Improving Perennial Flowering

Cold and light are two factors that can greatly influence the flowering of some perennials.

by BETH FAUSEY, SONALI PADHYE, ERIK RUNKLE and ART CAMERON

Figure 1. Flowering of non-vernalized Lychnis flos-cuculi 'Jenny' exposed to a 9-hour short day with low light (top left), a 16-hour long day with low light (top center), and a 16-hour long day with high light (top right; 30 percent higher daily light integral). In contrast, vernalized Lychnis flos-cuculi 'Jenny' plants flower profusely under both short and long days following a 15-week vernalization treatment at 41°F.

IN the previous four articles of this series, we discussed the general aspects of vernalization and the specific responses of cold-requiring herbaceous perennials with day-neutral and long-day photoperiod requirements. In this article, we focus on the facultative nature of vernalization.

Perennials with a facultative vernalization response often benefit from a cold treatment at 35°F to 45°F but do not absolutely require exposure to cold for flowering. These perennials may flower faster, have sturdier stems, increased vigor and have a more abundant flower display following a cold treatment compared to non-vernalized plants.

Of the nearly 400 herbaceous perennials that have been evaluated in Michigan State University research trials, only a handful have shown a facultative response to vernalization (Table 1). These plants are intriguing from the standpoint that flowering of non-vernalized plants is strongly influenced by irradiance and/or photoperiodic conditions during forcing. Irradiance is the amount of light reaching a plant and can be summed over a 24-hour period to provide a daily light integral (DLI) value. Many perennials have improved growth, greater flowering and are of higher plant quality when grown under a high greenhouse DLI.

In some cases, high DLIs, long day lengths (at least 16 hours) or both can partially or fully replace the need for vernalization. This is particularly important during winter production and forcing of perennials when natural day lengths are short and the DLI is low. For example, flowering of non-vernalized perennials such as Lychnis flos-cuculi 'Jenny' is generally poor, delayed and non-uniform unless plants are grown under long day lengths and with high irradiance (Figure 1). When DLI is low outdoors, many plants require supplemental lighting for at least 16 hours to achieve the necessary DLI for adequate flowering and plant quality. Although flowering occurs under low-light conditions, it may not be comparable to the flowering response achieved under similar photoperiod and DLI conditions following vernalization (Figure 1).

Vernalization treatments can modify the photoperiodic requirement for flowering of perennials once the cold treatment is completed and plants are returned to warmer growing temperatures. Plants may only flower under a specific day length prior to vernalization and under a wider range of day lengths following a cold treatment. In the case of perennials like leucanthemum 'Snowcap,' non-vernalized plants require long days to flower while vernalized plants have a facultative response for long days to flower. In essence, vernalization treatments may override photoperiod requirements for flowering in some perennials. Several examples of perennials with facultative vernalization responses follow:

Corydalis. We have evaluated the flowering requirements of a number of corydalis species and hybrids including C. lutea, 'Blackberry Wine' and 'China Blue.' In general, non-vernalized plants flower most profusely under long days and with high light levels. Flowers are often absent or sparse under short days or with long days and low light levels. For example, complete flowering of non-vernalized C. lutea occurred only under 16-hour long days and few plants flowered under 9-hour short

days. Nearly all plants flowered under both short and long days following a 15-week vernalization treatment at 41°F. In addition, vernalized plants had more vigorous growth and improved flowering uniformity. Flowering time also was reduced by two to four weeks.

Corydalis 'Blackberry Wine' responded similarly with only 10 percent to 20 percent of non-vernalized plants flowering under short days or long days with low light, while all plants flowered following a 15-week vernalization treatment at 41°F. Vernalized plants flowered three to four weeks earlier under long days and 10 weeks earlier under short days compared to non-cooled plants.

Digitalis. In the past, we found that foxglove species and cultivars generally require or benefit from exposure to five or more weeks of vernalization at 41ºF before forcing. Although some foxgloves, such as 'Carillon' and 'Foxy,' may flower without cold, flowering of vernalized plants is generally more rapid and uniform (Figure 2). We also found that flowering percentage of digitalis 'Foxy' was highly dependent on the greenhouse light environment and increased when plants were grown under an elevated average DLI. With adequate light, all plants flowered under long days. Increasing vernalization treatment improved flowering under short days, but flowering never reached 100 percent.

Leucanthemum. We have evaluated a number of shasta daisy cultivars and all benefit from a vernalization treatment (Table 2). In particular, leucanthemum 'Snowcap' is an obligate long-day plant without cold and a facultative long-day plant following cold treatment. About two-thirds of plants flower without vernalization, but only if grown under a photoperiod of at least 16 hours or provided with a four-hour night interruption (Figure 3a). Exposing plants to a cold treatment of at least five weeks at 41°F greatly improves flowering uniformity. Flowering also occurs under shorter day lengths after vernalization but is delayed compared to when grown under long days (Figure 3b). Vernalized plants also form three to four times as many flowers under long days than short days.

In contrast to 'Snowcap,' leucanthemum 'Becky' is an obligate long-day plant regardless of vernalization and does not flower under short day lengths. Plants flowered completely without a cold treatment only when grown under long days and with ample irradiance. Only 60 percent of non-cooled 'Becky' flowered when grown under a 16-hour day and a low DLI. In contrast, all plants flowered when grown under long days with ~30 percent more light (Figure 4). All plants flowered under long days following vernalization.

Figure 3a. Non-vernalized leucanthemum 'Snowcap' requires long days for flowering, although flowering is never 100 percent.

Figure 3b. Vernalized plants flower more uniformly, form more flowers per plant and flower under a wider range of photoperiods than non-cooled plants.

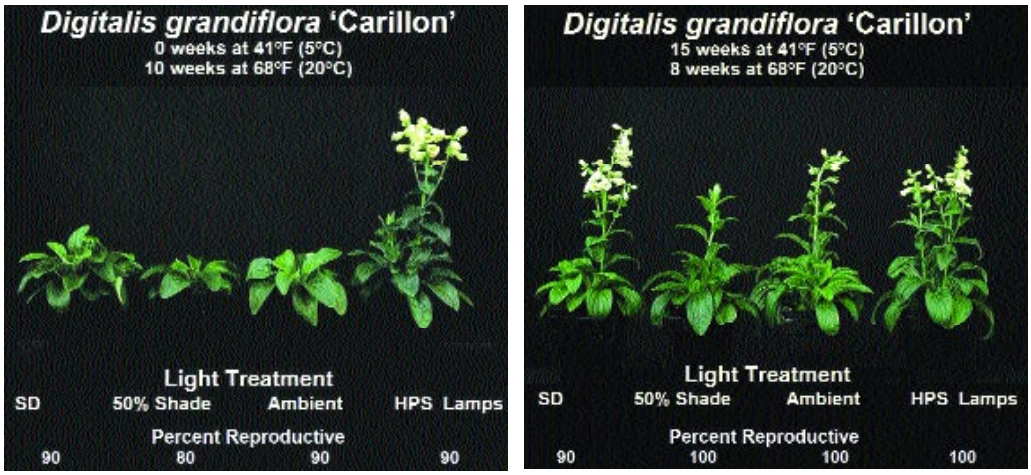

Figure 2. Flowering of foxgloves such as 'Carillon' and 'Foxy' is influenced by cold treatment and daily light integral. Non-vernalized plants flower more quickly under long days with high light while flowering is more uniform following extended cold treatments. Plants were grown under a 9-hour short day (SD), or a 16-hour long day that was shaded with 50 percent shade cloth, grown under ambient greenhouse light levels without supplemental lamps or grown with high-pressure supplemental lamps.

Maximizing Production With Facultative Vernalization Requirements

Although the majority of the perennials listed in Table 1 do not absolutely require cold for flowering, flowering percentage, timing, uniformity and plant quality are improved when plants are vernalized. Therefore, when possible, we recommend that growers provide a vernalization treatment (at least six weeks at 41°F) for these perennials. In some perennials, a high DLI can compensate for no cold treatment and vernalization can override the requirement for a particular

photoperiod to induce flowering. If forcing non-vernalized perennials to flower and natural light levels are low, maximize the greenhouse light environment by providing long-day lighting and increasing the DLI by using supplemental photosynthetic lighting. GG

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- Campanula portenschlagiana
- Corydalis species and cultivars
- Delasperma cooperi
- Digitalis purpurea 'Foxy'
- Erigeron 'Prosperity'
- Erysimum cheiri 'Gold Dust'
- Geranium sanguineum 'New Hampshire Purple' and others
- Leucanthemum 'Snowcap' and other cultivars
- Lobelia_speciosa 'Compliment Scarlet'
- Lychnis flos-cuculi 'Jenny'
- Osteospermum species and cultivars
- Penstemon species and cultivars
- Physostegia virginiana 'Rosea'
- Sisyrinchium bellum
- Thymus serphyllum 'Pink Chinz'

Table 1 Perennials With A Facultative Vernalization Response

Table 2. Forcing Recommendations For Leucanthemum Cultivars

Shasta Daisy cultivar	Weeks of cold at 41°F that are beneficial for flowering[1]	Photoperiod response for flowering of non-vernalized plants[2]	Photoperiod response for flowering of vernalized plants[2]	Weeks to flower at 68°F
'Becky'	6	Obligate LD	Obligate LD	8-9
'Alaska'	8	LD	LD	9
'Ice Star'	15	Obligate LD	Facultative LD	6
'Snow Lady'	15	LD	LD	7-8
'Snow Cap'	5+	Obligate LD	Facultative LD	6
'White Knight'	10-15	Facultative LD	Facultative LD	9

1 In some cases, only 0 or 15 weeks of cold were tested, and plants may require less cold for flowering although the exact duration has not been tested.

2 Most plants were grown under a 9-hour short day (SD) or a 16-hour long day (LD) provided by incandescent or high-pressure sodium lamps. In some cases, plants were grown under a range of photoperiods created with day-extension lighting from incandescent lamps.

Figure 4. Non-cooled leucanthemum 'Becky' plants grown under a 9-hour short day (left), a 16-hour long day with low light (center) and a 16-hour long day with high light (30 percent more light than other two treatments). Plants flowered only under long days with high light following nine weeks of forcing. Following a 15-week cold treatment at 41°F, 'Becky' plants also flowered in nine weeks under long days (center and right) regardless of light level; no plants flowered under short days (left).