North Carolina Flower Growers' Bulletin

Volume 41, Number 6
December, 1996

NORTH CAROLINA COMMERCIAL FLOWER GROWERS' ASSOCIATION
N • C • C • F • G • A

Official Publication of the North Carolina Commercial Flower Growers' Association

PERENNIALS: BASICS OF PROFITABLE PRODUCTION (PART II)

Douglas A. Bailey and Holly Scoggins
Department of Horticultural Science, NCSU

(This is the second portion of an article started in the October 1996 issue of the North Carolina Flower Growers' Bulletin. Tables and figures are numbered sequentially starting with the previous article.)

Allan Armitage recommends two forcing periods -- early spring and late spring / early summer (Tables 4 and 5). The species and cultivars listed in Tables 4 and 5 should give any prospective producer a place to begin building a perennials program.

Perennial Production Planning

Still want to produce perennials? The next step after reaffirming your dedication to perennials is planning for production. We have already discussed which species and cultivars to investigate. Now it is time to list the facilities and systems required for successful production.

Propagation Facilities: Unless you intend to purchase plugs or rooted cuttings, you will need propagation facilities that offer light, moisture, and temperature control. Given the various temperature and moisture requirements for different species during the germination / rooting stage, it may be necessary to have temperature and moisture zones in the propagation facilities. A cooler may be useful for treating some seed for best germination, such as with *Aquilegia* sp., which benefits from 6 weeks of moist storage at 40 °F.

Growing Facilities: Other than the capability of supplying a normal fertilization and insect / disease prevention program, perennials will need temperature and photoperiod control.

In general, perennial production can be completed with two temperature zones, a cold zone set at 35 to 50 °F night temperatures and a warm zone at 50 to 62 °F night temperatures.

The availability of a cold zone is essential for forcing of many perennials. Most perennial species have evolved to include a period of cold temperatures in their life cycle, so producers must be able to fulfill this cold requirement to control growth and development.

Along with a cold requirement, many perennials have evolved to produce flowers as temperatures increase and as daylength increases. Therefore, growers need to have the capability of

Table 4. Perennials recommended for early spring forcing.*

Genus and species	Common name	Cultivars	Normal flowering period**	Propagation method(s)
Achillea millefolium	Common Yarrow	Summer Pastels	Summer	Seed
Ajuga reptans	Bugleweed	Bronze Beauty, Burgundy Glow	♣ Late spring	Cuttings, division
Alchemilla mollis	Lady's Mantle		Spring	Seed
Anchusa sp.	Alkanet		Late spring	Root cuttings
Aquilegia x *hybrida*	Columbine	Musik series, Song Bird series	Spring	Seed
Arabis albida	Rock-cress	Snow Cap, Spring Charm	Early spring	Division, cuttings, seed
Armeria x *hybrida*	Sea Thrift	Ornament Mix	Summer	Seed
Armeria maritima	Sea Thrift	Splendens, Vindictive	Summer	Division, seed
Armeria pseudoarmeria	Pinkball Thrift		Summer	Seed
Artemisia ludoviciana	White Sage	Silver King	♣ Late summer	Division, cuttings
Artemisia schmidtiana	Wormwood	Silver Mound	♣ Summer	Cuttings
Artemisia x 'Powis Castle'	Wormwood	Powis Castle	♣ Summer	Cuttings
Astilbe x *arendsii*	Astilbe	Deutschland, Finale, Glow, many more	Late spring	Division
Aubrietia deltoidea	Rock Cress	Novalis Blue, Royal Red	Spring	Seed
Campanula carpatica	Carpathian Harebell	Blue Clips, White Clips	Summer	Seed
Campanula garganica	Gargano Bellflower		Spring	Seed, cuttings
Cerastium tomentosum	Snow-in-summer	Silvery Summer	♣ Late spring	Seed, cuttings
Dianthus deltoides	Maiden Pinks	Arctic Fire, Zing Rose	Summer	Seed
Dianthus gratianopolitanus	Cheddar Pinks	Bath's Pink, Spotty, Tiny Rubies	Spring	Cuttings
Dicentra spectabilis	Bleeding Heart		Spring	Cuttings
Digitalis purpurea	Foxglove	Foxy	Spring	Seed
Geranium sanguineum	Bloody Cranesbill	Alba, Album	Spring	Division, cuttings
Gypsophila paniculata	Baby's Breath	Double Snowflake	Summer	Seed
Gypsophila repens	Creeping Baby's Breath	Alba, Rosea	Summer	Seed
Heuchera micrantha	Small-flowered Alumroot	Purple Palace	♣ Late spring	Seed
Heuchera sanguinea	Coral Bells	Bressingham Hybrids	Late spring	Seed
Hosta sp.	Hosta Lily	many	♣ Summer	Division
Iberis sempervirens	Candytuft	Alexander's White, Snowflake	Spring	Cuttings (Alex.), seed (Snow.)
Linum perenne	Perennial Flax	Saphyr	Spring	Seed
Myosotis scorpiodes	Forget-me-not	Indigo Blue, Rosea	Spring	Seed
Papaver nudicaule	Iceland Poppy	Wonderland	Spring	Cuttings
Phlox subulata	Creeping Phlox	Delight series, Emerald series, Scarlet Flame	Early spring	Cuttings
Primula x *polyanthus*	Primrose	Pacific Giants	Spring	Seed
Salvia superba	Perennial Sage	Blue Queen, Stradford Blue	Summer	Cuttings, seed
Saxifraga arendsii	Arend's Saxifrage	Purple Robe	Spring	Seed

*From Armitage, 1989; Armitage, 1993; Armitage, 1996a; and Cameron et al., 1996a.

** ♣ = grown for ornamental foliage.

Table 4, Continued.*

Genus and species	Common name	Cultivars	Normal flowering period**	Propagation method(s)
Sedum spurium	Stonecrop	Dragon's Blood	Summer	Cuttings
Sempervivum tectorum	Hens and Chicks		♣ Summer	Cuttings, division
Verbena canadensis	Verbena	Homestead Purple, Silver Anne, many more	Summer	Cuttings
Veronica longifolia	Long-leaf Veronica	Sunny Border Blue	Summer	Cuttings
Veronica repens	Creeping Speedwell		Late Summer	Seed
Veronica spicata	Spiked Speedwell	Blue, Red Fox	Summer	Seed (Blue), cuttings (Red F.)
Vinca major	Large Periwinkle	Variegata	♣ Spring	Cuttings

*From Armitage, 1989; Armitage, 1993; Armitage, 1996a; and Cameron et al., 1996a.

** ♣ = grown for ornamental foliage.

supplying long day (4-hour night break mum lighting of 10 footcandles of light at plant level) conditions for forcing many perennial species. In most cases, long day treatments will be necessary from January through March for the spring forcing season.

Perennial Production Stages

The most important aspect for greenhouse production of perennials is the presence of flowers or at least flower buds. The goal of the grower is reaching this stage of development as rapidly and efficiently as possible and at the same time, produce a well-developed plant that will survive in the landscape.

To understand perennials and to successfully produce them, we need to look carefully at their life cycle. Just like humans, plants are "borne" (seeds germinate), are juvenile, become reproductive, bear offspring (seeds), and die. If we know which factors (such as photoperiod and temperature) affect growth and flowering in the species we intend to produce, it makes scheduling possible and should reduce total cropping time by more efficient environmental control during production.

Tom Weiler has described the perennial life cycle (and production cycle) very well (Figure 4). Note that not all life cycle stages are conspicuous in all species. Those stages that may be "missing" from a specie's life cycle are shadowed in Figure 4.

Seed Dormancy and Germination: Seed germination of perennials can be more involved than for annuals. For example, some species require scarification (breaking of the seed coat) and / or stratification (a cold moist treatment to remove seed dormancy) prior to sowing to ensure a high percentage of germination. Lupine (*Lupinus polyphyllus*) is an example of a species that benefits from seed scarification prior to sowing. Columbine (*Aquilegia* x *hybrida*) seed goes dormant as it ages, and germination of older seed can be increased through stratification. A few good references addressing seed dormancy and germination requirements of perennials are Armitage, 1989; Nau, 1993; and Nau, 1996. Perennial producers will find these references essential.

Juvenility and Reproductive Vegetativeness: For many perennials, young plants must attain a certain size prior to acquiring the ability to initiate flowers. A recent report in GrowerTalks (Cameron et. al., 1996b) summarized age requirements prior to floral initiation for some perennials (Table 6).

A good example is columbine. Columbine must receive a cold treatment in order to initiate flowers. However, plants must be mature enough to perceive the cold treatment or they will not

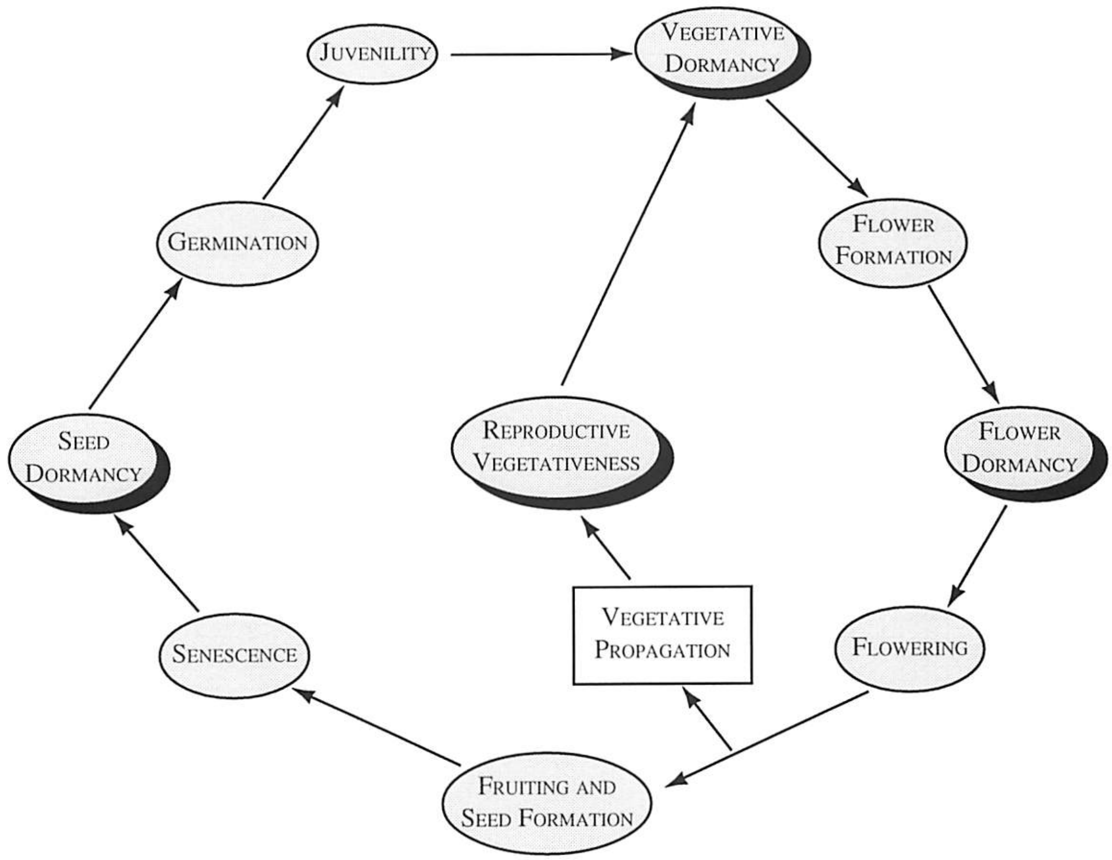

Figure 4. The life cycle of perennials. A shadow around the stage indicates that it is not a required stage for all species and many species will not proceed through or exhibit this stage in their life cycle.

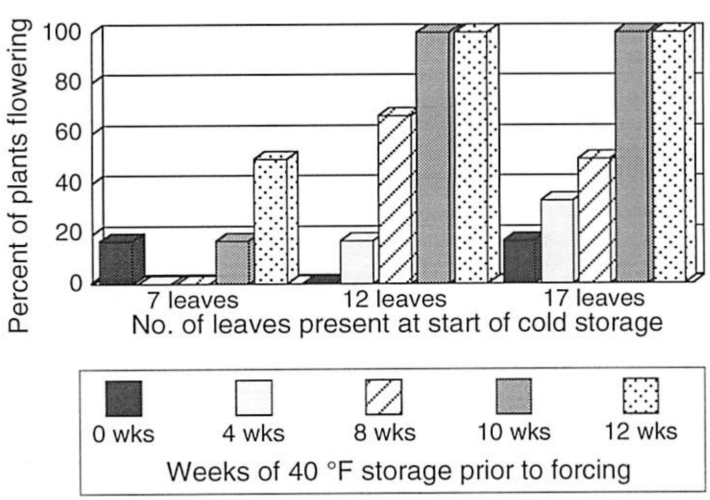

Figure 5. Interaction of plant age and cold storage duration on flowering of 'McKana's Giant' columbine. Figure adapted from Weiler, 1996.

flower. They are "juvenile" and unable to respond to inductive conditions until they reach a certain stage of development (Figure 5). For columbine, plants must have 12 leaves prior to cold treatment.

Other crops also must attain a minimum size prior to giving treatments to initiate flowering. Lavender 'Munstead' (*Lavandula angustifolia*) plants should have at least 40 to 50 leaves (20 to 25 nodes) prior to the beginning of cold treatment (Whitman et al., 1996). Coreopsis 'Sunray' (*Coreopsis grandiflora*) plants should have at least 16 leaves (eight nodes) prior to cold treatment and subsequent long day treatment for flowering (Yuan et al., 1996).

Table 5. Perennials recommended for late spring / early summer forcing.*

Genus and species	Common name	Cultivars	Normal flowering period**	Propagation method(s)
Achillea filipendulina	Fern-leaf Yarrow	Cloth of Gold	Summer	Seed
Asclepias tuberosa	Butterfly Weed		Late spring	Root cuttings, seed
Aster alpinus	Alpine Aster	Goliath	Summer	Cuttings
Aster dumosus	Dwarf Asters	Prof Kippenburg	Summer	Seed
Aster x *frikartii*	Frikart's Aster	Monch	Summer	Cuttings
Ceratostigma plumbaginoides	Leadwort		♣ Late Summer	Cuttings
Chrysanthemum coccineum	Painted Daisy	James Kelway	Early Summer	Seed, cuttings
Coreopsis auriculata	Mouse-ear Coreopsis	Nana	Spring	Cuttings
Coreopsis grandiflora	Tickseed	Early Sunrise, Sunray	Summer	Seed
Coreopsis rosea	Pink Tickseed	Nana	Summer	Cuttings
Coreopsis verticillata	Thread Leaf Coreopsis	Moonbeam, Zagreb	Summer	Cuttings
Delphinium x *elataum*	Delphinium	Blue Mirror, Magic Fountains series	Summer	Seed
Echinacea purpurea	Purple Coneflower	Bravado	Summer	Seed
Gaillardia x *grandiflora*	Blanket Flower	Goblin	Summer	Seed
Heliopsis scabra	Heliopsis	Summer Sun	Summer	Seed
Hibiscus moscheutos	Hibiscus	Disco Bell series	Summer	Seed
Lavandula angustifolia	Lavender	Hidcote, Munstead Dwarf	Summer	Seed
Leucanthemum x *superbum*	Shasta Daisy	Alaska, Snow Lady	Summer	Seed
Lobelia x *speciosa*	Lobelia	Compliment Scarlet, Fan series	Summer	Seed
Oenothera missouriensis	Ozark Sundrops		Summer	Seed
Physostegia virginiana	Obedient Plant	Alba	Late Summer	Cuttings
Platycodon grandiflorus	Balloonflower	Sentimental Blue	Summer	Seed
Rudbeckia fulgida	Gloriosa Daisy	Goldilocks, Goldsturm, Marmalade	Summer	Seed
Scabiosa caucasica	Pincushion Flower	Butterfly Blue	Summer	Seed
Sedum x 'Autumn Joy'	Autumn Joy Sedum	Autumn Joy	Late Summer, Autumn	Cuttings

*From Armitage, 1989; Armitage, 1993; Armitage, 1996a; and Cameron et al., 1996a.

** ♣ = grown for ornamental foliage.

Not all the perennials grown are propagated from seed. Actually, the majority of named cultivars are vegetatively propagated. These plants do not have a juvenile stage but can exhibit the same lack of responsiveness due to reproductive vegetativeness (Figure 4). An example of when a producer may encounter reproductive vegetativeness would be with cuttings of Coreopsis 'Goldfink', a selection of *Coreopsis grandiflora* that does not come true from seed so vegetative propagation is practiced. Rooted cuttings of 'Goldfink' would require a minimum size, similar to 'Sunray' mentioned above prior to cold treatment and subsequent

Table 6. Age requirements for receptiveness to floral initiation treatments.*

Plant name	Common name	Age requirements
Achillea filipendulina Cloth of Gold	Fern-leaf Yarrow	Plants with 8 to 13 leaves flowered inconsistently (must be at least 13 leaves)
Aquilegia -- most species	Columbine	At least 12 leaves; for some, at least 15 leaves for consistent bloom
Aster alpinus	Alpine Aster	Plants require at least 15 leaves to flower consistently
Astilbe arendsii	Astilbe	Plants with 5 to 6 leaves flowered very inconsistently (must be at least 6 leaves)
Chrysanthemum coccineum	Painted Daisy	Plants require at least 15 leaves to flower consistently
Coreopsis grandiflora Sunray	Tickseed	Plants require about 16 leaves to flower consistently
Delphinium x *elataum*	Delphinium	Plants with 4 to 5 leaves flower
Echinacea purpurea	Purple Coneflower	Plants with 4 leaves flower
Euphorbia epithymoides	Cushion Spurge	Plants with 6 to 8 leaves failed to flower (must be greater than 8 leaves)
Goniolimon tatarica	German Statice	Plants with 10 to 14 leaves failed to flower (must be greater than 14 leaves)
Heuchera sanguinea	Coral Bells	Plants require 16 leaves to flower consistently
Lavandula angustifolia	Lavender	Most consistent flowering with 40 to 50 leaves
Lobelia x *speciosa* Compliment Scarlet	Lobelia	Plants with 6 to 7 leaves will flower
Papaver orientale Brilliant	Oriental Poppy	Plants with 10 to 14 leaves failed to flower (must be greater than 14 leaves)
Physostegia virginiana	Obedient Plant	Plants require at least 10 leaves to flower consistently
Rudbeckia fulgida Goldsturm	Gloriosa Daisy	Plants require 10 leaves for flowering
Veronica spicata Blue	Speedwell	Plants with 6 to 8 leaves will flower

*From Cameron et al., 1996b.

long day treatment for flowering. Another example would be varieties of Carpathian harebell (*Campanula carpatica*) grown from cuttings (however, most are grown from seed). Work conducted at Michigan State University (Whitman et al., 1995) indicates that for *C. carpatica*, a minimum of 15 leaves is required prior to start of inductive long day treatment, so rooted *C. carpatica* cuttings would need to attain 15 leaves to be receptive to long day treatment.

Vegetative Dormancy: Many perennials have evolved into species that will enter a vegetative dormancy to protect the plant from harsh winter temperatures. For some species of perennials, the short day conditions of autumn trigger this dormancy response. A good example is bleeding heart (*Dicentra spectabilis*). Bleeding heart plants will continue to grow vegetatively if kept in long daylengths (if temperatures are not to high and plants do not dry out) , but become dormant in short daylengths. Once dormant, a cold treatment is required to resume growth and subsequent flowering (Weiler, 1996). Bleeding heart will also go dormant during the summer in the South, mainly due to temperature and water stress (Armitage, 1989). Producers should be aware of potential vegetative dormancy and the environmental factors that control it in species they intend to produce.

Flower Formation: Flowering is caused by a cold treatment or specific daylength control (usually long days are required for flowering) in

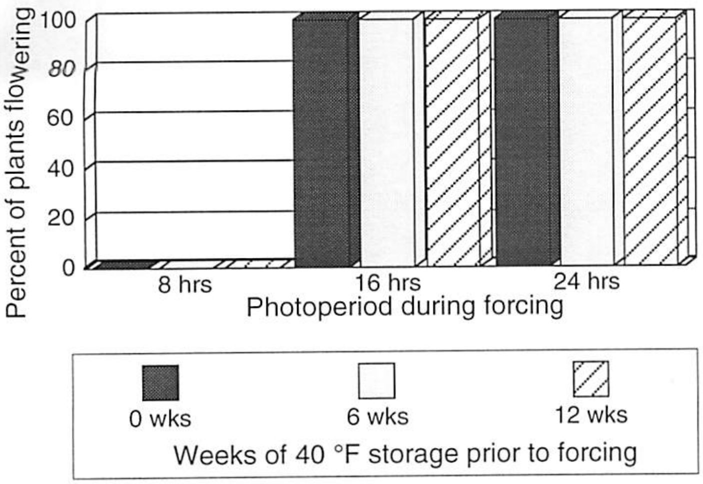

Figure 6. Effect of photoperiod and cold storage duration on flowering of Sedum spectabile. Note that cold storage had no effect on flowering. Figure adapted from Weiler, 1996.

many perennials (Table 7). An example species requiring cooling is Columbine, which required 10 weeks or more of 40 °F treatment for 100% flowering (Figure 5). An example species requiring photoperiod control without a cold treatment is Showy Stone Crop (*Sedum spectabile*), which requires long days for flowering (Figure 6). Some species such as Japanese Anemone (*Anemone* x *hybrida*), require both cold storage and photoperiod control for flowering (Figure 7). Growers should be cognizant of flowering requirements for perennials in order to successfully set flowers and time their crops.

The Integrated Production System: The diversity in perennial species may make them appealing to the customer, but it makes streamlining their production quite difficult. Since different plants have different requirements for growth and development, it is crucial to know the species you intend to produce and know their stages of development and the factors controlling their development. However, we do not have that information for all species produced.

Allan Armitage has summarized how to approach perennial forcing in general and has outlined four basic rules to follow (Armitage, 1996b). Fortunately, there are very few species that fall outside of his "cookbook" approach to forcing perennials in the greenhouse.

Unless you have more precise information, the steps listed on the following page are perhaps the best place to begin:

❶ **Learn about the plant.**

- Research the plant and how it is propagated using general perennial references such as Armitage, 1989; Jelitto and Schacht, 1990; Nau, 1996; and Still, 1988.
- Take note of its growth and development:
  - --Is it tall or short?
  - --Does it bloom in the spring, summer, or fall?
  - --Does it flower with many leaves, a few leaves, or no leaves?
  - --Will a single plant fill the container?

❷ **All species should be cooled before being forced.**

- Cool as plugs (or in small containers) in a cooler or in the greenhouse; or purchase precooled material.

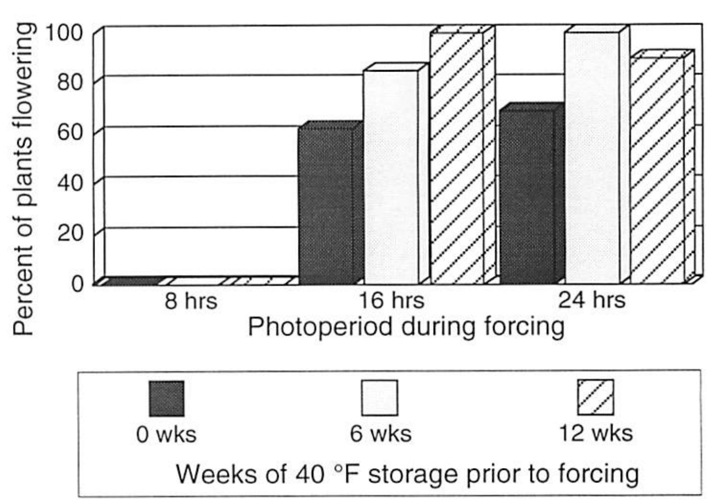

Figure 7. Effect of photoperiod and cold storage duration on flowering of Anemone x *hybrida. Note that both cold storage and long days were needed for best flowering. Figure adapted from Weiler, 1996.*

• Cooling is beneficial for most species and will not harm those plants that have no response to cooling, so cool as insurance.
• Cooled plants spend less time on the forcing bench resulting in lower forcing costs.

• Most species require about 6 weeks of cooling at 40 °F in a cooler. From 8 to 10 weeks may be required in a greenhouse, as temperatures will rise above effective cooling temperatures during the day. Use these durations as a starting point and adjust as needed or as information for

Table 7. The influence of long days (4-hour night break) and cold temperatures (40 °F storage for 6 to 16 weeks [species dependent]) on flowering of selected perennials.*

	No Response to Long Days	Long Days Beneficial	Long Days Required
No Response to Cold	*Aquilegia* x *hybrida* - cultivars that do not require cold (e.g. Songbird series) *Cerastium tomentosum* (NO LD and no cold for foliage only) *Perovskia atriplicifolia* *Primula* x *hybrida* 'Pacific Giants'	*Leucanthemum* x *superbum* 'Snow Lady'	*Asclepias tuberosa* (if no SD**) *Campanula carpatica* 'Blue Clips' (if no SD) *Catananche caerulea* *Coreopsis grandiflora* 'Early Sunrise' *Coreopsis verticillata* 'Moonbeam' *Hibiscus moscheutos* 'Disco Bell Mixed' (if no SD)
Cold Beneficial	*Arabis albida* 'Snow Cap', 'Spring Charm', 'Compinkie' *Armeria maritima* *Armeria pseudoarmeria* *Armeria* x *hybrida* 'Ornament Mix' *Aubrietia deltoidea* 'Royal Red', 'Whitewall Gem' *Delphinium elatum* 'Blue Mirror' *Dianthus deltoides* 'Zing Rose' *Erodium reichardii* 'Roseum' *Myosotis sylvatica* 'Victoria Rose', 'Victoria Blue' *Platycodon grandiflorus* 'Astra' *Veronica spicata* 'Blue'	*Anchusa capensis* 'Blue Bedder' *Anemone sylvestris* *Echinacea purpurea* 'Bravado' *Lobelia* x *speciosa* 'Compliment Scarlet' *Oenothera tetragona* *Phlox subulata* *Platycodon grandiflorus* 'Sentimental Blue' *Scabiosa caucasica* 'Butterfly Blue'	*Gypsophila paniculata* 'Double Snowflake' *Oenothera missouriensis* *Rudbeckia fulgida* 'Goldsturm'
Cold Required	*Arabis sturii* *Aster alpinus* 'Goliath' *Aquilegia* x *hybrida* - hybrids that require cold *Heuchera sanguinea* 'Bressingham Hybrids' *Iberis sempervirens* 'Snowflake' *Linum perenne* 'Saphyr' *Veronica longifolia* 'Sunny Border Blue'	*Astilbe* x *arendsii* *Cerastium tomentosum* (for flowers) *Coreopsis grandiflora* 'Sunray' *Gaillardia* x *grandiflora* 'Goblin' *Gypsophila repens* *Lavandula angustifolia* 'Munstead Dwarf' *Salvia superba* 'Blue Queen'	*Achillea filipendulina* 'Cloth of Gold' *Anemone* x *hybrida* *Asclepias tuberosa* (after SD) *Chrysanthemum coccineum* 'James Kelway' *Lavandula angustifolia* 'Hidcote' *Physostegia virginiana* 'Alba'

*From Armitage, 1996a; Armitage, 1996b; and Cameron et al., 1996a. No response to a treatment means there is no need to apply that treatment; plant quality will be about the same either way. A beneficial treatment means flowering will either occur more rapidly or more uniformly; or plant quality will somehow be enhanced by applying the treatment. A required treatment means that flowering will not occur in a reasonable length of time unless the treatment is applied.

**SD = short days.

specific plants becomes available (e.g., see Hamaker et al., 1996a; Whitman et al., 1996; and Yuan et al., 1996).

- Some plants may not be receptive to cold treatment until they reach a certain size (effect of juvenility or reproductive vegetativeness). Make sure plants are of adequate size prior to cold treatment.
- Do no allow plants to dry out or to remain too moist during the cooling stage.

❸ **The greenhouse must be outfitted with lights for long days (LD).**

- Use incandescent lights (or metal halide HID lights) for lighting during natural short day conditions.
- Although many perennials are day neutral (see Table 7), some greatly benefit from LD treatment.
- Light intensity should be between 10 and 20 footcandles to effectively create LD conditions.
- Day neutral plants will not be adversely affected if LD are provided.
- Apply lights as a 4 hour night break (10:00 PM to 2:00 AM). This technique appears to be as effective as extending the natural daylength and in many cases, is less expensive.
- Lighting can be stopped when daylength is greater than 13 hours.

❹ **After completion of the cold treatment, plants may be grown warm or cool.**

- Growing plants at low (40 to 50 °F nights) makes sturdier plants, but more time is needed for forcing.
- Warmer (60 to 68 °F nights) temperatures can be used without sacrificing much plant quality, and less time will be required during forcing. Warmer temperatures can increase stretching, especially under low light.

Growth Regulators: Most spring flowering perennials will not require height control unless day temperatures are too high and/or light intensity is too low. The most commonly used chemical growth regulator for perennials is B-Nine applied at 3,000 to 5,000 ppm as a spray. Example species that respond to this treatment are columbine, candytuft, forget-me-not, phlox, and salvia (Armitage, 1996a; Latimer, 1994). Cycocel at 750 to 1,500 is effective on balloon flower, pinks, and English daisy as a drench or a spray (Armitage, 1996a). A-Rest, Bonzi and Sumagic are also useful on some crops (Table 8). Check labels prior to use to assure chemicals are registered for use on the crop needing height control.

Nutrition: Nutrient requirements are temperature dependent. Armitage (1996a) offers the following suggestions for fertilizing perennials: When growing plants at cooler temperatures, 50 to 100 ppm nitrogen at each watering should be sufficient for most species. As temperatures increase, increase the concentration to 100 to 200 ppm nitrogen. Use a mixture of calcium nitrate and potassium nitrate to feed perennials. Avoid high ammonium-N fertilizers such as 20-20-20, especially when temperatures are cool. Once flowering occurs, reduce the concentration to about 100 ppm nitrogen supplied with potassium nitrate.

Parting Perennial Shots

We have concentrated on forcing flowering perennials, but you should also consider producing "foliage" perennials, grown for their attractive leaves. Hostas, ferns, and ornamental grasses are tremendously popular right now. Producing them in warm greenhouse conditions will put you ahead of growers utilizing field or hoop-house (overwintering house) production schedules. Shade tolerant hostas and ferns can be forced under existing benches and in shady corners of the greenhouse.

This information deals in generalities and draws upon details when available. Propagation techniques, cold storage durations, and photoperiod responses still need defining for many perennials produced today. Hopefully the

Table 8. Response of 35 species of herbaceous perennials to repeated spray applications (every 10 days from established transplants to flowering) of 100 ppm A-Rest, 5,000 ppm B-Nine, 30 ppm Bonzi, 1,500 ppm Cycocel, or 15 ppm Sumagic.*

Species		Response to chemical growth retardant				
Plant name	Common name	A-Rest	B-Nine	Bonzi	Cycocel	Sumagic
Achillea millefolium Summer Pastels	Common Yarrow	moderate	moderate	slight	no response	moderate
Alcea rosea Chater's Double Mix	Hollyhock	no response	moderate	moderate	strong	strong
Asclepias tuberosa	Butterfly Weed	moderate	strong	moderate	no response	strong
Aster alpinus Alpine Mix	Alpine Aster	no response	moderate	slight	no response	no response
Astilbe arendsii Bressingham Beauty	Astilbe	slight	no response	slight	slight	no response
Campanula carpatica Blue Clips	Carpathian Harebell	strong	strong	strong	strong	strong
Campanula persicifolia Blue	Bellflower	slight	moderate	no response	no response	no response
Centaurea montana Violet	Mountain Bluet	no response	moderate	no response	no response	moderate
Chelone glabra	Turtlehead	no response	no response	no response	no response	no response
Chrysanthemum coccineum J. Kelway	Painted Daisy	slight	moderate	no response	strong	no response
Coreopsis grandiflora Sunray	Tickseed	slight	strong	no response	no response	strong
Coreopsis verticillata Moonbeam	Threadleaf Coreopsis	no response	strong	no response	no response	moderate
Delphinium x *elataum* Mix	Delphinium	slight	no response	moderate	no response	strong
Echinacea purpurea Bravado	Purple Coneflower	moderate	slight	slight	strong	slight
Gaillardia x *grandiflora* Burgundy	Blanket Flower	no response	no response	no response	no response	no response
Gaura lindheimeri Whirling Butterflies	Gaura	no response	no response	no response	no response	no response
Gypsophila paniculata Double Snowflake	Baby's-breath	no response	no response	slight	slight	no response
Helenium autumnale	Sneezeweed	no response	moderate	no response	no response	no response
Hemerocallis Hall's Pink	Daylily	moderate	no response	no response	no response	slight
Heuchera sanguinea Bressingham	Coral Bells	no response	slight	no response	no response	slight
Hibiscus x *hybrida* Disco Belle Mix	Mallow	slight	slight	slight	strong	strong
Lavandula angustifolia Munstead Dwarf	Lavender	slight	moderate	no response	no response	strong
Leucanthemum x *superbum* Marconii	Shasta daisy	no response	no response	moderate	no response	strong
Linum perenne Saphire	Flax	moderate	no response	slight	no response	no response
Lobelia x *hybrida* Queen Victoria	Cardinal Flower	moderate	moderate	slight	slight	strong
Lobelia x *speciosa* Compliment Scarlet	Lobelia	moderate	moderate	slight	slight	strong
Perovskia atriplicifolia	Russian Sage	moderate	moderate	slight	slight	moderate
Phlox paniculata Eva Cullum	Summer Phlox	no response	no response	slight	slight	slight
Physostegia virginiana Summer Snow	Obedient Plant	no response	no response	no response	no response	no response
Rudbeckia fulgida Goldsturm	Gloriosa Daisy	slight	slight	slight	slight	no response
Salvia x *superba* Blue Queen	Sage	no response	moderate	no response	no response	moderate
Sedum spurium Dragon's Blood	Sedum	no response	no response	slight	no response	moderate
Veronica longifolia Red Fox	Speedwell	moderate	moderate	slight	no response	strong
Veronica longifolia Sunny Border Blue	Speedwell	strong	strong	strong	no response	strong
Veronica spicata Blue	Speedwell	strong	moderate	no response	no response	strong

*From Hamaker et al., 1996b. Note that these are reported responses to the chemical growth retardants and NOT commercial recommendations.

☐ = no response ☐ = slight response ☐ = moderate response ■ = strong response tools offered here will make your exploration into perennial production more profitable.

Literature Cited

Armitage, A.M. 1989. Herbaceous perennial plants: a treatise on their identification, culture, and garden attributes. Varsity Press, Inc. Athens, Ga.

Armitage, A.M. 1993. Forcing perennials for early spring sales. Professional Plant Growers Assn. Nwsl. 24(6):2–3.

Armitage, A.M. 1996a. Forcing perennials in the greenhouse. GrowerTalks. 60(3):86, 88, 93–94, 96–97.

Armitage, A.M. 1996b. User-friendly forcing for perennials. Greenhouse Grower. 14(3):96–97.

Cameron, A., R. Heins, and W. Carlson. 1996a. Forcing herbaceous perennials. Professional Plant Growers Assn. Nwsl. 27(7):3.

Cameron, A., M. Yuan, R. Heins, and W. Carlson. 1996b. Juvenility: your perennial crop's age affects flowering. GrowerTalks 60(8):30–32, 34.

Groff, D. 1991. Producing perennial starter plants. Presentation at the International Floriculture Industry Short Course, Cincinnati, Ohio, on 17 July 1991.

Hamaker, C.K., R. Heins, A. Cameron, and W. Carlson. 1996a. Forcing perennials crop by crop: threadleaf coreopsis. Greenhouse Grower 14(8):43–46.

Hamaker, C.K., B.E. Engle, R.D. Heins, W.H. Carlson, and A.C. Cameron. 1996b. Using growth regulators to control height of herbaceous perennials. GrowerTalks 60(6):46–47, 50, 53.

Jelitto, L. and W. Schacht. 1990. Hardy herbaceous perennials. 3rd ed. Timber Press. Portland, Ore.

Karlovich, P.T. 1995. The pros and cons of producing perennials from seeds. Greenhouse Management and Production. 14(7):37, 41–42.

Latimer, J.G. 1994. Growth regulators on perennials. Presentation at the Southeast Greenhouse Conference and Trade Show on 17 June 1994 in Greenville, S.C.

Nau, J. 1993. Ball culture guide: the encyclopedia of seed germination. 2nd ed. Ball Publishing. Batavia, Ill.

Nau, J. 1996. Ball perennial manual: propagation and production. Ball Publishing. Batavia, Ill.

Rhodus, T. 1995. Top 20 perennials. Greenhouse Grower. 13(1):80, 82, 84.

Still, S. 1988. Manual of herbaceous ornamental plants. 3rd ed. Stipes Publishing Co. Champaign, Ill.

Weiler, T.C. 1996. Forcing perennials. Presentation at the Southeast Greenhouse Conference and Trade Show on 14 June 1996 in Greenville, S.C.

Whitman, C., R. Heins, A. Cameron, and W. Carlson. 1995. Production guide for *Campanula carpatica* as a flowering potted plant. Professional Plant Growers Assn. Nwsl. 26(4):2–4.

Whitman, C., R. Heins, A. Cameron, and W. Carlson. 1996. Forcing perennials crop by crop: lavender. Greenhouse Grower 14(5):37–40.

Yuan, M., R. D. Heins, A. Cameron, and W.H. Carlson. 1996. Forcing perennials crop by crop: tickseed. Greenhouse Grower 14(6):57–60.