Perennials: best long-day treatments for your varieties

by Cheryl K. Hamaker, Royal Heins, Art Cameron and Will Carlson

New MSU research reveals precise strategies for using long-days to force perennial flowering

In the greenhouse industry, growers often use photoperiod manipulation to shorten or lengthen natural day lengths to obtain vegetative or reproductive growth. When days are naturally short, you can provide long-days by lighting in the middle of the night (night interruption lighting) or by lighting before or after the natural day (predawn or day-extension lighting). Like in poinsettia and chrysanthemum production, you can use lighting to create long-days to induce flowering in long-day herbaceous perennials. In our experiment at Michigan State University, we wanted to determine how different lighting strategies compared for inducing consistent flowering in several plants in other treatments (blank cells).

<table>
<thead>
<tr>
<th>Light treatments</th>
<th>Four-hour Night Interruption</th>
<th>Seven-hour Night Interruption</th>
<th>Seven-hour Day Extension</th>
<th>Seven-hour Predawn Treatments</th>
<th>24-hour Four-hour Night Interruption</th>
<th>12 weeks at 41°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>Flowering</td>
<td>Flowering percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achillea filipendulina</td>
<td>Days to first flower</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asclepias tuberosa</td>
<td>Days to first flower</td>
<td>Flowering percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campanula carpatica</td>
<td>Days to first flower</td>
<td>Flowering percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coreopsis lanceolata</td>
<td>Days to first flower</td>
<td>Flowering percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leucanthemum × superbum</td>
<td>Days to first flower</td>
<td>Flowering percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salvia superba</td>
<td>Days to first flower</td>
<td>Flowering percentage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A green plus (+) indicates faster or greater flowering percentage, while a red minus (-) indicates delay or smaller flowering percentage compared to that of plants in other treatments (blank cells).
PERENNIALS

Figure 1. Flowering percentage of Asclepias tuberosa was affected by long-day lighting strategies. Only 40% flowering occurred for plants grown under a seven-hour predawn extension. Plants initiated buds under this treatment; however, buds were aborted before first flower.

Figure 2. Early Sunrise Coreopsis grandiflora doesn't require cold in order to flower. However, time to flower for coreopsis was delayed 10 days in plants grown under a seven-hour predawn extension compared to other long-day treatments.

Influence of Daylength Delivery on Flower Induction of Asclepias tuberosa

A constant 68°F after receiving either zero or 12 weeks of 41°F. Plants were forced under a nine-hour short-day or one of five long-day lighting strategies for 12 weeks. The five long-day lighting methods include a seven-hour day extension, a four-hour night interruption, a seven-hour night interruption, a seven-hour predawn extension and 24-hour continuous light. All treatments received nine-hour natural day lengths before black cloth was pulled. All long-day treatments were delivered by incandescent lamps that provided a minimum of 10 ft.e.

In this experiment, each long-day lighting strategy induced flowering, but some lighting treatments were more effective than others for some species (Table 1). Factors such as flowering percentage, time to flower and bud number at first flower were influenced by the long-

herbaceous perennials. Keep in mind that short-day and long-day plants respond differently to photoperiodic lighting. Most short-day plants remain vegetative in response to relatively short periods of night interruption lighting. However, most long-day plants require night breaks of at least several hours for uniform and consistent flowering.

Traditionally, long-days used to prevent flowering in poinsettias and mums have been delivered as a four-hour night interruption, a seven-hour night interruption, a seven-hour predawn extension and 24-hour continuous light. All treatments received nine-hour natural day lengths before black cloth was pulled. All long-day treatments were delivered by incandescent lamps that provided a minimum of 10 ft.e.

In this experiment, each long-day lighting strategy induced flowering, but some lighting treatments were more effective than others for some species (Table 1). Factors such as flowering percentage, time to flower and bud number at first flower were influenced by the long-

Figure 1. Flowering percentage of Asclepias tuberosa was affected by long-day lighting strategies. Only 40% flowering occurred for plants grown under a seven-hour predawn extension. Plants initiated buds under this treatment; however, buds were aborted before first flower.

Figure 2. Early Sunrise Coreopsis grandiflora doesn't require cold in order to flower. However, time to flower for coreopsis was delayed 10 days in plants grown under a seven-hour predawn extension compared to other long-day treatments.

Influence of Daylength Delivery on Flower Induction of Asclepias tuberosa

A constant 68°F after receiving either zero or 12 weeks of 41°F. Plants were forced under a nine-hour short-day or one of five long-day lighting strategies for 12 weeks. The five long-day lighting methods include a seven-hour day extension, a four-hour night interruption, a seven-hour night interruption, a seven-hour predawn extension and 24-hour continuous light. All treatments received nine-hour natural day lengths before black cloth was pulled. All long-day treatments were delivered by incandescent lamps that provided a minimum of 10 ft.e.

In this experiment, each long-day lighting strategy induced flowering, but some lighting treatments were more effective than others for some species (Table 1). Factors such as flowering percentage, time to flower and bud number at first flower were influenced by the long-

herbaceous perennials. Keep in mind that short-day and long-day plants respond differently to photoperiodic lighting. Most short-day plants remain vegetative in response to relatively short periods of night interruption lighting. However, most long-day plants require night breaks of at least several hours for uniform and consistent flowering.

Traditionally, long-days used to prevent flowering in poinsettias and mums have been delivered as a four-hour night interruption, a seven-hour night interruption, a seven-hour predawn extension and 24-hour continuous light. All treatments received nine-hour natural day lengths before black cloth was pulled. All long-day treatments were delivered by incandescent lamps that provided a minimum of 10 ft.e.

In this experiment, each long-day lighting strategy induced flowering, but some lighting treatments were more effective than others for some species (Table 1). Factors such as flowering percentage, time to flower and bud number at first flower were influenced by the long-
day delivery strategy. In general, a seven-hour predawn treatment was less effective than other long-day treatments for inducing flowering. For example, flowering percentage for *Asclepias tuberosa* grown under the seven-hour predawn treatment was low compared to plants grown under other long-day treatments (Figure 1).

Long-day delivery method affected time to flower in both *Early Sunrise Coreopsis grandiflora* and *Snow Lady Leucanthemum x superbum*. Flowering was delayed approximately 14 days in coreopsis grown under seven-hour predawn treatments compared to plants grown under other long-day treatments either with or without a cold treatment (Figure 2). Time to flower for leucanthemum was also delayed approximately 10 days when plants were grown under seven-hour predawn treatments. Finally, final inflorescence number was reduced in both Blue Clips *Campanula carpatica* Early Sunrise and coreopsis when grown under the seven-hour predawn treatment compared to other long-day delivery methods.

Plant response to long-day treatments was also affected by cold treatment. Cooling often decreases the minimum photoperiod required for flowering of many long-day plants. We found that flowering was significantly delayed in uncooled Blue Clips *Campanula carpatica* grown under 24-hour continuous lighting; following a cold treatment, flowering was no longer delayed (Figures 3 and 4). As mentioned previously, flowering of coreopsis grown under seven-hour predawn treatment was delayed on cooled and uncooled plants. However, the delay in time to flower was reduced approximately seven days on cooled plants.

This experiment shows the variation in response of herbaceous perennials to different long-day delivery techniques. Overall, both night-interruption and day-extension treatments were superior to predawn treatments for most species tested. In addition, a four-hour night interruption was horticulturally similar to both a

---

**P.L. Light Systems**

15 Light Years Of Experience

Over the past 15 years P.L. Light Systems has become the acknowledged HID lighting specialist in horticulture.

We can provide a computer designed greenhouse HID light system to meet your specific requirements.

Simply provide us with your greenhouse specifications. This is a P.L. Light Systems' service ...at no obligation.

Note: This computer designed HID light system applies to P.L. Light fixtures only.

**Warranty**

All of our Advance HID Ballasts carry a 5 year Warranty, effective July 1996.

Call today for some “light conversation”

1-800-263-0213

183 South Service Rd.,
P.O. Box 206,
Grimsby, ON, Canada
L3M 4G3

Fax 905-945-0444 Tel 905-945-4133

---

Write in No. 468

November 1996 • GrowerTalks 39
VIS SEED COMPANY, INC.

- Offering the Best In Flowering Annual and Perennial Varieties
- 45 Years of Experience
- Low Competitive Prices
- Same Day Service From Our Large Inventory
- Call Today For A FREE Catalog

PO. BOX 661953, 153 LA PORTE ST.
TEL. (818) 445-1233
FAX (818) 445-3779

PATILITE is a revolutionary film, made for the modern grower. With special additives, PATI is able to produce a film with “microbubbles”. The film contains “inert” gas in such a way that it gives the film “arctic” characteristics.

DIFFRACTION EFFECT
- Diffraction on the incoming light with a low reflection effect.
- High reduction of the short “infrared” rays, giving cooler conditions for growth, during the hottest hours of the day with no reduction in P.A.R. light.
- A better climate in the greenhouse, which results in a 50% reduction of the hydric requirements of the plant and less need for pesticides because of lower “Peak Temperature”.

GREENHOUSE EFFECT
- A great increase in greenhouse effect, through the sum of the additives, microbubbles acting as micro chambers and a special gas in combination with the basic material E.V.A. This gives the film a greenhouse effect never reached before by normal thermal films. Frost protection to 24°F.

PATILITE SUNLIGHT RAYS FROM OUTSIDE

PATILUX ON THE OUTSIDE-PATILITE ON THE INSIDE

- not affected by ice or even golf-ball size hail
- thermal-resulting in 20% to 25% fuel savings
- 90% to 92% light transmittance

PATILITE ON INSIDE
- highest greenhouse effect resulting in an additional 5% to 7% fuel savings
- blocks out the heat producing short infrared rays, resulting in a 15°F to 20°F cooler temperature during the hot days of summer with no shade required
- plants are not stressed producing better quality flowers and fruit

Distributed by:

For additional information or to place an order contact Bill Clifford
TOLL FREE 1-800-819-8776
PHONE (519) 326-4466 FAX (519) 326-8038
1735 Hwy. 18 East, Kingsville, Ontario, Canada N9Y 2M7

Write in No. 384

PERENNIALS

seven-hour day extension and a seven-hour night interruption for supplying long-days to induce flowering because plants actually perceive the duration of darkness, rather than light, in each daily cycle.

For flowering to be induced in a long-day plant, the length of the dark period must be less than a critical value. For example, if a plant has a critical photoperiod of 16 hours, it actually requires a period of darkness equal to or less than eight hours. So, even though plants grown under a seven-hour day extension receive three hours more light than those grown under a four-hour night interruption, the uninterrupted period of darkness for both long-day treatments is less than the critical value required for flowering.

MSU’s forcing advice

You can use a variety of methods to provide long-days in the greenhouse to force herbaceous perennials effectively. Certainly, plants will flower under the natural long-days of the summer; so what’s the best way to provide long-days under naturally short-days? The results of this experiment show that both seven-hour day extensions and four-hour night interruptions can be equally effective during the middle of winter when days are shortest. However, the four-hour night interruption requires less electricity because plants are lit for three fewer hours each night. During the longer days of spring, the difference in electrical usage disappears because the duration of a day extension only needs to be long enough to provide a 16-hour photoperiod.

We suggest a four-hour night interruption to provide long-days to herbaceous perennials. If electrical service to your greenhouse is inadequate to light all the plants you want to light simultaneously, we suggest that you light part of the plants as a day extension so the total day length is 16 hours. Light the remainder of the plants with a night interruption. If electrical services are still inadequate, lighting before sunrise to provide a 16-hour day will promote flower-
PERENNIALS

INFLUENCE OF DAYLENGTH DELIVERY ON FLOWER INDUCTION OF CAMPANULA CARPATICA 'BLUE CLIPS'
0 DAYS AT 5°C
90 DAYS AT 20°C

LONG DAYS VIA INCANDESCENT LIGHTS AT 1.8 MICRO MOL/SQ M•S

SD 4-HR NI 7-HR NI 7-HR DE 7-HR PD 24-HR
08-17 22-02 21-04 17-00 01-08 17-09

Figure 3. A cold treatment isn't necessary for flowering of Blue Clips Campanula carpatica. However, without a cold treatment, flowering is delayed significantly (approximately 30 days) when plants are grown under 24-hour continuous lighting.

Cheryl Hamaker is currently a graduate student, and Drs. Royal Heins, Will Carlson and Art Cameron are professors of horticulture, Michigan State University, East Lansing, Michigan. They would like to thank industry supporters who made the research discussed in this article possible, as well as Erik Runkle, Cara Wallace and Tom Wallace.

INFLUENCE OF DAYLENGTH DELIVERY ON FLOWER INDUCTION OF CAMPANULA CARPATICA 'BLUE CLIPS'

LONG DAYS VIA INCANDESCENT LIGHTS AT 1.8 MICRO MOL/SQ M•S

SD 4-HR NI 7-HR NI 7-HR DE 7-HR PD 24-HR
08-17 22-02 21-04 17-00 01-08 17-09

Figure 4. After a cold treatment, flowering of Blue Clips Campanula carpatica was no longer delayed when grown under 24-hour continuous lighting. All plants flowered quickly and uniformly, regardless of long-day lighting strategy.