FORCING PERENNIALS

Follow these strategies to regulate perennial plant height.

by ROYAL D. HEINS, ERIK S. RUNKLE, ARTHUR CAMERON, and WILL CARLSON

HEN you are producing flowering herbaceous perennials, you might find that the plants are taller than what you expected. Some perennials are naturally tall, but others become too tall because of environmental or cultural factors.

Since consumers are more attracted to flowering plants than green, vegetative ones, controlling height is essential. This requires understanding factors that contribute to stem extension. By using various strategies, growers can successfully produce perennials to meet desired height specifications.

GENETICS

Within a species, genetic variation exists so that some perennial cultivars grow significantly taller than others. For exam-

Figure 1. In some species, stem elongation increases as photoperiod increases. For example, scabiosa height increased as the photoperiod increased from 10 to 24 hours. Photoperiods consisted of a 9-hour natural day extended with incandescent lamps. NI represents a 4-hour night interruption.

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ple, *Gaillardia xgrandiflora* (Blanket flower) 'Burgundy' and 'Goblin' grow much taller than 'Baby Cole.' Selecting naturally short-growing cultivars reduces or eliminates the need for height control. But many tall-growing species have no short cultivars, and demand for these plants still exists. Therefore, other strategies must be used to produce short plants.

**CONTROLLING PHOTOPERIOD**

Many herbaceous perennials require long days for flower induction. Light duration for flowering varies from 12 hours for some species to almost 16 hours for others. Under natural short daylengths, electrical lighting can deliver photoperiods that are substantially longer than what is required for flowering.

In some species, stem elongation and plant height increases as photoperiod increases (Figure 1). Limiting the photoperiod required for flower induction will help limit stem elongation.

Controlling daylength is easier in early spring when natural days are short because growers can limit the electrical lighting duration. Black cloth can be used during long summer days, but many growers do not have such a system. Adversely, temperature can become too high under black cloth in the summer.

Limited induction photoperiod can reduce elongation during bolting. When black cloth is available during long summer days or when plants are forced in the natural short days of spring, placing perennials under short days after they have been induced to flower can control the height of some species, such as *Coreopsis xgrandiflora* or tickseed (Figure 2).

Bob Lyons at Virginia Polytechnic Institute called this technique limited induction photoperiod (LIP). Using LIP, plants are exposed to long days for a period sufficient for flower induction — generally 2-3 weeks. Then plants are shifted back to short photoperiods — 9 or 10 hours of light. Flowers continue developing to open bloom, but stem elongation is greatly retarded.

Problems with LIP include delayed flowering and fewer flowers. Also, LIP is not effective in all species (e.g., *Asclepias tuberosa*) because flowers will cease to develop or even abscise under short days. Although 2-3 weeks of
PRODUCTION
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lighting using LIP is adequate to induce flowering in many species, we suggest using long days until the first flower buds are visible.

Plants should then be returned to natural photoperiods in winter months or placed under shortened daylengths using black cloth when photoperiods are naturally long (after mid-March).

Short night breaks can reduce echinacea's height. Controlling echinacea height can be difficult. One method we discovered is to provide short night-break lighting treatments to plants growing under short days. Lighting for only 15-20 minutes at a low intensity (10 footcandles) in the middle of the night is adequate to induce flowering under short days, but plants are only half the height of those grown with the traditional 4-hour night break (Figure 3). Flowering can be delayed 1-2 weeks, compared to plants under longer durations of night break. Unfortunately, most long-day perennial species will not flower with such short night interruptions, so this technique may have limited usefulness.

INCANDESCENT LIGHTS PROMOTE STRETCH
Electrical lighting can simulate natural long days effectively under natural short days. Incandescent lamps are most commonly used to create long days because they are inexpensive and easy to install. Unfortunately, incandescent lamps are rich in far-red light, the part of the spectrum that promotes stem elongation.

Plants provided with long days by incandescent lamps will often be taller than those lit by other lamps, such as cool-white fluorescent, metal halide, or high-pressure sodium (Figure 4).

We suggest using high-pressure sodium lamps for photoperiod control. Although these lamps are expensive to install, electrical costs will be lower and plants will be shorter than those lit with incandescent lamps.

WATER STRESS HAS LIMITED POTENTIAL
Using water stress for height control is common in bedding plant production, especially during the dark, early spring season when plants dry slowly. Small quantities of water can be applied to keep plants alive, but they will still be stressed.

Water stress will limit stem elongation in perennials. But height control using water is more problematic. Controlled application of water to pots is more difficult than with flats. When many perennials are grown in late spring and summer, the time between limited irrigations must be short. If water is not applied when it is absolutely required, severe foliar damage and even death can occur.

While water can be a powerful tool for regulating height, there certainly is a high risk associated with it during bright, dry, warm weather.
INFLUENCE OF LIGHT QUALITY ON LONG DAY FLOWER INDUCTION
COREOPSIS LANCEOLATA 'EARLY SUNRISE'
60 DAYS OF 1700 TO 2400 TREATMENT AT 20 °C
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Figure 4. Incandescent (INC) lamps are rich in far-red light and can promote stem elongation in a variety of species, including coreopsis. Cool-white fluorescent (CWF), high-pressure sodium (HPS), or metal halide (MH) lamps can be used effectively to extend natural daylengths with less stem extension. Photo courtesy of Cathy Whitman.

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AVOID PLANT ELONGATION
Plant spacing. Herbaceous perennials' ecological survival strategy when confronted with competition from other plants is to elongate. Plants spaced closely elongate, putting them in more competitive positions to harvest light.

When sun-loving plants are not crowded, but widely spaced, they will elongate slowly and branch out widely to maximize light interception. Therefore, one of the most powerful growth retardants for herbaceous perennials is wide spacing. Although spacing is not consistent with maximum productivity, it's still a powerful height-control strategy.

Far-red filters can reduce plant height. Plants perceive competition based on the ratio of red and far-red light. When plants are widely spaced, leaves and stems are exposed to equal amounts of red and far-red light. When they get closer, they are exposed to more far-red than red light.
This far-red light promotes stem elongation. If far-red light is removed from sunlight, then the red to far-red ratio will not change dramatically by increasing spacing, and stem elongation will not be promoted.

We have found that one experimental filter, developed by the University of Reading and British Visqueen, effectively reduced some species' plant height (Figure 7). Far-red filters are being developed by several companies worldwide.

**TEMPERATURE**

A common perception among many growers is that warmer greenhouse temperatures will make perennials grow taller. This statement is only partially true. Warmer temperatures will hasten plant development, including plant height (Figure 8a). Final plant height at flower is not increased by forcing at warmer temperatures. We have grown dozens of perennial species at temperatures from the mid-50s to the mid-80s, from the start of forcing to flowering. In every case, plants grown at warm temperatures were either the same height or shorter at flower than those grown at cool temperatures (Figure 8b).

Warm temperatures should never be equated with causing tall plants, just like using cool temperatures is not a long-term method of height control.

**DIF can reduce elongation.** Many flowering potted and bedding plants respond to DIF, the relationship between day and night temperature. Stem elongation increases as day temperatures progressively become warmer than night temperatures.

Campanula carpatica has responded to DIF similar to many other species. DIF should control stem elongation on many herbaceous perennial species.

Cool nights and warm days (positive DIF) will result in tall plants. Plants grown under equal day and night temperatures (zero DIF) or cooler days than nights (negative DIF) will be shorter.

**GROWTH RETARDANTS REDUCE ELONGATION**

For many herbaceous perennial species, using growth retardants is the only way to maintain plant height at an acceptable level.

We have evaluated A-Rest, B-Nine, Bonzi, Cycocel, and Sumagic on more than 40 species. No one growth retardant controls height on all species.

The two chemicals that show the most widespread efficacy are B-Nine and Sumagic. Cycocel had the smallest range of height control.

For several growers, Sumagic at 10-15 ppm has been the most effective and widely used growth retardant. A second or third application often is required as the plant grows. The concentration and number of applications should be based on grower observations and decisions.

In addition, timing the application of growth regulators with the period of maximum plant elongation will be key to suppressing plant height. We have tested Florel on a number of plant species, and further information on its efficacy will soon be published.

**About the authors:** Drs. Royal D. Heins, Arthur C. Cameron, and Will Carlson are professors, and Erik S. Runkle is a graduate research assistant, Department of Horticulture, Michigan State University, East Lansing, MI 48824. Information in this article originated with several current or previous graduate students and research associates in MSU's herbaceous perennial program, including: Mary-Slade Morrison; Cheryl Hamaker; Alison Franc; Paul Koreman; Shi-Ying Wang; and Cathy Whitman.