Perennial flower induction—the light you use can make a difference

by Catherine Whitman, Royal Heins, Arthur Cameron, William Carlson

New perennial research at Michigan State University reveals ideal light intensity for uniform flowering and tells you which light source is best for your crop

While lighting systems for short-day plants are common, few horticultural crops are long-day plants, and little information exists on effective lighting systems for them. In preliminary experiments at Michigan State University, we've used "mum lighting" successfully to induce flowering in many perennial species. However, the actual required light intensity was unknown. In addition, some reports have said light sources effective for controlling development of short-day plants may not work well for long-day plants.

Several important horticultural crops, including poinsettias and chrysanthemums, are short-day plants. Controlling day length provides a convenient way to influence the development of plants that respond to photoperiod. Growers frequently use lighting to lengthen photoperiod and prevent flowering in short-day plants. Supplemental lights can be turned on in the middle of the night, often from 10 p.m. to 2 a.m., or for several hours after sunset. Light intensities required are much lower than those needed for photosynthesis. This "mum lighting" is usually provided with incandescent lamps at 10 f.c.

Experiments have shown that many perennials are long-day plants. Some species will never flower unless day lengths are longer than the critical photoperiod; others just flower more rapidly when photoperiods are longer.

In select species of perennials, we found that providing at least 10 f.c. will successfully induce flowering. While 5 f.c. is adequate to flower all species, we recommend designing for at least 10 f.c. to compensate for uneven lighting, variability within the crop and bulb dimming from lamp age. Standard mum lighting is quite adequate for inducing flowering in the perennial species we researched. Cool white fluorescent, high pressure sodium or metal halide lamps are also effective and will result in more compact plants for some plant species.

The first objective of this experiment was to determine the light intensity required to induce flowering in several perennial species. We wanted to establish two values: threshold, or lowest intensity that would induce any flowering, and saturation, or minimum intensity needed for uniform flowering. Our second objective was to compare the effectiveness of several different light sources for flower induction. Incandescent lights are inexpen-

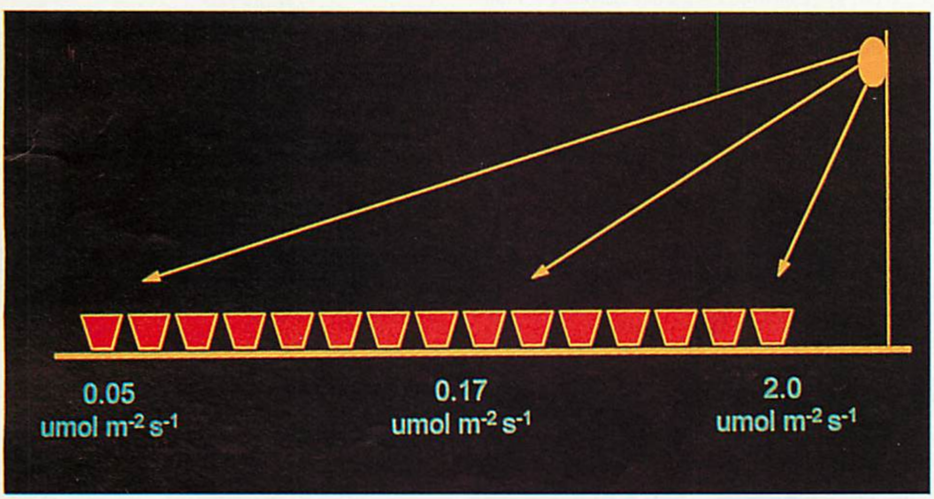

Figure 1. Diagram of light setup on each bench. Plants received 0.25 f.c. (left) to 10 f.c. (right). Lights were on from 5 p.m. until midnight.

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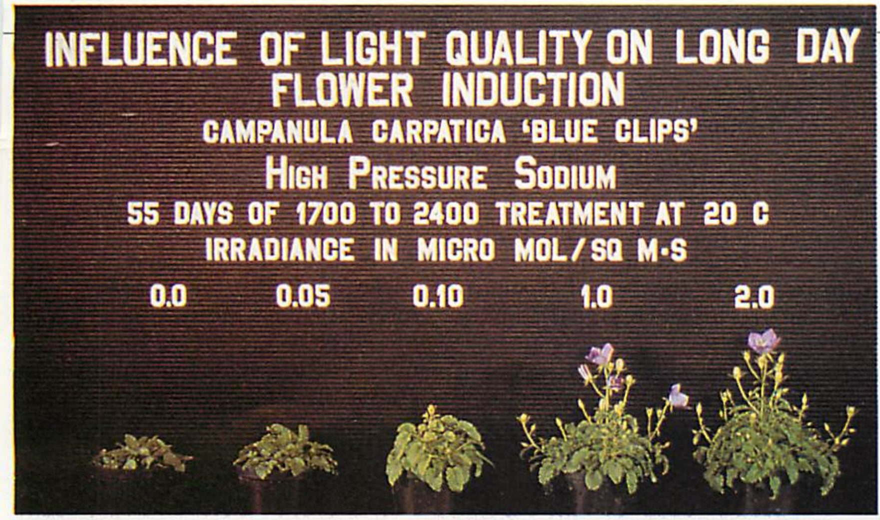

Figure 2. *Campanula carpatica* Blue Clips treated with high pressure sodium lights. Those treated with 5 f.c. (1.0 micromol/m^2•second) or more flowered at the same time. Flowering was delayed or not induced on plants exposed to lower light intensities—note bud on plant treated with 0.5 f.c. (0.1 micromol/m^2•second).

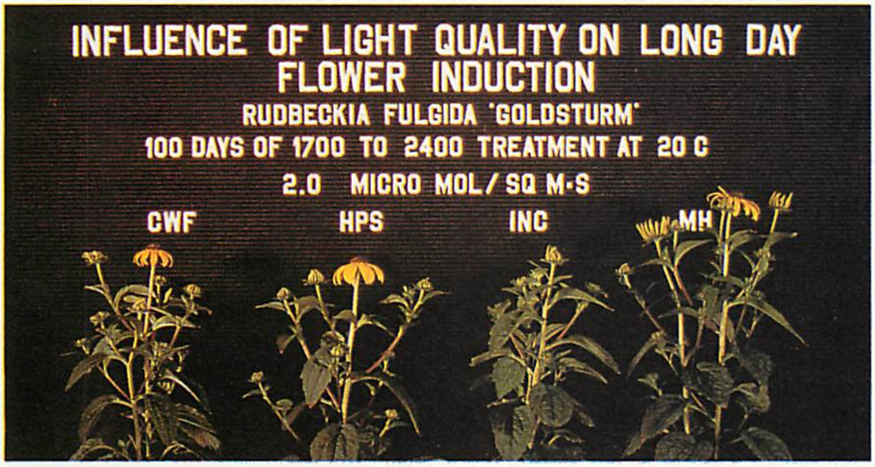

Figure 3. At the 10 f.c. level, time to flower didn't differ significantly among the four light sources we tested.

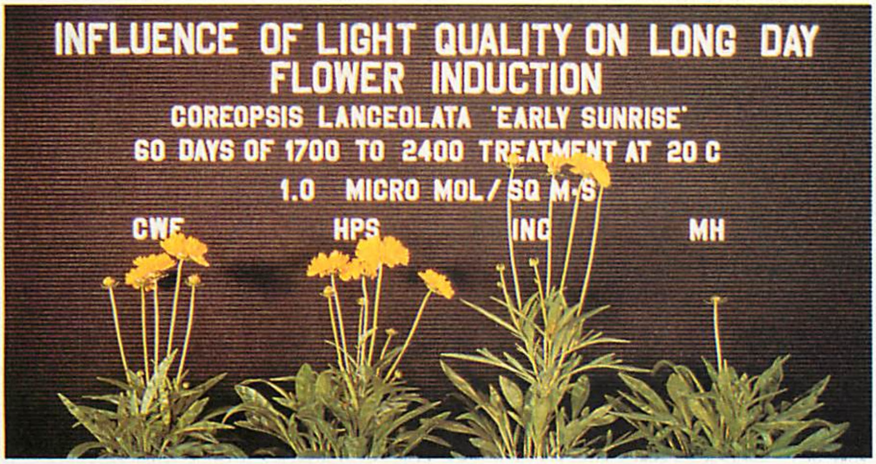

Figure 4. *Coreopsis lanceolata* Early Sunrise plants forced under incandescent lamps were taller than those in other treatments.

sive to purchase and install, but they emit a relatively large amount of far-red light that promotes stem elongation and reduces branching in many plants. They are also less efficient at converting electricity to light than most other light sources. Cool white fluorescent, high pressure sodium or metal halide lamps have the potential to limit plant height and provide savings in energy costs, compared to incandescent lamps. Other lamps can also simplify installation, as fewer fixtures may be required.

Finding the right light

We chose four species of herbaceous perennials that require long photoperiods for flowering, but have no requirement for cold treatments: *Campanula carpatica* Blue Clips, *Coreopsis grandiflora* Early Sunrise, *Coreopsis verticillata* Moonbeam and *Rudbeckia fulgida* Goldsturm. To ensure that plants were vegetative before the experiment began, we received them four weeks after sowing and grew them under a nine-hour photoperiod (short day) for roughly 10 weeks before beginning the experiment. We grew all plants at 68F.

We selected four lamps that are readily available for greenhouse use: cool white fluorescent, high pressure sodium, incandescent and metal halide. We installed each light above one end of a bench to create a gradient of light intensity, then lined up 15 plants of each species along the bench so they received 10 f.c. to 0.25 f.c. of light (Figure 1). We pulled blackcloth over the light and benches from 5 p.m. until 8 a.m. to exclude any stray light. Lights were on from 5 p.m. to midnight. We grew a separate group of plants under a nine-hour photoperiod.

None of the plants flowered under a nine-hour photoperiod. We found that *Campanula carpatica*, *Coreopsis grandiflora* and *C. verticillata* were very sensitive to low light levels—a few plants of each species treated with light intensities as low as 0.25 f.c. bloomed. Plants treated with higher intensities flowered more quickly. *Campanula carpatica*, *Coreopsis grandiflora* and *C. verticillata* plants treated with 5 f.c.

flowered at approximately the same time as those treated with 10 f.c. *R. fulgida* plants were somewhat less sensitive and didn't flower at light levels below 1 to 2 f.c. *Rudbeckia fulgida* plants treated with 6 f.c. or more flowered at about the same time.

These response patterns were very similar under all four light sources and for all four species tested. We found no significant differences in time to flower at light intensities above the saturation intensity (Figure 3). For *Campanula carpatica* and *Coreopsis grandiflora*, plants treated with incandescent light were significantly taller than those treated with any other lights (Figure 4). All *Coreopsis verticillata* and *Rudbeckia fulgida* plants that flowered were essentially the same height.

The details

To provide the correct light intensity from incandescent lamps, hang lights 5 ft. above the soil surface. For one 4-ft. bed, hang a single string of 60-watt bulbs spaced 4 ft. apart. For two beds, use a string of 100-watt bulbs 6 ft. apart, for three beds, 150-watt bulbs 6 ft. apart. It's impossible to recommend specific installations of cool white fluorescent, high pressure sodium or metal halide lamps due to the variety of fixtures and luminaire (reflector) shapes available. The luminaire shape has a dramatic influence on the spread and intensity of light emitted, so you must design these lighting systems by trial and error. Purchase a light meter and confirm the light intensities provided.

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Finished plants are generally more attractive if they're bulked or grown under non-inductive photoperiods for some time before being given long-day treatments. They tend to have more laterals and produce more flowers. Because these species are so sensitive to low levels of light, be careful during the bulking period to avoid exposure to stray light. It will induce premature flowering, particularly if you're using supplemental lighting in an adjacent greenhouse section. ❑

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