Cool Campanula

Cooling and daylength can regulate flowering of some campanula species and cultivars.

By Sonali Padhye, Cathy Whitman, Erik Runkle and Art Cameron

The genus campanula contains more than 300 species, many of which are of Northern origins. Campanula species are commonly referred to as bellflowers and can add a great splash of blue, white or red to any perennial garden.

Many campanulas such as *C. carpatica*, *C. portenschlagiana* and *C. poscharskyana* thrive in cool temperatures and high light conditions, making them very suitable for the springs and summers in Northern Europe. Therefore, it is not surprising that in Northern Europe campanulas are extremely popular and almost a staple in any perennial garden. Several campanulas, especially many noteworthy cultivars such as *C. punctata* 'Cherry Bells' and campanula 'Kent Belle' are reportedly adaptable to high heat and humidity. A few campanulas, including *C. rotundifolia*, are native to the United States and offer great untapped potential to gardeners and plant breeders looking for new plant material. Smaller-sized campanulas such as *C. carpatica* form charming mounds of flowers in small containers and are important potted flowering crops. Several campanulas suitable for domestic conditions have been significant to the American herbaceous perennial market.

Campanula persicifolia *'Chettle Charm'*

Top: Campanula punctata *'Cherry Bells' forced at 68° F without vernalization treatment did not flower under (from left to right) 9-hour photoperiod, 16-hour photoperiod provided by incandescent lamps and 16-hour photoperiod provided by high-pressure sodium lamps.* ***Bottom:*** Campanula punctata *'Cherry Bells' forced at 68° F following 15-week vernalization treatment at 41° F (from left to right) did not flower under 9-hour photoperiod but did flower under 16-hour long days provided by incandescent lamps and high-pressure sodium lamps.*

Figure 1. Vernalization requirements of select campanula species.

Species	Vernalization Requirement	Hardiness Zone	Notes
C. carpatica	None	3	Plants can be held at 41° F for up to 15 weeks, the longest duration tested.
C. garganica	Obligate	5	No plants flowered without cold in our trials.
C. glomerata	Facultative	2	Less than 20 percent of starting material with 4-9 leaves flowered without vernalization, more than 80 percent with. Cold treatment had little effect on time to flower.
C. persicifolia	Obligate	3	Some persicifolia cultivars reportedly require bulking before vernalization; vegetatively propagated 'Chettle Charm' did not. We tested vernalization for 0, 6 or 12 weeks, and only 12 weeks flowered completely.
C. portenschlagiana	Obligate	4	No plants flowered without cold in our trials.
C. poscharskyana	Facultative	3	Cooling increased flowering percent and bud number and decreased time to flower by approximately 20 days. Supplemental lighting increased bud number in uncooled plants.
C. punctata	Obligate	6	Cooling is essential for complete and consistent flowering. Complete flowering was achieved by bulking 'Cherry Bells' for 15 weeks and vernalizing for 10 weeks at 41° F. 'Wedding Bells' did not flower without cooling; less than half flowered with cooling.

Note: Recommendations are based on the specific cultivars tested. These recommendations may not be applicable to other cultivars within the same species, though they should make a good starting point for experimentation. Unless stated otherwise, plants were vernalized in plug trays at 41° F for 15 weeks.

Flowering campanulas

When perennials are offered in flower, their marketability is boosted considerably. Forcing perennials and scheduling them to flower on a specific date requires an understanding of perennial flower induction mechanisms. Our research program has studied several campanulas, and it is intriguing to review unique strategies to force them.

Flowering or sexual reproduction is considered the culmination of a plant's developmental process. In order to ensure reproductive success, plants have evolved highly regulated mechanisms that operate on environmental cues. Thus, plants flower when the environment is most conducive for flowering and pollination. Two important environmental signals that plants, especially in Northern origins, respond to are exposure to cool temperatures, known as vernalization, and response to daylength, known as photoperiodism.

Their similar botanical characteristics cause campanulas to be grouped in the same genus, but we have found that campanula species and cultivars vary greatly in their flowering requirements. We will overview the flowering requirements of campanulas that enable these plants to be forced into bloom for subsequent market sales.

'Birch Hybrid' were vernalized for (from left to right) 0, 3 or 6 weeks and then forced in the greenhouse at 68° F. No plants flowered without vernalization; all flowered after three weeks of vernalization. Flower number and time to flower were significantly improved after six weeks of vernalization. (Photo courtsey of Leslie Finical)

Vernalization Requirements

We have found that campanula species vary widely in their vernalization requirements (see Figure 1, page 72). *Campanula carpatica* has no vernalization requirement. In our studies, plants that were not cooled and plants that were cooled for short or long durations were similar in their flowering percent, time to flower and other flowering characteristics such as bud number and height at flowering. It is interesting that *C. carpatica* is very cold tolerant and can be held at low temperatures for extended periods, but exposure to cold is not required for flower induction.

Campanula glomerata and *C. poscharskyana* showed a facultative or quantitative vernalization response. During our research only a few plants flowered without cooling, but after cooling for 15 weeks at 41° F flowering percent increased significantly. Although cooling did not affect the flowering time of *C. glomerata*, *C. poscharskyana* flowered approximately three weeks sooner following vernalization compared to non-vernalized plants.

Campanula garganica, *C. persicifolia*, *C. portenschlagiana* and *C. punctata* have an obligate or qualitative vernalization requirement. These species did not flower unless cold was provided; however, vernalization induced these species to flower. It is essential to overcome the juvenile phase before ➧

Figure 2. Vernalization requirements of select campanula hybrids. Unless stated otherwise, plants were vernalized in plug trays at 41° F for 15 weeks.

Hybrid	Vernalization Requirement	Notes
'Birch Hybrid'	Obligate	Cross of *C. portenschlagiana* and *C. poscharskyana*. Plants were vernalized for 0, 3, 5, 7, 9 or 12 weeks. All plants flowered with at least 5-weeks cold treatment. Time to flower decreased by two weeks when vernalization increased from five to seven weeks with no further effect from additional vernalization.
'Kent Belle'	Facultative	Reportedly derived from *C. punctata*, *C. latifolia* and *C. takesimana*. Only 10-40 percent of plants flowered without vernalization, 100 percent after vernalization.

Figure 3. Photoperiodic requirements of select campanula species. Long-day (LD) and short-day (SD) plants were grown under nine hours of natural light provided by blackout system from 8 a.m. to 5 p.m. with supplemental high-pressure sodium lighting when the light levels were below 140 µmol·m^{-2}·s^{-1}. LD plants received an additional seven hours of lighting by incandescent lamps provided from 5 p.m to 12 a.m.

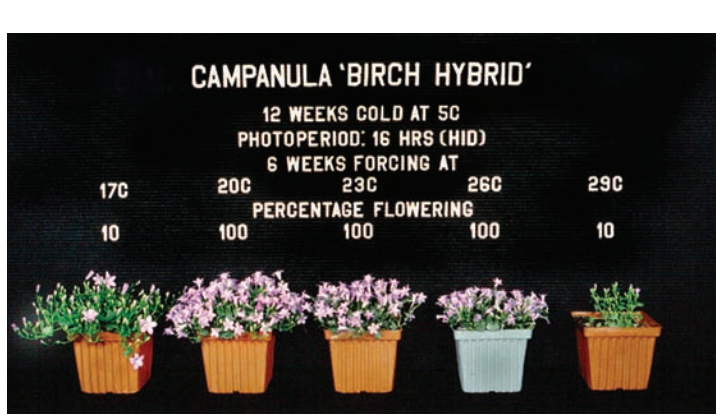
Species	Photoperiodic Requirement	Notes
C. carpatica	Obligate LD	The critical photoperiod of 'Blue Clips' is 14 hours. Sixty percent of plants flowered between 13 and 14 hours; all plants flowered at more than 16 hours. If LD are provided as night interruption to 'Blue Clips', lighting should be for four hours in the middle of the night, and lights should be on constantly.
C. garganica	Facultative LD	LD increased percent flowering, hastened flowering by approximately 25 days and considerably increased bud number.
C. glomerata	Facultative LD	LD increased flowering percent and hastened flowering by approximately 20 days but did not consistently affect bud number.
C. persicifolia	Day neutral	Plants flowered under all photoperiods.
C. portenschlagiana	Day neutral	Photoperiod did not affect flowering characteristics.
C. poscharskyana	Facultative LD	LD hastened flowering by approximately 20 days and increased bud number and plant height at flowering.
C. punctata	Obligate LD	After sufficient vernalization, no 'Cherry Bells' flowered under SD in 15 weeks; all flowered under LD. After 15-week vernalization, no 'Wedding Bells' flowered under SD; complete flowering did not occur under LD.

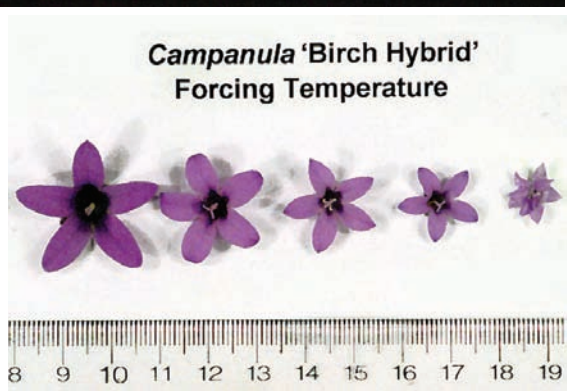
Figure 4. Photoperiodic requirements of select campanula hybrids.

Hybrid	Photoperiodic Requirement	Notes
'Birch Hybrid'	Day neutral	Complete flowering after sufficient vernalization. Plants were more compact under SD. Supplemental lighting considerably increased the number of buds.
'Kent Belle'	Day neutral	Photoperiod had little effect on time to flower, bud number or plant height at flowering.

beginning the cooling period. Some *C. persicifolia* cultivars reportedly require bulking, but in our preliminary screen the vegetatively propagated cultivar 'Chettle Charm' flowered readily without bulking.

'Kent Belle' reportedly has *C. punctata*, *C. latifolia* and *C. takesimana* in its parentage. In our studies, 'Kent Belle' has a facultative vernalization requirement. Percent flowering of non-vernalized 'Kent Belle' plants ranged from 10 to 40 percent depending on the light regime provided, but following vernalization all plants bloomed completely, regardless of the light regime tested. 'Birch Hybrid' is reportedly a hybrid between *C. portenschlagiana*, having obligate vernalization requirement, and *C. poscharskyana*, having facultative vernalization requirement. 'Birch Hybrid' has "inherited" an obligate vernalization requirement. We have maintained stock plants of 'Birch Hybrid' for the last 2-3 years. In rare instances, overgrown stock plants initiate a few flowers; however, flowering is non-uniform and very sparse. Therefore, horticulturally speaking, 'Birch Hybrid' requires vernalization for flowering.





***Top:** 'Birch Hybrid' forced under (from left to right) 63, 68, 73, 79 and 84° F. Note the reduced plant size and flower number under higher temperatures. **Bottom:** 'Birch Hybrid' forced under (from left to right) 63, 68, 73, 79 and 84° F. Note the reduced size and faded color under higher temperatures. (Photos courtesy of Alison Frane)*

Vernalization and Hardiness

The observed diverse vernalization responses prompted us to explore whether there is an obvious link between vernalization requirements and a plant's native range or reported USDA Cold Hardiness Zone. *Campanula carpatica*, which is of very Northern origin and cold hardy to Zone 3, has no vernalization requirement; whereas, *C. glomerata* and *C. poscharskyana*, which are also native to the North and cold hardy to Zones 2 and 3, respectively, have a facultative vernalization requirement (see Figure 1, page 72).

Finally, *C. garganica*, *C. persicifolia*, *C. portenschlagiana* and *C. punctata* have obligate vernalization requirements yet varying cold hardiness between Zones 3 and 6. Thus, for campanula there does not appear to be a direct relationship between cold hardiness and vernalization requirement.

Figure 5. Forcing recommendations for campanula species and hybrids. Long-day (LD) plants were grown under nine hours of natural light provided by blackout system from 8 a.m. to 5 p.m. with supplemental high-pressure sodium lighting when the light levels were below 140 µmol·m^{-2}·s^{-1} and additional seven hours of lighting by incandescent lamps 5 p.m. to 12 a.m. All plants were vernalized in plug trays at 41° F under 9-hour photoperiod provided by fluorescent lamps. No plant growth regulator applications were made.

Cultivar/Hybrid	Vernalization Duration (week)	Photoperiod	Weeks to First Open Flower at 68° F	Plant Height at Flowering (inch)	Notes
C. carpatica 'Blue Clips'	0	LD: greater than or at 16 hours	7-8	5-7	Bulk plants to desired size under SD prior to LD. Supplemental lighting increased bud number. Larger flowers and more intense color when grown cooler.
C. carpatica 'Blue Uniform'	0	LD	8	6-7	As uniform as other cultivars. Supplemental light increased number of buds.
C. carpatica 'Deep Blue Clips'	0	LD	8	5-6	Supplemental light increased bud number. Very similar to 'Blue Clips'.
C. carpatica 'Experimental Blue'	0	LD	7	5-6	Supplemental light increased bud number.
C. carpatica 'White Clips'	0	LD	7-8	5-7	Supplemental light increased bud number. Culture similar to 'Blue Clips'.
C. garganica	15*	LD	7	5-6	Plants may have juvenility, and bulking may be essential prior to vernalization.
C. glomerata	15*	LD	6	14-16	No treatment gave 100-percent flowering when starting material had 4-9 leaves. Juvenility may be a problem. Little response to supplemental lighting.
C. portenschlagiana	15*	Natural	5	3-5	Plants continue to flower over a long period of time.
C. poscharskyana	15*	LD	6	13-14	Supplemental lighting increased flowering in non-vernalized plants but did not affect bud number.
C. persicifolia 'Chettle Charm'	12 or more	LD**	6-7	15-24	Vegetatively propagated with no juvenility. Suitable for 1-gal. or larger containers. PGRs may be required. May become aggressive.
C. punctata 'Cherry Bells'	10 or more	LD	5-6	15-18	Supplemental lighting resulted in 100-percent increase in bud number. Plant height and flower size were decreased at higher temperatures, but all plants were acceptable quality. Suitable for 1-gal. or larger containers. PGRs may be required. May become aggressive.
C. punctata 'Wedding Bells'	15*	LD	7-8	12-18	May have a juvenility and should be bulked before cooling. Supplemental lighting increased bud number.
'Birch Hybrid'	5 or more	Natural	4-5	5-7	Supplemental lighting increased bud number. Flower size and color improve under cool forcing temperature.
'Kent Belle'	15*	Natural	7-8	15-25	Suitable for 1-gal. or larger containers. PGRs may be required.

**Only 0- and 15-week vernalization were tested.*
***LD was the only photoperiod tested.*

'Kent Belle' flowered when forced at 68° F following vernalization at 41° F for 15 weeks under (from left to right) 9-hour photoperiod and 16-hour photoperiod provided by incandescent and high-pressure sodium lamps. Plants under 9-hour photoperiod flowered later than plants under 16-hour photoperiod. (Photo courtesy of Art Cameron)

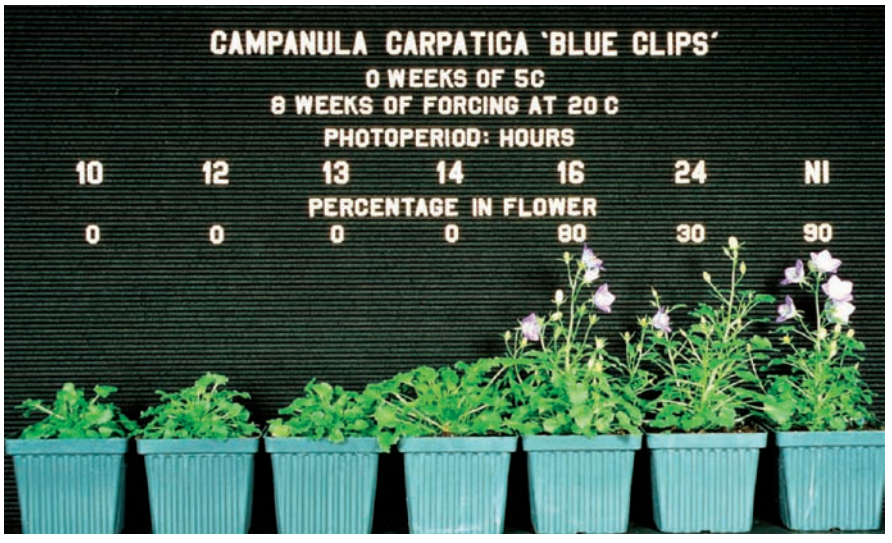
When trying to identify the forcing requirements of new campanula species and cultivars, new plants should be tested under controlled conditions since there have been no obvious relationships between a species' native range and its vernalization response type. Although the vernalization response types of hybrids tend to be similar to that of a parent, without conducting experiments it would be impossible to guess whether a hybrid would have a vernalization requirement or not.

Temperature and Duration

Most of our vernalization recommendations are based on cooling plants at 41° F. Our research results indicate that 'Birch Hybrid' flowers in response to a very broad range of temperatures — 32-55° F, depending on the duration of exposure. Note that vernalization at 55° F only delayed flowering 1-2 weeks compared to the quickest flowering treatment, which was 41° F. Complete flowering of 'Birch Hybrid' was achieved ➧

after five weeks of vernalization at 32-46° F, and plants vernalized at 32 and 37° F flowered approximately 10 days later than those at 41 and 46° F.

When we moved actively growing 4-week-old 'Birch Hybrid' plugs from 68 to 28° F the plugs often died during vernalization. Since 'Birch Hybrid' is very cold tolerant in the garden and is cold hardy to Zone 4 (-30 to -20° F), we believe exposing actively growing plant material to 28° F does not allow it to harden, resulting in plant death. Therefore, growers who wish to vernalize plants without pre-hardening should avoid vernalizing at or less than 28 °F.



'Blue Clips' were forced under (from left to right) 10-, 12-, 13-, 14-, 16- and 24-hour photoperiod and 9-hour photoperiod with 4-hour night interruption provided by incandescent lamps. Sixty percent of plants flowered under 14-hour photoperiod, and all plants flowered under photoperiods of greater than or at 16 hours. Also, flowering under 14-hour photoperiod was slower. (Photo courtesy of Art Cameron)

Photoperiodism

We have also found that the photoperiodic requirements for flowering Campanula species vary greatly (see Figure 3, page 76). C*ampanula persicifolia* and *C. portenschlagiana* are day neutral and, therefore, flower under any photoperiod. Also, the photoperiod does not affect flowering characteristics such as plant form, height, flower number, etc.

Campanula garganica, *C. glomerata* and *C. poscharskyana* are facultative long-day plants. Under long days, *C. garganica* and *C. glomerata* flowered completely and faster, and *C. garganica* also had more buds. On the other hand, *C. poscharskyana* flowered under short and long days but flowered faster under and had more buds when forced under long days.

Campanula carpatica and *C. punctata* are obligate long-day plants. When grown under short days, these plants form rosettes; when grown under long days, plants elongate and bolt during flowering. The critical photoperiod of *C. carpatica* 'Blue Clips' is 14 hours. Therefore, at any photoperiod less than 14 hours plants form rosettes, and at or greater than 14 hours plants elongate and flower. It should be noted that 'Blue Clips' flowers faster under photoperiods of 16 or more hours rather than 14 hours.

Both 'Birch Hybrid' and 'Kent Belle' are day-neutral plants and can be forced under any photoperiod (see Figure 4, page 76).

For the different campanula species tested in our program, we did not observe any apparent relationship between the native ranges, cold hardiness, vernalization requirements and photoperiodic requirements for flowering. Thus, along with vernalization requirements, the photoperiodic requirements for flowering campanulas must be tested in controlled experiments to ensure successful forcing.

Forcing Campanulas

Campanulas can effectively be forced into flower by manipulating their photoperiod, vernalization requirement or both (see Figure 5, page 77).

Along with the forcing requirement, cultural requirements should also be considered prior to campanula production.

Growing temperature. The primary effect of forcing temperature is the regulation of plant growth rate. As the forcing temperature increases time to flower decreases. However, forcing temperature also has secondary effects on flowering characteristics. Growing campanulas under high temperatures not only induces them in flower quickly but also reduces plant height, decreases flower number and size, and reduces the intensity of flower color. As mentioned earlier, most campanulas prefer cool seasons and should be forced under cool temperatures to obtain more aesthetically appealing plants. We have produced campanulas of good quality under 68° F in our research program.

Light quantity. Most campanulas respond favorably to light quantity, regardless of their photoperiodic requirements. The most commonly observed effect of supplemental lighting is increased bud number, as reported in several cultivars including all carpatica cultivars tested and 'Birch Hybrid'. The only exception to this was *C. glomerata*, which showed no response to light quantity. Often times, adding supplemental lighting also hastens flowering. However, supplemental lighting increases plant temperature, and therefore, quicker flowering may be due to the increase in plant temperature and not the light quantity.

Plant growth regulators. Typically, plant growth regulator applications are effective at reducing the height of the campanulas we tested, though under our experimental conditions, the actual response of different cultivars varied. For example, A-Rest (SePRO), B-Nine (Chemtura Corporation), Bonzi (Syngenta Professional Products), Cycocel (OHP) and Sumagic (Valent USA) were all effective in height control of *C. carpatica*. Whereas, 'Kent Belle' responded well only to A-Rest, B-Nine, Cycocel and Sumagic. The rates, timing and choice of chemical depend on growing conditions and should be tested prior to use.

Summary

In summary, there are many campanulas suitable for production as potted crops. Scheduling campanulas is easier when manipulating photoperiod, vernalization requirements or both. Most campanulas tested favored high light conditions and responded well to most plant growth regulators tested. GPN

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