600-700 nm) and far-red (FR; 700-800 nm) absorbing forms ($P_R$ and $P_{FR}$, respectively). The ratio of R to FR light determines the phytochrome photoequilibria ($P_{FR}/P_{R+FR}$), which influences flowering in crops such as petunia and poinsettia.

Incandescent lamps emit light that is rich in both R and FR and are commonly used to provide low-intensity lighting to shorten the night length. However, they are energy inefficient and are being phased out of production. In some instances, light emitted by other commonly used lamp types, such as fluorescents, is less effective for regulating flowering. Therefore, we are using LEDs to identify desirable R:FR to control flowering of photoperiodic ornamentals.

## METHODOLOGY

Special R and FR LED fixtures were designed and manufactured by CCS, a company based in Japan. Light emitted from the LEDs was carefully measured (Figure 2). Seven different night interruption treatments were supplied, ranging from all R to all FR. In addition, plants were grown under a long day (LD) with traditional incandescent night interruption and a 9-hour short-day (SD) photoperiod.

Figure 1. Light-emitting diodes (LEDs) were used to deliver night-interruption lighting. The LEDs emitted different ratios of red and far-red light on each bench, and results were compared to those under incandescent lamps.

Each night interruption treatment was assigned to a greenhouse bench that was covered with black cloth from 5pm to 8am (Figure 1). The LED and incandescent lamps provided an average night interruption light intensity, from 600 to 800 nm, of 1.11 to 1.33 $\mu mol \cdot m^{-2} \cdot s^{-1}$.

A variety of LD plants (LDP) were chosen for study including snapdragon, fuchsia, and three petunia varieties. The following SD plants (SDP) were also included: marigold, cosmos, dahlia, and chrysanthemum.

Young plants were received and held under non-inductive photoperiods until transplant into 4-inch pots, when night interruption treatments began. Plants were grown at a constant 68 °F and night interruption lighting was provided from 10:30pm to 2:30am. The following data were collected: temperature and light in each treatment, flowering dates, plant height at flowering, and flower number.

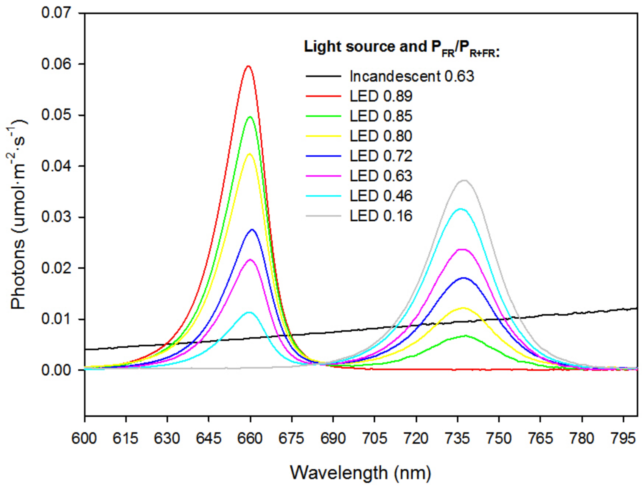


Figure 2. Light quality and estimated phytochrome photoequilibria ($P_{FR}/P_{R+FR}$) of incandescent and LED lamps

## RESULTS

Some crops flowered in all treatments; in contrast, the flowering percentage was reduced under SD or FR light only for some LDP such as petunia 'Wave Purple Improved', petunia 'Shock Wave Ivory', and fuchsia. For LDPs, SD, FR light only and sometimes only R light caused the greatest delay in flowering. For SDPs, flowering occurred earliest under SD and FR light only.

Flower bud or inflorescence number in many species did not show a treatment response. In responsive species (cosmos, fuchsia, and snapdragon), bud number generally increased with increasing R:FR of the night interruption.

A R:FR similar to that of the incandescent lamps caused the greatest extension growth in the three petunia cultivars and fuchsia. Snapdragon, however, had the greatest extension growth under only FR light or only R light. Extension growth in cosmos and fuchsia did not respond to the R:FR.

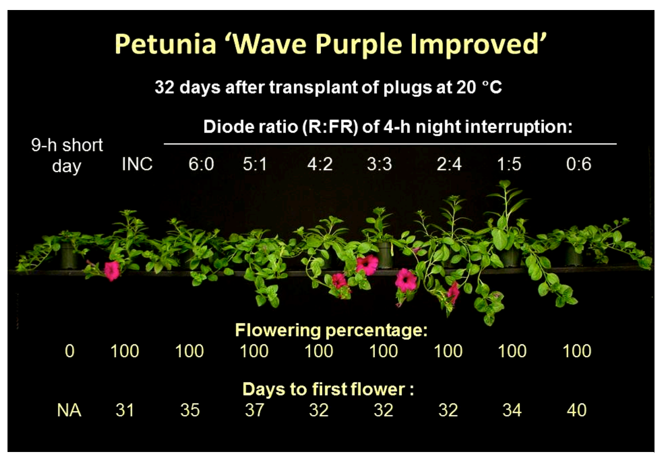


Figure 3. The effect of the ratio of red (R) to far-red (FR) light during 4-hour night interruption treatments on petunia 'Wave Purple Improved'.

## CONCLUSIONS

Neither R nor FR light alone were very effective at controlling flowering under our conditions. In most cases, plant responses under LED fixtures with a R:FR diode ratio of 1:2 were similar to those under the incandescent lamps. Therefore, LED fixtures can be used to control flowering of floricultural crops. The same R:FR can be used to promote flowering in LDPs and delay flowering in SDPs.

To date, we have not identified an LED fixture that is more effective than INC lamps for control of flower induction. Photoperiod responses varied even within a species, e.g., petunia, thus, further testing is needed. Research with LEDs continues at MSU. For more information on greenhouse lighting, visit the MSU Floriculture website at www.flor.hrt.msu.edu/lighting.

## IMPACTS TO THE INDUSTRY

LEDs consume 75% to 80% less energy than incandescent lamps while delivering the same light intensity. LEDs could provide additional advantages, such as accelerating flowering and minimizing stem elongation of some crops.

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