How Green Light Affects Floriculture Crops

Is green light really a safe light for floriculture crops? Researchers at Michigan State University find out the impact it has on daylength-sensitive plants.

By Qingwu (William) Meng and Erik Runkle

Many common bedding plants and perennials flower in response to the lengths of the day and night. When natural days are short, photoperiodic lighting at the end of the day (day extension) or during the middle of the night (night interruption) promotes flowering of long-day plants and inhibits flowering of short-day plants. A combination of red and far-red light at 1 to 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ is usually the most effective at promoting flowering of long-day plants, whereas red light is mainly responsible for inhibiting flowering of short-day plants. In contrast, a higher intensity of blue light (e.g., 30 $\mu mol \cdot m^{-2} \cdot s^{-1}$) is needed to create a long day.

Green light is sometimes used as a safelight in horticultural operations. It allows crop inspection at night and is believed to not affect flowering. However, this is based on some experiments in the 1900s and has been disputed in others. We performed an experiment with green light-emitting diodes (LEDs) to determine whether green light delivered at night influenced flowering of daylength-sensitive floriculture crops grown in greenhouses. The short answer is, yes.

Experimental Design

We grew four long-day plants and four short-day plants (Table 1) in a greenhouse under truncated nine-hour natural short days with or without seven-hour day-extension lighting (Figure 1). Lamps used for day-extension lighting were green LEDs (delivering a light intensity of 2, 13, or 25 $\mu mol \cdot m^{-2} \cdot s^{-1}$) or red+white+far-red LEDs (delivering a light intensity of 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$). The red+white+far-red LEDs are as effective as incandescent lamps at controlling flowering and thus, were used as a long-day control. The experiment was performed twice at a constant temperature setpoint of 68°F (20°C) in all treatments.

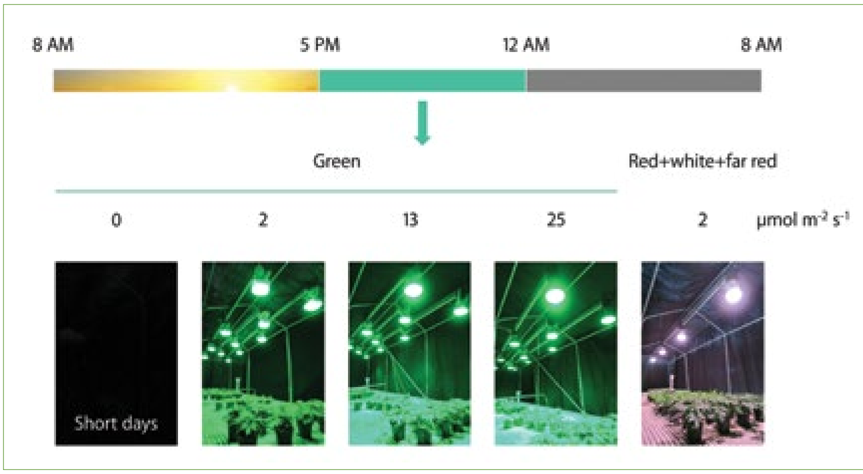

Figure 1. **Crops were grown under nine-hour natural short days with or without seven-hour day-extension lighting treatments provided by green or red+white+far-red light-emitting diodes.** All photos courtesy of Michigan State University.

Table 1. **Floriculture Crops Tested in This Study**

Long-Day Plants	Short-Day Plants
Petunia 'Easy Wave Burgundy Star'	*Chrysanthemum* 'Cheryl Spicy Orange'
Petunia 'Wave Purple Improved'	*Chrysanthemum* 'Cheryl Golden Improved'
Ageratum 'Hawaii Blue'	*Chrysanthemum* 'Cheryl Jolly Red'
Snapdragon 'Liberty Classic Yellow'	Marigold 'American Antigua Yellow'

Flowering of Long-Day Plants

Compared to short days, green light promoted flowering of most long-day plants (Figure 2, page 28). Green light at 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ accelerated flowering of *Petunia* 'Easy Wave Burgundy Star,' *P.* 'Wave Purple Improved,' and *ageratum* by 16, 9, and 12 days, respectively, but did not influence flowering of snapdragon. The green light intensity to saturate flowering responses was 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for ageratum and 13 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for petunia and snapdragon.

As the green light intensity increased from 2 to 13 or 25 $\mu mol \cdot m^{-2} \cdot s^{-1}$, flowering occurred 8, 10, and 4 days earlier for *P.* 'Easy Wave Burgundy Star,' *P.* 'Wave Purple Improved,' and snapdragon, respectively. Compared to red+white+far-red light, green light at 13 or 25 $\mu mol \cdot m^{-2} \cdot s^{-1}$ was similarly effective for petunia and ageratum, but less effective for snapdragon at promoting flowering.

Flowering of Short-Day Plants

Compared to short days, green light

Take-Home Messages

Green light can control flowering of long-day and short-day floriculture crops, although sensitivity to green light varies among species and cultivars. As low as 2 μmol·m^{-2}·s^{-1} of green light as day-extension lighting can be enough to regulate flowering. Therefore, using green light as a safelight may inadvertently promote flowering of some long-day plants and inhibit flowering of some short-day plants when operating it for several hours. Interestingly, green light can promote flowering of petunia and ageratum as effectively as red+white+far-red light, with less extension growth and more branches.

inhibited flowering of all short-day plants (Figure 3). *Chrysanthemum* 'Cheryl Spicy Orange,' *C.* 'Cheryl Golden Improved,' *C.* 'Cheryl Jolly Red,' and marigold flowered 16, 19, 32, and 11 days later under green light at 2 μmol·m^{-2}·s^{-1} than under short days. Increasing the green light intensity from 2 to 13 or 25 μmol·m^{-2}·s^{-1} further inhibited flowering of chrysanthemum, but not marigold. Compared to red+white+far-red light, green light at 25 μmol·m^{-2}·s^{-1} was more effective at inhibiting flowering of chrysanthemum but similarly effective for marigold.

Extension Growth and Branching

Green light did not cause pronounced extension growth of some crops as observed under red+white+far-red light (Figure 2). For example, ageratum was about 1½ inches shorter under green light than red+white+far-red light. The main stem of *Petunia* 'Wave Purple Improved' was 6.7 to 7.7 inches shorter under green light than red+white+far-red light. In addition, compared to short days, petunia developed three to five fewer branches under green light but nine fewer branches under red+white+far-red light (Figure 2). GG

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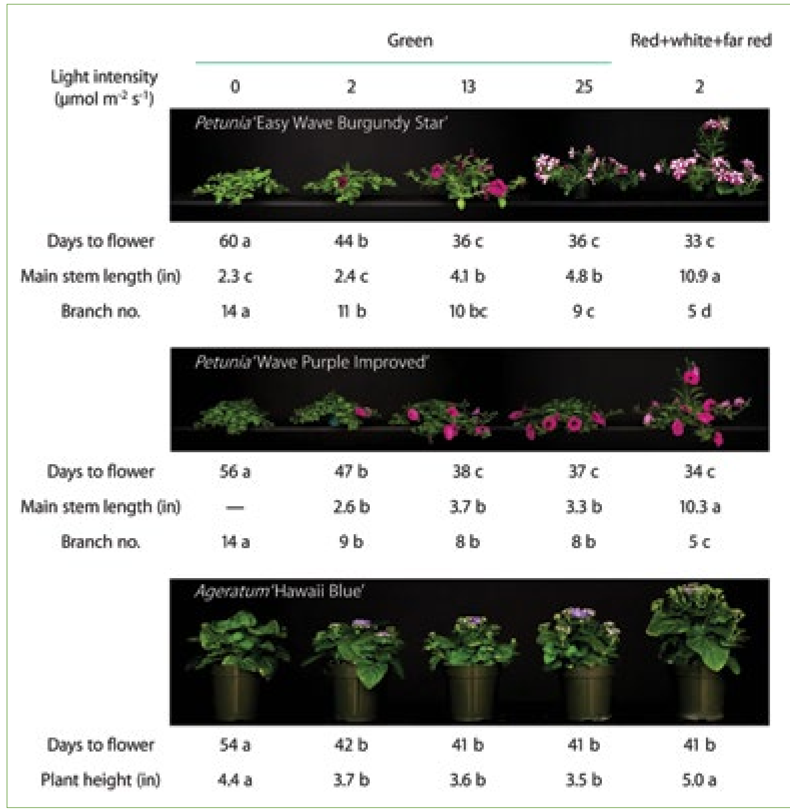

Figure 2. **Time to flower, extension growth, and branching of long-day plants petunia and ageratum. Means followed by the same letter are not significantly different (α = 0.05).**

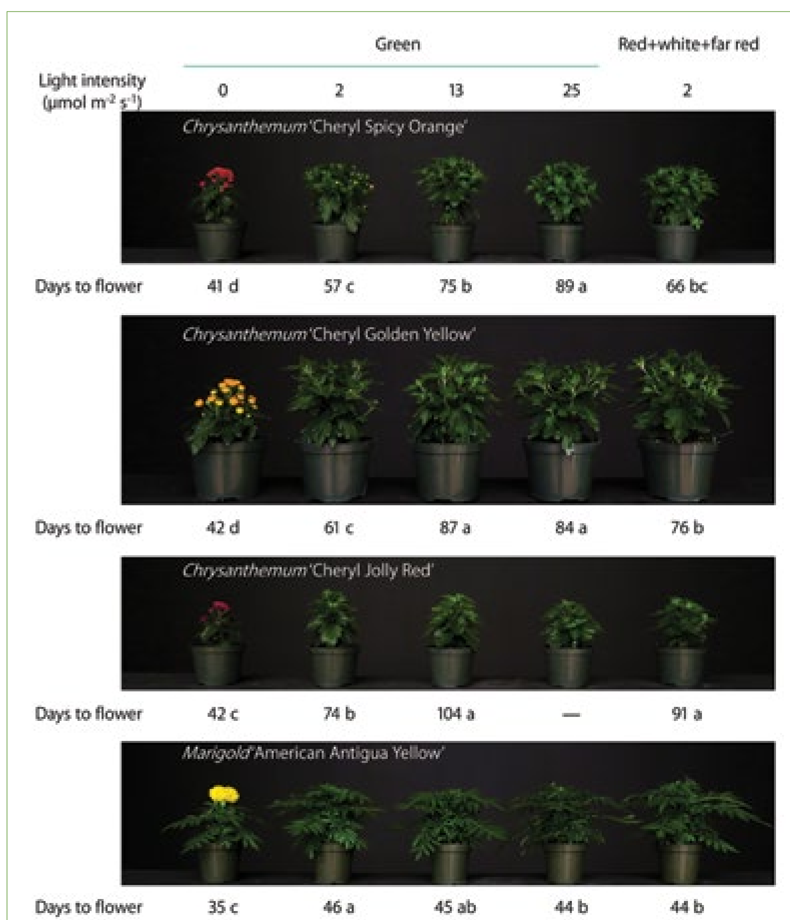

Figure 3. **Time to flower of short-day plants chrysanthemum and marigold. Means followed by the same letter are not significantly different (α = 0.05). Data were not collected on plants that had not flowered at the end of the experiment.**