FORCING PERENNIALS

– Cold Requirements –

Cold can enhance many aspects of herbaceous perennial growth and development.

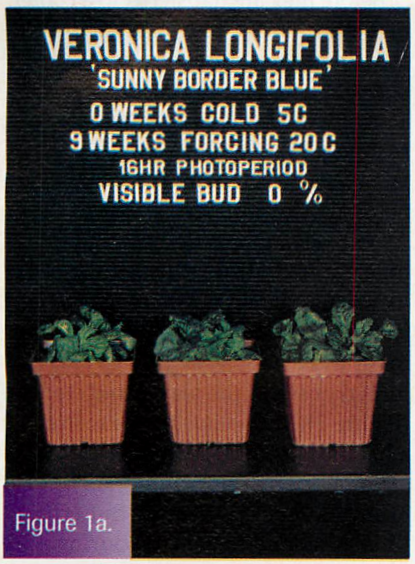

Figure 1a. *Veronica longifolia* **'Sunny Border Blue' grown without a cold treatment for 9 weeks in a 68°F (20°C) greenhouse under 16-hour day-extension lighting with high-pressure sodium lamps.** ***Photos courtesy of Leslie Finical.***

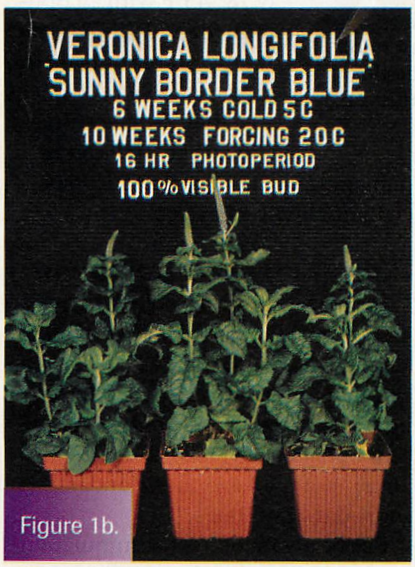

Figure 1b. All *Veronica longifolia* **'Sunny Border Blue' plants flowered after 6 weeks of cold treatment at 41°F (5°C) and 10 weeks of forcing at 68°F (20°C). When the experiment was repeated the following year, only 60% of the plants flowered after 6 weeks of cold.**

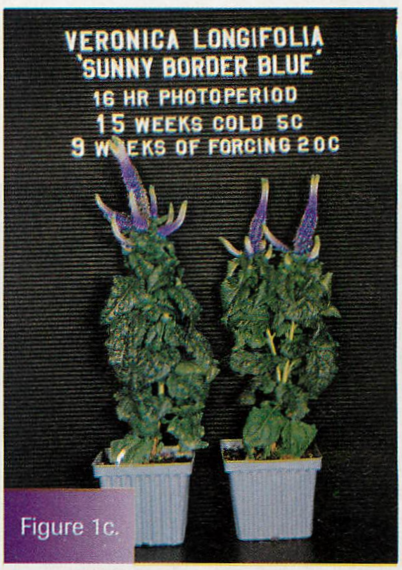

Figure 1c. *Veronica longifolia* **'Sunny Border Blue' after 15 weeks of cold treatment at 41°F (5°C) and 9 weeks of forcing at 68°F (20°C).**

Editor's note: Michigan State University and GREENHOUSE GROWER bring you our second series on forcing perennials. This group of articles will be bound into another GG Plus booklet: Firing Up Perennials II. Part 11 focuses on the cold treatment of herbaceous perennials.

by ***EMILY CLOUGH, LESLIE FINICAL, ARTHUR CAMERON, ROYAL D. HEINS,*** *and* ***WILL CARLSON***

HERBACEOUS perennials are plants with soft stems and are represented by a vast number of species, genera, and families. Not surprisingly, herbaceous perennials overwinter in diverse forms, depending on their relative hardiness and the severity of a particular winter.

As part of our research program on growth and development of herbaceous perennials, we are studying the effect of cold on plant performance. Exposure to cold temperatures can enhance many aspects of flowering, plant height, lateral branching, overall crop quality, and uniformity.

Many herbaceous plants have mechanisms to avoid growth and development during the unfriendly conditions of winter. Some become

Figure 2. *Phlox paniculata* 'Eva Cullum' after 15 weeks of storage at 41°F (5°C). Plugs appear dead but close inspection reveals buds that will begin growing when transferred to forcing temperatures. *Photo courtesy of Erik Runkle.*

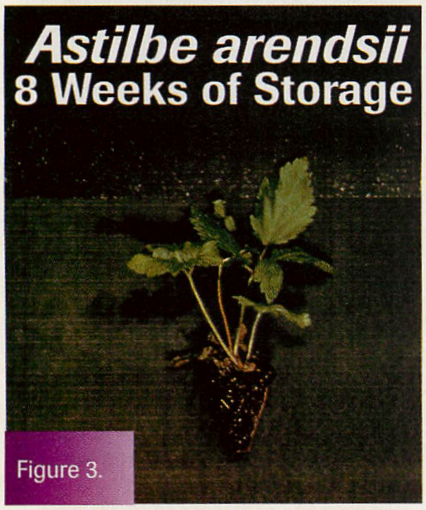

Figure 3. Plugs of astilbe after 15 weeks at 41°F (5°C). *Photo courtesy of Beth Engle.*

dormant and require exposure to cold, others require long days, and still others require both cold and long days before they initiate growth and move toward flowering.

In one experiment, *Veronica longifolia* 'Sunny Border Blue' remained vegetative until it was exposed to 6 weeks of cold. Then 60%-100% of the plants flowered in 80 days with an average of five inflorescences. After 15 weeks of cold, all plants flowered in about 63 days and had an average of 10 inflorescences. All plants were grown at 68°F (Figures 1a, 1b, and 1c).

A cold treatment also can broaden the span of effective photoperiods. Before cold treatment, plants of *Lavandula angustifolia* 'Munstead' flower only under long days. After a 15-week cold treatment at 41°F (5°C), 'Munstead' plants are day-neutral and can be forced to flower under any daylength.

What Constitutes Cold?

The range of cold temperatures that influences flowering is broad: usually 28°-45°F with an optimum of 41°F (5°C). Temperatures outside this range are generally not as effective. Temperatures lower than 28°F can be damaging to many perennials, especially to their root systems.

Delivering Cold Treatment

In our experiments, cold is delivered in environmentally controlled chambers set at 41°F (5°C). In the cooler, plants are provided with 9 hours of light (25-50 footcandles) from fluorescent bulbs which create a small amount of photosynthesis under short-day conditions.

But be aware of frost accumulation on the cooling chambers' coils. It reduces cooling efficiency and poses two problems: potential breakdown of coolers and loss of temperature control, resulting in nonuniform cold treatment. Appropriate defrost cycles are required.

In most Northern commercial nurseries, plants are given their cold treatments in minimally heated greenhouses. We recommend keeping greenhouses at a minimum of 28°F. Although crowns of many species can tolerate much lower temperatures, roots of many container-grown plants can be damaged below 28°F.

There are several challenges that growers face when cold is delivered in a greenhouse. Maintaining cool temperatures can be difficult on sunny days and is limited by the amount of venting. We have not studied whether frequent temperature shifts between cold nights and sunny, warm days might affect a plant's growth, development, or perception of cold during forcing.

Insufficiently cooled plants can be devernalized above 86°F (30°C). Exposure to such high temperatures can negate the beneficial aspects of cold. Cold treatments that are interspersed with periods of warm air temperatures may be less effective, so longer cold treatments may be necessary to compensate. But we have no definitive data.

Cooling in greenhouses may be a problem in warm Southern regions, so some Southern growers are using coolers with lights.

Cold Treatment Care

Before they are transfered to a cooler, plants are given a fungicide and insecticide drench to control disease and insect problems. During cooling, plants are watered about two times each week, as needed. When plugs are cooled, special attention is required so that they do not get over- or underwatered.

Generally, plants do not exhibit much growth during the cold treatment. A number of species, like *Phlox paniculata* 'Eva Cullum,' become dormant when kept at 41°F (5°C) and exhibit dieback of the leaves and stems (Figure 2). Those like astilbe maintain a healthy, green appearance (Figure 3).

Some species grow noticeably. For example, *Scabiosa caucasia* 'Butterfly Blue' unfolded five leaves during a 15-week cold treatment. Temperatures lower than 41°F (5°C) are required to prevent development of such species.

Plant material. For perennials undergoing forcing, it is convenient to cool the seedlings while they are in plug trays, since they take the least amount of space. But hardy, mature plants can be cooled in containers of any size or even while bare-rooted.

It is important to ensure that any juvenility requirements are met before the treatment is given, or flowering will be inhibited or eliminated. For perennial plants, leaf or node number can be used as an estimate of age.

For instance, when *Heuchera sanguinea* 'Bressingham Hybrid' seedlings, with an average of eight leaves, were given a cold treatment, only 50% flowered. When seedlings were older before cold treatment, all of the crop flowered.

Table 1.

Aspects Of Growth And Development For Herbaceous Perennials That Respond To Cold Treatment

Species	Cold Category 1 = Cold Required 2 = Cold Beneficial	Recommendation (weeks of cold)	Increase % Flowering	Faster Flowering	Increase # Of Flowers	Increase Height	Comments
Anemone hupehensis	2	6-15	Yes	Yes	No	No	Improves uniformity
Campanula **'Birch Hybrid'**	1	6-9	Y	Y	Y	N	More than 12 weeks of cold makes plants sparse
Coreopsis grandiflora **'Sunray'**	1	10	Y	Y	Y	Y	Obligate cold requirement for this cultivar
Gaillardia x grandiflora **'Goblin'**	2	9-12	Y	Y	Y	N	Improves uniformity
Gaura lindheimeri **'Whirling Butterflies'**	2	6	N	N	Y	N	Improves vigor and sturdiness
Geranium dalmaticum	2	6-9	Y	Y	Y	N	With more than 9 weeks of cold, stems elongate excessively
Heuchera sanguinea **'Chatterbox'**	1	12	Y	N	Y	Y	100% flowering not reached until 12 weeks of cold
Monarda didyma **'Gardenview Scarlet'**	1	15	Y	Y	Y	Y	Height dramatically increases
Oenothera fruitcosa **'Youngii-Lapsley'**	1	3-15	Y	N	Y	N	Flower number increase seen only with 15 weeks of cold
Penstemon digitalis **'Husker Red'**	2	9-15	Y	Y	Y	Y	Height dramatically increases
Phlox paniculata **'Eva Cullum'**	2	9	N	N	Y	N	Number of flowers increases with 15 weeks of cold
Physostegia virginiana **'Alba' and 'Rosea'**	1 'Alba' 2 'Rosea'	12-15	Y	Y	Y	Y 'Alba' N 'Rosea'	Poor performance without cold
Rudbeckia fulgida **'Goldsturm'**	2	6	Y	Y	Y	Y	Increase in flower number not seen until 9 weeks of cold
Salvia nemorosa **'May Night'**	2	6-9	N	N	Y	N	Improves uniformity; height decreases with cold
Salvia xsuperba **'Blue Queen'**	2	6-9	N	Y	Y	N	Improves uniformity; height decreases with cold
Saxifraga arendsii **'Triumph'**	1	9-15	Y	Y	N	N	Bulk before cold to increase flower numbers
Stokesia laevis **'Klaus Jelitto'**	2	6-9	Y	Y	N	N	Improves uniformity
Veronica longifolia **'Sunny Border Blue'**	1	12-15	Y	Y	Y	N	Branching promoted after 12 weeks of cold

Table 2.

No Cold For These Herbaceous Perennial Plants

Species	Comments
Asclepias tuberosa (if kept under long days)	Blooms fine from seedling when grown continuously under long days; can be difficult to hold in plug tray during cold treatment. Very sensitive to overwatering. A pinch at transplanting increases branching.
Campanula carpatica 'Blue Clips'	Cold treatment not required, but can slightly hasten flowering (10 days). Can be stored at low temperatures.
Coreopsis grandiflora 'Early Sunrise'	This cultivar of coreopsis has no cold requirement, while most other coreopsis cultivars will not flower without a cold treatment.
Echinacea purpurea 'Bravado'	Cold treatment not required, but can slightly hasten flowering by 1-2 weeks. Can be stored at low temperatures.
Gypsophila paniculata 'Happy Festival'	No effect of cold on plants grown in high light conditions; cold treatment can be beneficial if plants are grown in low light. We had problems with Anthracnose during the cold period.
Hibiscus moscheutos 'Disco Belle Mixed'	Hibiscus plugs are very difficult to keep at low temperatures; best just to grow under continuous long days.

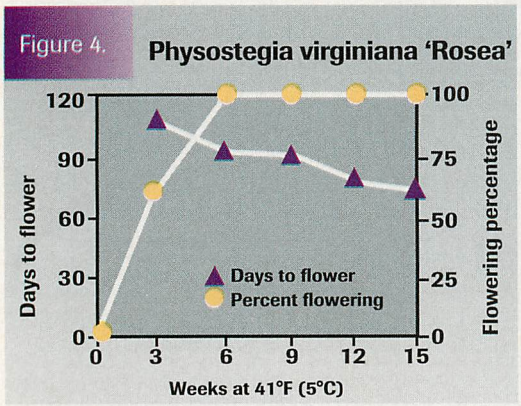

Figure 4. Influence of increasing lengths of cold on flower timing and flowering percentage of *Physostegia virginiana* 'Rosea.' The indicated cold treatments were given in a cooler at 41°F (5°C). Plants were grown in a 68°F (20°C) greenhouse under 16-hour day-extension lighting with high-pressure sodium lamps.

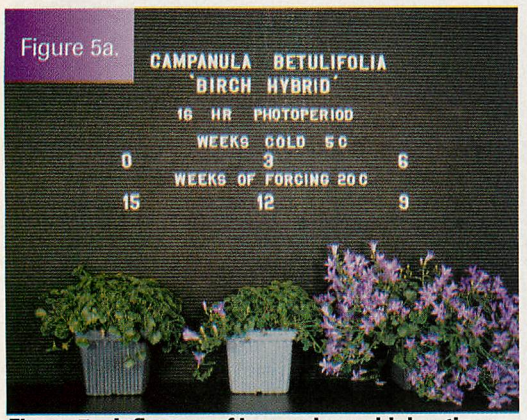

Figure 5a. Influence of increasing cold durations on number of flower buds of campanula 'Birch Hybrid.' Plants were given 0-, 3-, and 6-week cold treatments at 41°F (5°C) and grown in a 68°F (20°C) greenhouse under 16-hour day-extension lighting and high-pressure sodium lamps. *Photo courtesy of Leslie Finical.*

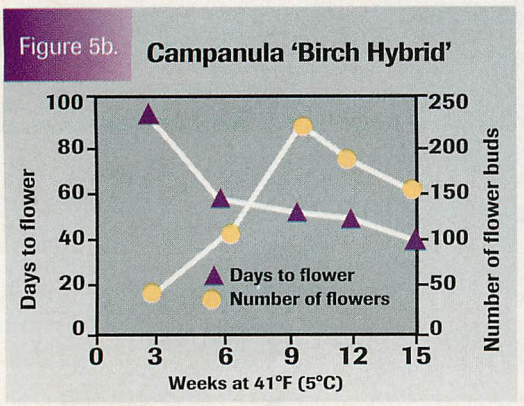

Figure 5b. Influence of increasing cold durations on flower timing and number of flowers for Campanula 'Birch Hybrid.'

Allen Pyle of C. Raker and Sons, Inc., Litchfield, MI, suggests that chilling immature plants may be possible if the cold treatment is given in greenhouses where some growth occurs. We have not yet tested this suggestion, but it could offer an efficient way to fulfill two requirements with one step.

Duration of cold treatment. We have conducted experiments to test the effect of different lengths of cold treatment on flowering of herbaceous perennials. We divided plants into three main categories based on plant response to cold: cold required; cold beneficial; and no cold recommended. Plant growth and development can change with increasing lengths of cold. We have attempted to identify an optimum length of cold for perennials that respond to cold treatments (Table 1).

Cold required and cold beneficial. For most species in these categories, increasing the cold treatment shortens the time to flower while increasing flowering percentage and uniformity. For example, 60% of *Physostegia virginiana* 'Rosea,' a cold-requiring species, flowered after 3 weeks of cold in an average of 105 days.

After 6 weeks of cold, 100% of Rosea flowered, requiring only 89 days (Figure 4). For *Geranium dalmaticum*, a cold-beneficial species, 80% of the plants started from 72-cell plugs flowered without a cold treatment in 80 days. After 3 weeks of cold, all plants flowered in 63 days.

Longer cold durations generally increase the number of flowers per plant. With 3 weeks of cold, campanula 'Birch Hybrid' had an average of 40 flower buds when the first flower opened. After 6 weeks of cold, they had about 110 flower buds per plant (Figure 5a). More than 200 flower buds were produced when the duration of cold was increased to 9 weeks (Figure 5b).

Some species increase in height following increasing cold durations. The increase can be quite dramatic. For example, *Penstemon digitalis* 'Husker Red' attained a height at first flower of 24, 28, or 32 inches (60, 70, or 80 centimeters) following 9, 12, or 15 weeks of cold, respectively. But cold treatments do not affect height for many perennials and even reduced height of *Salvia nemorosa* 'May Night.'

No cold recommended. A few species do not require cold to improve flowering but usually can be stored at low temperatures (Table 2). For two species, we recommend avoiding cold treatment. *Hibiscus moscheutos* 'Disco Belle Mixed' are damaged between 32° and 41°F and are also very sensitive to over- or underwatering during cooling.

Asclepias are also difficult to store at low temperatures because of extreme sensitivity to overwatering. Both species can be flowered directly from seed if kept under long days without exposure to cold.

Formula For Success: Cold Treatment

1. Use environmentally controlled chambers set at 41°F (5°C) or greenhouses kept between 28°F (-2°C) and 45°F (7.5°C).
2. Provide 9 hours of light using fluorescent bulbs (25-50 footcandles) in chambers.
3. Make sure juvenility requirements are met before cooling plants.
4. Water plants as needed but avoid too much or too little water during cooling.
5. Choose a length of cold appropriate for each species.
6. Plants can be transferred directly from cold to 68°F without any problems, although plants can be devernalized at temperatures of about 86°F.

Future Directions

We look forward to increased efficiency in production because of crop scheduling based on optimum conditions for flower induction, including plant juvenility, cold duration, and photoperiod. Manipulating flowering requirements could allow year-round production and open up new markets for consumers with different needs and desires. **GG**

About the authors: Emily Clough and Leslie Finical are graduate research assistants, and Drs. Royal D. Heins, Will Carlson, and Arthur Cameron are professors, Department of Horticulture, Michigan State University, East Lansing, MI 48824.