COMING UP IN THIS SERIES

Basic Science
Cold Temperatures
Lavender *(Lavandula angustifolia)*
Tickseed *(Coreopsis grandiflora)*
Threadleaf *(Coreopsis verticallata)*
✔ Carpathian Harebell *(Campanula carpatica)*
Russian sage *(Perovskia atriplicifolia)*
Balloon flower *(Platycodon grandiflorus)*
Obedient plant *(Physostegia virginiana)*
Black-eyed Susan *(Rudbeckia fulgida)*
Blanket flower *(Gaillardia grandiflora)*

FORCING PERENNIALS

– CROP BY CROP –

SPECIES: CAMPANULA CARPATICA 'BLUE CLIPS'
COMMON NAME: CARPATHIAN HAREBELL

Editor's note: *In this exclusive series, Michigan State University researchers tell growers how to give the public what they want: perennials in flower. Part Six provides precise prescriptions for Campanula carpatica. These articles will be bound into a handy booklet at the end of the year.*

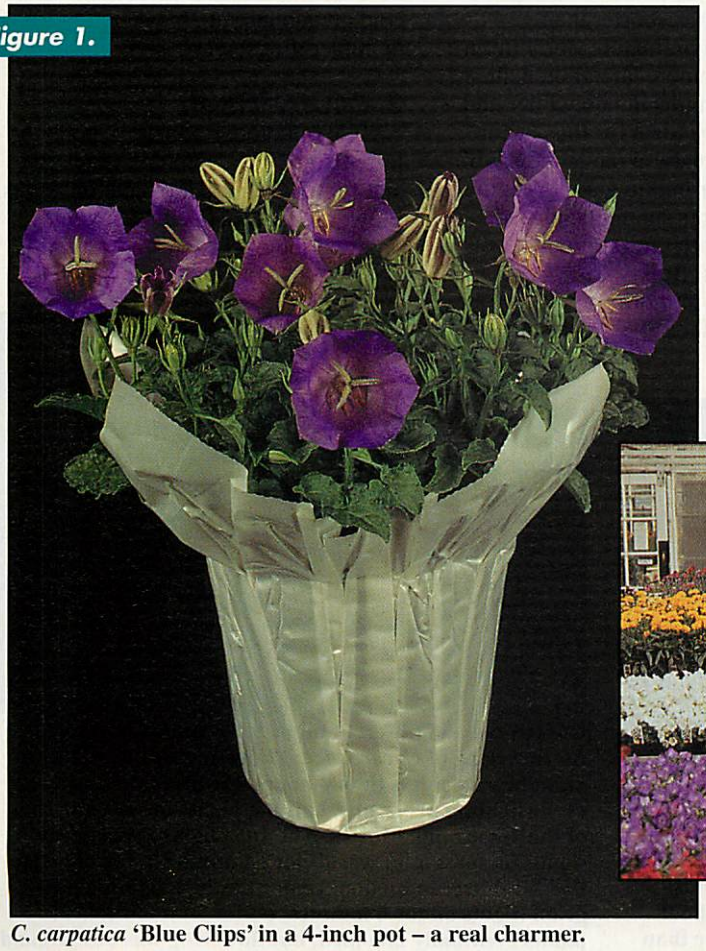
by CATHERINE WHITMAN, ROYAL D. HEINS, ARTHUR CAMERON, and WILL CARLSON

THERE are more than 300 species within the Campanula genus, many of which have been popular garden plants for hundreds of years. *Campanula carpatica* is native to the Carpathian mountains of Eastern Europe and is also known as "Carpathian harebell." Recommendations in this article apply only to this plant and may not be appropriate for other species of Campanula.

C. carpatica is hardy from USDA zones 3 to 8 and has a long flowering season. The plant grows as a compact mound 9-12 inches in height, which is ideal for rock gardens or edging a flower bed. The blue or white flowers are bell-shaped, face upwards, and are held above the foliage (Figure 1). This attractive, showy plant is used extensively in perennial gardens in the U.S. and in Europe.

C. carpatica is an important pot crop in Northern Europe and could easily be adapted to that use in North America. It is an attractive potted

Figure 1.



C. carpatica **'Blue Clips' in a 4-inch pot – a real charmer.**

Figure 2.

Successful production of *C. carpatica* 'Blue Clips' and 'White Clips' at Michigan State University. Left to right: Drs. Royal Heins, Art Cameron, and Will Carlson.

flowering plant, as well as a long-lived addition to the home garden. *C. carpatica* responds strongly to photoperiod, so growers can control plant development and schedule flowering quite predictably.

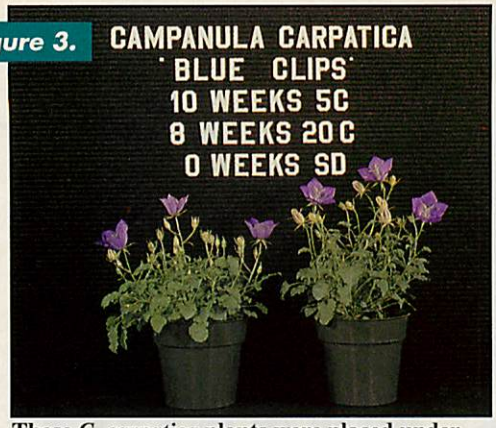


Figure 3.

These *C. carpatica* plants were placed under long-days (LD) immediately after transplant from 128-cell plug trays, when they had approximately 8-10 leaves. LD were provided with a 4-hour night interruption. Photo was taken after 8 weeks of LD.

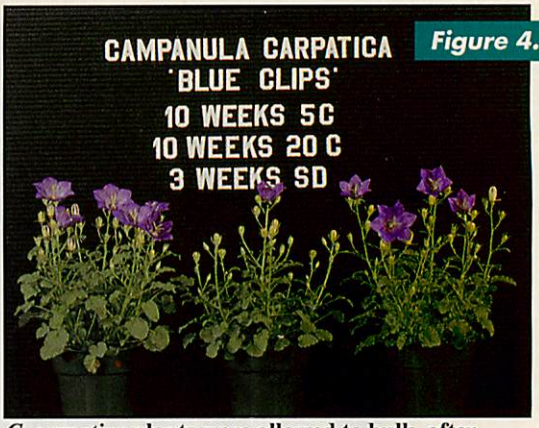


Figure 4.

***C. carpatica* plants were allowed to bulk, after transplant from 128-cell plug trays, under a 9-hour photoperiod for 3 weeks before LD treatments began. Plants had approximately 15-17 leaves at the start of LD. Photo was taken after 7 weeks of LD.**

Cultivars

The most common seed-propagated cultivars in North America are 'Blue Clips,' with medium lavender/blue flowers, and 'White Clips' with clear, white flowers (Figure 2). Recent introductions include 'Deep Blue Clips,' which has flowers of darker lavender/blue, and the 'Uniform' series. 'Karl Foerster' is a clone with lilac-blue flowers that is grown extensively in Europe. Suggested production information in this article was primarily tested on 'Blue Clips,' and some experiments included 'White Clips.' While we expect that other cultivars of *C. carpatica* will respond similarly, our recommendations may not be appropriate for all cultivars.

Flower Induction Requirements

Daylength is the main factor controlling flowering in *C. carpatica* 'Blue Clips' and 'White Clips.' This species is an obligate long-day plant – it will not flower under short days.

1. PLANT SIZE

Small seedlings of 'Blue Clips' can be induced to flower, and we have even observed flowering on 9- to 11-leaf plants in plug trays when long daylengths were provided during germination. However, to produce an attractive flowering potted plant, plants need a period of vegetative growth to gain size or "bulk up" before flowering is induced.

At all stages prior to reproductive forcing, 'Blue Clips' should be grown under daylengths shorter than 13 hours to avoid premature floral initiation and to promote lateral branching. Natural daylengths in late winter and early spring are ideal for this stage. After April 1, natural daylengths will be too long for bulking, so if bulking is needed, plants should be placed under blackcloth until reproductive forcing begins. Bulking will result in more attractive finished plants with greater number of flowers at sale (Figures 3 and 4).

2. COLD TREATMENT

Cold temperatures are not required for flowering of 'Blue Clips.' Exposure to cold does not significantly hasten flowering and has little effect on plant appearance. However, cold is not detrimental either, and plants can readily be held or overwintered in a cooler or cold greenhouse at 35°-45°F (2°-7°C) or colder if necessary.

3. PHOTOPERIOD

Under photoperiods of 12 hours or less, 'Blue Clips' remains vegetative and forms a compact rosette of leaves. Flower induction occurs when the photoperiod exceeds 14 hours and is

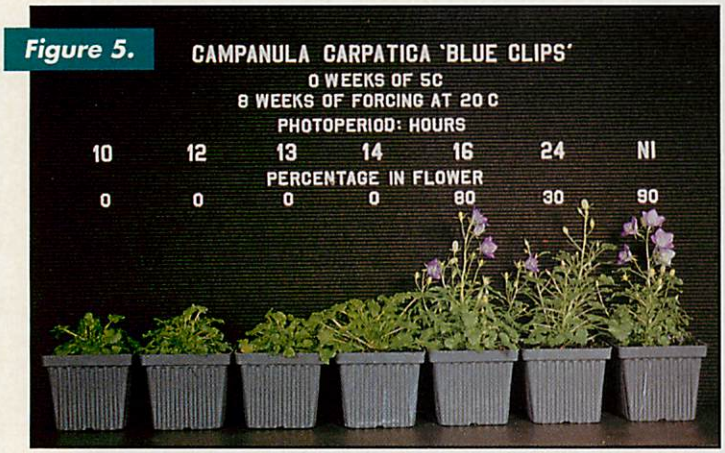


Figure 5.

Critical photoperiod for flowering of *C. carpatica*. All plants under 16-hour photoperiods or 4-hour night-interruption treatments eventually flowered. Less than 60% flowered under the 14-hour photoperiod, and none flowered under photoperiods shorter than 14 hours. *Photo courtesy of Erik Runkle.*

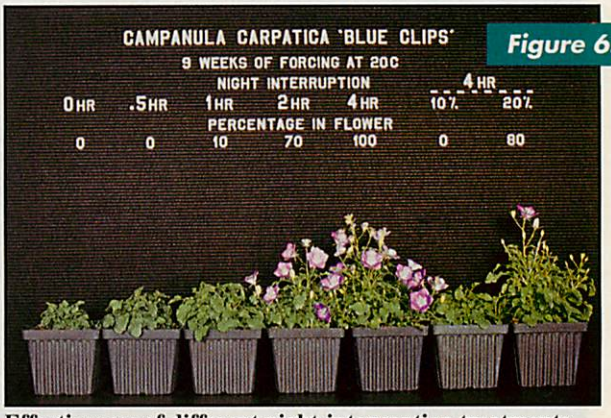


Figure 6.

Effectiveness of different night-interruption treatments for flowering of *C. carpatica*. Flowering was slower under night breaks of less than 4 hours. We also tested two cyclic lighting programs, lighting plants for 10% or 20% of the 4-hour night break. The 10% lighting program (lights on for 6 minutes, off for 54 minutes) was not effective for flower induction. Under the 20% lighting program (lights on for 6 minutes, off for 24 minutes), all plants eventually bloomed, but flowering was delayed and not uniform. *Photo courtesy of Erik Runkle.*

hastened under 16-hour photoperiods or a 4-hour night break (Figure 5). After flower initiation has occurred and buds are visible, flowering will occur even if the plants are subsequently placed under short days. Under short days, some of the elongation associated with long-day (LD) bolting will decrease, hence plants will be shorter.

LD treatments can begin any time after the plants have at least 15 leaves and should continue at least until flower buds are visible. LD can be provided either by extending the daylength to 16 hours or by night-break lighting for 4 hours from 10 p.m. to 2 a.m. Flowering will be slower if night breaks are less than 4 hours (Figure 6).

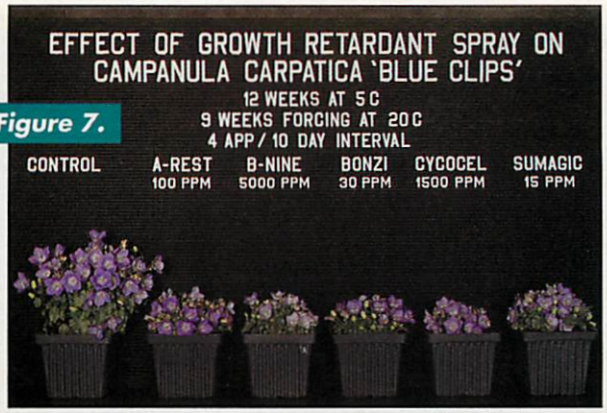
Cyclic Lighting

We have also tested two cyclic lighting programs, lighting plants for 10% or 20% of the 4-hour night break (Figure 6). The 10% lighting program (lights on for 6 minutes, off for 54 minutes) was not effective for flower induction. Under the 20% lighting program (lights on for 6 minutes, off for 24 minutes), all plants eventually bloomed but flowering was delayed and not uniform. For rapid and uniform flowering, night breaks should be 4 hours long, and the lights should be on the entire 4 hours.

Light Source

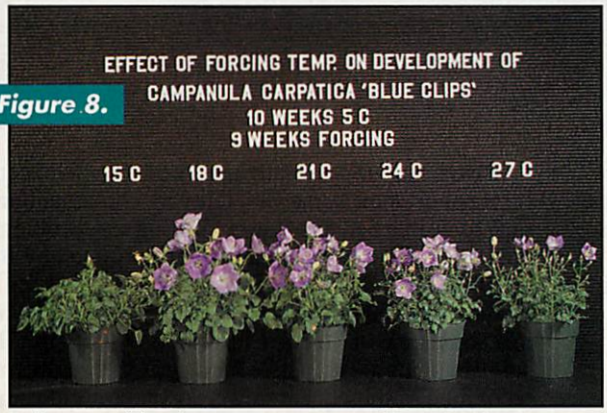
Incandescent, high-pressure sodium, cool-white fluorescent, or metal halide lamps are effective, but incandescent lights generally cause more stem elongation than the other light sources. Provide a minimum light intensity of 5-10 footcandles. When using incandescent lamps, about 1.5 watts of lamp wattage per square foot of growing space is required. 'Blue Clips' are very sensitive to light, and a light intensity of 0.5 footcandle will induce some flowering. Growers should be aware that light from adjacent greenhouses may affect development of 'Blue Clips' and could inadvertently result in flower induction when vegetative growth is desired.

Figure 7.



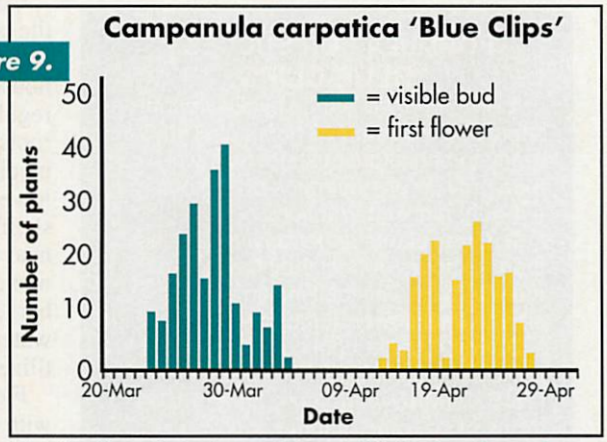
Response of *C. carpatica* to common growth retardants applied frequently and at high rates. Applications began 10 days after LD treatments began. This experiment was intended only to determine which compounds would be effective, not to determine recommended rates. *Photo courtesy of Cheryl Hamaker.*

Figure 8.



Influence of forcing temperature on flowering in *C. carpatica*. Plants flowered more quickly under warmer temperatures, but note the marked reduction in flower size with increasing forcing temperature. Average daily temperature did not affect plant height.

Figure 9.



Distribution of plants reaching visible bud and opening of first flower in a 194-plant population we forced to bloom at 65°F (18°C).

4. PROPAGATION

C. carpatica can be propagated easily by cuttings or by seed. In North America, most plants are started from seed. Some seedling variation will be present, but available cultivars are quite uniform. Light is required for germination, so the small seeds should not be covered. Maintain medium temperatures at 68°-72°F (20°-22°C). Seedlings will emerge in 14-20 days. After germination, the photoperiod should be maintained at less than 14 hours to maintain vegetative growth. Established seedlings are readily available from plug producers. In our experience, seedlings from 128-cell trays have 8-12 leaves, and those from 50-cell trays have 12-17 leaves.

5. MEDIA AND FERTILIZATION

Use of a well-drained medium is especially important. The pH should be maintained around 6.0. Campanula requires moderate levels of fertility, and constant fertilization at 100-150 ppm N, 10-20 ppm P, and 100-150 ppm K_20 is adequate (for example, 20-10-20).

6. LIGHTING AND SPACING

Provide full natural light intensity during late spring forcing. Supplemental lighting with 500 footcandles of light from high-pressure sodium lamps has greatly improved plant quality during winter and early spring forcing in Michigan.

7. IRRIGATION

Keep plants evenly moist, avoiding waterlogging or drought. Repeated drought will delay flowering, and reduce plant quality.

8. PLANT HEIGHT CONTROL

'Blue Clips' is naturally quite compact and generally forms a well-proportioned potted plant. If needed, several cultural techniques can be used to control plant height. Plants grown under positive DIF (mathematical DIF-ference between day and night temperatures) conditions will be taller than those grown under 0 DIF or negative DIF. A 2-hour temperature

TABLE 1. *Campanula carpatica* 'Blue Clips' Production Schedule

Growing Time	Cultural Practice	Temperature	Photoperiod
2-3 weeks	Sow seeds ↓ Germination OR purchase plugs	68°-72°F (20°-22°C)	<13 hours of light
9-11 weeks	Grow on until at least 15 leaves have formed ↓	64°-68°F (18°-20°C)	<13 hours of light
Hold at 35°-45°F (1°-7°C) if needed. (Plants do not require cold to flower.)			
Begin forcing			16 hours of light or 4-hour night interruption
↓ 61°F(16°C) 10-11 weeks flower	↓ 66°F(19°C) 8-9 weeks flower	↓ 70°F (21°C) 7-8 weeks flower	**Visible Bud to Flower** 61°F (16°C) - 26 days 66°F (19°C) - 22 days 70°F (21°C) - 20 days

drop at sunrise also reduced final plant height in experiments at Michigan State University (MSU). Average daily temperature does not affect plant height.

The type of supplemental lighting used to provide LD will influence plant height. Incandescent lights cause more elongation than high-pressure sodium, metal halide, or cool-white fluorescent due to the higher proportion of far-red light emitted by incandescent lamps. In our experiments, 'Blue Clips' treated with incandescent lamps were 1-2 inches taller than those under any other light source.

Growth regulators can also be used to control height. Our research shows that A-rest, B-Nine, Bonzi, Cycocel, and Sumagic are all effective (Figure 7).

9. TEMPERATURES AND CROP SCHEDULING

The time to flower after beginning LD depends on forcing temperature: about 10-11 weeks at 60°F (15°C), 8-9 weeks at 65°F (18°C), or 7-8 weeks at 70°F (21°C). During forcing, we suggest temperatures of 60°-68°F (16°-20°C) since flower size is larger at cooler temperatures (Figure 8).

'Blue Clips' plants are available in several plug sizes and as field-grown divisions. Plants from 128-cell plug trays are appropriate for 4-inch pots. To fill out 6-inch or gallon pots use several small plugs or plants from 50-cell trays or larger.

'Blue Clips' are generally quite uniform but do show some variability in time to visible bud and flower within a population (Figure 9). In this example of 194 plants, date of first flower occurred over a 10-day period. Variability in a population of 'White Clips' was similar. Plants are attractive for a period of time as subsequent flowers open.

10. DISEASE AND INSECT PESTS

'Blue Clips' is susceptible to damping-off root rot caused by Pythium or Rhizoctonia. Use of a well-drained medium will help to reduce these problems. Leaves may become infected by *Botrytis cinerea*, so it is helpful to keep the foliage as dry as possible.

Few insects are attracted to 'Blue Clips,' but spider mites may become a problem. We have noticed that pesticide applications caused some discoloration of open flowers, so avoid spraying blooming plants if possible.

FORMULA FOR SUCCESS: 'BLUE CLIPS'

1. Photoperiod is the key! Daylengths should be less than 13 hours until you're ready to begin forcing them to flower, then provide photoperiods of 16 hours, or a 4-hour night interruption.

2. Grow plants under daylengths less than 13 hours or until they have 15 or more leaves. This bulking time will increase final flower number.

3. Force under cool conditions, 68°F (20°C) or less. Plants forced at 61°F (16°C) at MSU were more attractive, in terms of size and number of flowers, than those at any higher temperatures.

4. Plants from 128-cell plug trays are appropriate for 4-inch pots. Use plants from 50-cell trays or larger to fill out 6-inch or gallon pots.

5. Cold treatments are not required for flowering and have little effect on time to flower or plant appearance. Plants are quite hardy and can readily be held or overwintered in coolers or a cool greenhouse.

11. POSTHARVEST CONCERNS

Conditions in the retail setting or the consumer's home are very different from those of the greenhouse. Water may not be provided regularly, and salt damage to the roots is a potential problem if the medium is nutrient-rich and allowed to dry out. For maximum shelflife, a reduction in fertilization near the end of the crop is recommended. Two or 3 weeks before harvest, begin irrigating with clear water or use reduced levels of fertilizer – especially nitrogen.

Flower longevity is correlated with ethylene production. In Europe, a spray of 6 ppm of silver in the form of silver thiosulfate is commonly applied shortly before harvest to maximize postharvest life. **GG**

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