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Research funded by:

American Floral Endowment

This 7-part series from Michigan State University, brought to you by GMPRO/Greenhouse Management & Production discusses how perennials can be commercially grown as indoor flowering plants that can then be moved outdoors and planted in the garden. Individual articles of the introduction and specific crops appeared in the January-July 2002 issues of GMPRO.

INTRODUCTION

Programming perennials for early sales is a relatively recent discovery. Retailers have benefited from programmed perennials because these plants, like annuals, sell better when they have flowers and are in color.

What would the commercial potential be to growers and retailers of using perennials as indoor flowering pot plants before they were planted outdoors?

Observing these programmed perennials led Michigan State University researchers to identify some that are suited for indoor flowering plants. These plants have a more compact habit and are quite floriferous. Upon further observation, some plants were quite impressive in their ability to look good, even after two weeks indoors.

Some industry professionals and gardeners believe that forcing perennials and marketing them to consumers is misleading since it could ruin the flowering potential in subsequent years. In trials (including plantings made in the MSU demonstration gardens and the researchers’ backyards), no serious problems were observed with the performance of the plants if they had been forced.

Indoor/outdoor trials

A grant from the American Floral Endowment enabled MSU researchers to initiate experiments in market potential, controlled flowering and postharvest and subsequent garden performance of selected forced herbaceous perennials. The project has generated information that growers and retailers can use to help them properly value and price their products, as well as provide information on the post-sale nature of the plants.

There are two specific objectives of this research:

- Modify production methods to produce more compact plants in 4- to 5-inch (some may be appropriate for 6-inch) containers that are suitable for marketing as indoor pot plants.
- Quantify the performance of these plants indoors as potted plants and afterwards in the garden.

These programmed perennials were compared to the performance of traditional perennials.

Originally, several perennial species were selected based on their suitability as pot plants, consumer popularity and their potential programming properties.

The species planted the first year were Aquilegia flabellata Cameo Mix, Campanula carpatica ‘Blue Clips,’ Campanula ‘Birch Hybrid,’ Coreopsis grandiflora ‘Sunray,’ Echinacea purpurea ‘Muns,’ Lavandula angustifolia ‘Hidcote Blue’ and Leucanthemum x superbum ‘Snowcap.’ Other species that have been studied include Gaura lindheimeri ‘Whirling Butterflies,’ Geranium dalmaticum, Pennisetum setaceum ‘Rubrum’ and Veronica spicata ‘Red Fox.’ Although pennisetum is not a perennial in Michigan, it has become a popular garden plant within the past few years and warranted inclusion in the study.

Ten plants of each species were used as a comparison or control group, which were grown in a 62°F greenhouse with natural light. Plants in the four other treatments were forced in the greenhouse. Half of the
INTRODUCTION CONTINUED

forced plants were programmed to flower on May 15 and the other half were programmed to flower on June 1.

Plants that flowered on May 15 were subjected to a three-day shipping simulation (no water and no light), followed by two weeks of in-store display simulation (72°F under fluorescent lights). The postharvest treatment ended when the other forced plants flowered on June 1. All the plants were then transplanted into outdoor flower beds on the MSU campus in East Lansing (USDA Hardiness Zone 5).

The trial beds were dug to a depth of 24 inches and the poor soil removed. Initially there were some drainage problems, which were overcome by slightly raising the beds. Beds were in full sun and no overhead irrigation was available until the second year.

At planting, half of the plants programmed to flower on May 15 and June 1 were cut back 2-3 inches above the ground before transplanting. Plants were installed on 1- to 2-foot centers on May 31, 1999. Typical landscape maintenance activities included removing dead flowers, weeding the beds and supplemental irrigation. Fertilization was applied annually with a slow-release fertilizer at planting.

Data collected included: flower, foliage and plant quality, percent of plants in flower and for those plants in flower, what was in bud, open or fading. Quality data were based on All-America Selections' standards (5=excellent, 4=good, 3=average, 2=poor, 1=unacceptable). Data were collected weekly for first-season plants until the first frost (Oct. 5, 1999, and Oct. 1, 2000). Data for second-season plants were collected monthly except during flowering when it was collected weekly. After analyzing the data, we found some plants did well indoors and out, while others were better suited to one location or the other.

Categorizing the plants

Based on their postharvest and garden performance, the plants were grouped into four categories.

The first group contained plants that were generally good candidates for forcing, showed adequate postharvest life and tolerated low-light levels before being moved into the garden. They also showed good garden performance, earning them the classification “good in the home, great in the garden.”

The second category performed well indoors but didn’t show good performance outdoors, earning the classification “good in the home.” This second category may offer some new products for the florist or interior pot plant market.

The third category didn’t perform as well outdoors, but forced well and showed good garden performance. These plants are still great for forcing exclusively for garden center sales then planting directly outdoors in the garden. Forcing appeared to have little detrimental effect on the garden performance of any of the forced plants.

The fourth category of plants didn’t fare well in the studies at all. These plants may be great in the garden in some areas of the country, but they need much more work before they can be included in another category.

1. Good in the home, great in the garden

Plants in this category showed no detrimental effect on garden performance as a result of forcing or postharvest treatment. All treatments generally performed equally well. Cutting back plants at installation did not greatly improve garden performance.

These plants may be forced successfully for an early market date, to be used first indoors, or they may be marketed for use only outdoors.

Coreopsis grandiflora ‘Sunray’ was a bit leggy for a small container, but forced nicely. It really performs after forcing when placed in the garden. Echinacea purpurea ‘Magnus’ forced well, with some irregularity in height, but had a slight fragrance and good interior performance. As the 1998 Perennial Plant of the Year, it was expected to perform well outdoors, and it did.

Another perennial commonly found in European homes is lavender. ‘Hidcote Blue’ performed well both indoors and in the garden. Lavender is well known and recognized by retailers and consumers. It is valued for its fragrance and should be an ideal candidate for dual use.

2. Good in the home, not in the garden

Plants that have potential in this category are Aquilegia flabellata ‘Cameo Mix,’ Campanula carpatica ‘Blue Clips,’ Campanula ‘Birch Hybrid’ and Geranium dalmaticum. Leucanthemum x superbum ‘Snowcap’ did well in both indoor and garden trials, but has an unpleasant odor that may not be evident until it is brought indoors.

Although Sedum ‘Brilliant’ was not one of the original plants studied, it did well outdoors and would make a good flowering pot plant. ‘Brilliant’ was superb indoors and looks a lot like a kalanchoe. Outdoors, it was not as good as Sedum ‘Autumn Joy,’ but it still performed well.

Although it’s not a perennial, Pennisetum setaceum ‘Rubrum’ should be considered for its colorful foliage. Its plumes add a nice feature.

The plants in this category show great potential for marketing as indoor potted plants, but some will require additional instructions to assist consumers interested in moving them outdoors.

3. Not good in the home, great in the garden

Flowers of Gaura lindheimeri ‘Whirling Butterflies’ absconded shortly after the plants were placed in the interior environment. The plants did well in the garden, but were too leggy and the flowers shattered to easily for further consideration as an indoor, forced pot plant.

Like gaura, Perovskia atriplicifolia ‘Longin’ is great in the garden but not a viable candidate for indoor enjoyment. Flowers shattered very quickly and created a messy appearance.

Saxifraga arendsii ‘Triumph’ was another plant that was forced, but not included in the formal study. ‘Triumph’ didn’t do well as an indoor plant, but makes a great rock garden plant.

4. Not good in the home or garden

Delphinium ‘Butterfly Blue’ had attractive blue flowers, but it didn’t fare well in the study. Perhaps another cultivar may be worth investigating.

The remaining six articles in this series will focus on individual species, the steps needed to bring the plants into flower and their postharvest and garden performance.

Perennial production schedules in this booklet are based on research conducted by Royal Heins, Cathy Whitman, Leslie Finical, Erik Runkle, Hongwen Gao and ShiYing Wang.
**Potted herbaceous perennials**

<table>
<thead>
<tr>
<th>Herbaceous perennial</th>
<th>Rating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aquilegia flabellata</em> 'Cameo Blue &amp; Rose'</td>
<td>Interior ****</td>
<td>Looked really good as container plant. Great potential as an indoor plant. Already grown extensively in Europe. Does drop flowers after a week or two in low light.</td>
</tr>
<tr>
<td><em>Campanula carpatica</em> 'Blue Clips'</td>
<td>Garden ***</td>
<td>Struggles a bit in the garden since plants were small. Flowers in early spring, not much during summer. Not bad for a dwarf cumbine. Proclive seed production.</td>
</tr>
<tr>
<td><em>Campanula</em> 'Birch Hybrid'</td>
<td>Interior ****</td>
<td>Holds up well for two weeks. Makes an excellent container plant. Has been extensively produced as a pot crop in Europe.</td>
</tr>
<tr>
<td><em>Coreopsis grandiflora</em> 'Sunray'</td>
<td>Garden ***</td>
<td>Very nice in the interior environment. Holds up well for two weeks with wonderful flower show.</td>
</tr>
<tr>
<td><em>Coreopsis</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Delphinium</em> 'Butterfly Blue'</td>
<td>Garden ***</td>
<td>A great shot of yellow color, though plants tend to be shortlived. Performance not negatively affected by forcing.</td>
</tr>
<tr>
<td><em>Echinacea purpurea</em> 'Magnus'</td>
<td>Interior ***</td>
<td>Great potential as a container plant, but producing a uniform crop from seed is a real problem. Holds flowers for an extended time in the interior environment. Has a nice aroma indoors. Too tall if produced without plant growth regulators. Very nice and easily identified by consumers.</td>
</tr>
<tr>
<td><em>Echinacea purpurea</em> 'Triumph'</td>
<td>Interior ***</td>
<td>Prefers a cool, well-drained location in the garden. Didn’t do well in heavy clay soils in MSU test plots. No problems associated with forcing.</td>
</tr>
<tr>
<td><em>Eucalyptus</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Geranium dalmaticum</em></td>
<td>Garden ****</td>
<td>Holds up well for two weeks. Makes an excellent container plant. Has been extensively produced as a pot crop in Europe.</td>
</tr>
<tr>
<td><em>Gaura lindheimeri</em> 'Whirling Butterflies'</td>
<td>Interior ***</td>
<td>Good potential, but flowers turn black as they die (not very aesthetic). Continues to look good with regular dead-heading. Probably a little tall for a 4- to 5-inch container.</td>
</tr>
<tr>
<td><em>Gaura lindheimeri</em> 'Classic Blue &amp; Rose'</td>
<td>Garden ***</td>
<td>Really a rock garden plant that prefers cool temperatures and well-drained soils. All treatments died in the heavy clay soils in MSU test plots independent of forcing.</td>
</tr>
<tr>
<td><em>Herbaceous perennial</em></td>
<td>Safety</td>
<td></td>
</tr>
<tr>
<td><em>Heliopsis</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Hemerocallis</em></td>
<td>Interior ***</td>
<td>Good in the interior environment. Flower drop eventually increases under low light. Has attractive foliage. Its aroma is a real plus.</td>
</tr>
<tr>
<td><em>Leucanthemum x superbum</em> 'Snowcap'</td>
<td>Garden ***</td>
<td>Absolutely beautiful in the garden, a great performer. Forced plants are outstanding. No effect of forcing on overwinter survival. 'Siskyou Pink' and other great cultivars are available.</td>
</tr>
<tr>
<td><em>Lavandula angustifolia</em> 'Hidcote Blue'</td>
<td>Garden ****</td>
<td>A very popular garden perennial. Plant performance was not affected by forcing treatment. Excellent show the second summer.</td>
</tr>
<tr>
<td><em>Lavandula sarmentosa</em></td>
<td>Interior ***</td>
<td>Initially plants looked great but they declined quickly and became unattractive. Open flowers deteriorated and buds were not able to open properly. Plants also required more water than the others. After two weeks, plants had almost no ornamental value.</td>
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<td><em>Leucanthemum x superbum</em> 'Snowcap'</td>
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</tr>
<tr>
<td><em>Leucanthemum</em> 'Longin'</td>
<td>Garden ****</td>
<td>Held up well indoors. New flowers developed and were as nice as the originals. New leaves unfolded, increasing plant size. Flowers were lovely, but foliage was too large. If there was a way to make the foliage compact, this would be an attractive plant. These are tidy plants that are easy to care for as long as the soil is kept moist.</td>
</tr>
<tr>
<td><em>Lupinus</em></td>
<td>Interior ***</td>
<td>A very popular garden perennial. Plant performance was not affected by forcing treatment. Excellent show the second summer.</td>
</tr>
<tr>
<td><em>Lupinus</em></td>
<td>Interior ***</td>
<td>Great potential but was not impressive during two weeks in an interior environment. Flowers are a brilliant blue and purple combination. Each plant started out with many flowers and this made for a nice effect. Unfortunately, the flowers died rapidly and fell off if the plants were moved, making quite a mess. Can prevent flower abscission with STS.</td>
</tr>
<tr>
<td><em>Malope</em></td>
<td>Interior ***</td>
<td>Flowers for about three weeks and is then done until next year. Foliage turns reddish color that is attractive as summer progresses.</td>
</tr>
<tr>
<td><em>Oxalis</em></td>
<td>Garden ****</td>
<td>Good potential and value as a hanging basket. Hardy to Zone 5. Overwinter survival is a problem in Michigan, which is in Zone 5.</td>
</tr>
<tr>
<td><em>Penisetum setaceum</em> 'Rubrum'</td>
<td>Garden ****</td>
<td>A great garden performer. No evidence that forcing has a detrimental effect on garden performance or overwinter survival even after the second winter.</td>
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</tr>
<tr>
<td><em>Perovskia atriplicifolia</em> 'Longin'</td>
<td>Garden ***</td>
<td>Absolutely beautiful in the garden, a great performer. Forced plants are outstanding. No effect of forcing on overwinter survival. 'Siskyou Pink' and other great cultivars are available.</td>
</tr>
<tr>
<td><em>Salvia</em></td>
<td>Interior ***</td>
<td>Great potential. Foliage color is more intense when produced under high light. Loss of purple color is a problem in the interior environment. Plants were less attractive after two weeks, but recovered nicely after transplanting into the garden.</td>
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LAVENDER

Lavandula angustifolia 'Hidcote Blue' is an economical plant to grow from seed. Its indoor postharvest life of 10-14 days and hardiness in the landscape make it a good plant for use in an indoor/outdoor flowering plant program.

Indoor postharvest performance
At room temperature (72°F) and under light levels that would be encountered indoors, 'Hidcote Blue' had a shelflife of about one week. After 10 to 14 days, flowers began to fade and abscise and some leaves began to droop. Under low interior light conditions, flower development ceased and, in some cases, visible buds aborted before flowers developed.

Lower temperatures could extend the plants' shelflife. Although they don't have the indoor longevity of orchids, 'Hidcote Blue' did show acceptable indoor postharvest performance.

'Hidcote Blue' lavender was produced from seed and some plants were more compact and had a longer shelflife than others. Strains with more compact foliage and flowers might be selected to improve postharvest performance of crops programmed to flower for indoor use.

Garden performance
At the time of outdoor planting, the control plants were beginning to flower along with plants programmed to flower on June 1. Throughout the growing season, both groups performed similarly in the garden and, with regular dead-heading, continued to flower until the end of September.

Initial flower and foliage quality of plants subjected to postharvest treatments were not as high as for plants moved directly from the greenhouse to the garden. However, the indoor plants recovered in the garden and by mid-August were similar in appearance to the others.

Shearing plants at time of outdoor planting removed all flower buds. Although plants recovered relatively quickly and were in full flower by the end of August, shearing lavender plants in the first year is not recommended, except for those plants with significant numbers of dead or dying branches and flowers.

Regardless of treatment, all plants transplanted outdoors survived the first and second winters, despite a relatively severe 2000-2001 winter. There were essentially no differences in plant performance during the second summer. In fact, toward the end of the second growing season, forced plants tended to be larger than control plants and received higher ratings.

As of May 15, 2001, plants from all treatments were similar with essentially no differences in appearance. So it appears that programming plants to flower as indoor pot plants had no detrimental effect on overwinter survival or long-term performance in USDA Hardiness Zone 5.

Production schedule
Lavandula angustifolia 'Hidcote Blue' can be forced as an indoor flowering pot plant. Produced from seed, plants are relatively uniform and economical to grow.

Plants can be forced to flower in seven to eight weeks following a 10-week vernalization treatment at 32°F-45°F Seedlings nicely fill a 4- to 5½-inch container. Larger starter material will produce an even larger final product and significantly more flowers. Larger finished plants would be expected to perform even better in the outdoor landscape.
Large numbers of forced lavender plants have been planted in the MSU trial gardens with excellent success and overwinter survival. The results of these studies confirm that there are no negative effects of forcing on garden performance.

*Lavandula stoechas* (Spanish lavender) is already being marketed as a potted flowering plant by some nurseries. It makes a beautiful potted flowering plant with long-lasting flowers, although it is not reliably hardy in Michigan.

After 3 days simulated shipping and 10-14 days under interior, postharvest conditions, flowers on forced plants began to fade and abscise and foliage began to droop.

Throughout the growing season, both the control plants and those forced into flower performed similarly in the garden and, with regular deadheading, continued to flower until the end of September.

**Lavandula angustifolia ‘Hidcote Blue’**

<table>
<thead>
<tr>
<th>Schedule date</th>
<th>Production activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 47</td>
<td>Receive 72-cell plugs and place them in a cooler at 41°F. Follow optional protocol for receiving plant material in the research greenhouses which includes: * Spray with 8 ounces of Avid per 100 gallons. * Drench with Marathon 60WP. * Drench with 8 ounces Truban/Cleary’s 3336 per 100 gallons. Plugs must have 40-50 leaves before cooling to ensure complete, uniform flowering.</td>
</tr>
<tr>
<td>Week 10</td>
<td>Transplant one plug per 4- to 5½-inch container using a high-porosity growing mix. Place plants under natural days at a temperature of 68°F.</td>
</tr>
<tr>
<td>Week 10-18</td>
<td>An adequate application of fertilizer is begun at each watering. Growing medium pH should be between 5.8 and 6.2 and electrical conductivity between 0.5 to 0.8. Adjustments may be made to these ranges, depending on performance of the plants. Monitor and maintain graphs of both pH* and EC** each week.</td>
</tr>
<tr>
<td>Week 10-18</td>
<td>Monitor for insect and disease problems. Use yellow sticky cards. Treat with appropriate insecticides if: * Five thrips are found on one card in one week. * Five whiteflies are found on one card in one week. * Five leaf miners are found on one card in one week. * Any aphids are found in the greenhouse.</td>
</tr>
<tr>
<td>Week 10-18</td>
<td>Every month, drench plants with a preventive fungicide treatment. Plotting graphs of plant height vs. week number can be used to monitor growth.</td>
</tr>
<tr>
<td>Week 18</td>
<td>Ship to market.</td>
</tr>
</tbody>
</table>

* pH was controlled by incorporating sulfuric acid into the irrigation water. Water pH was kept between 5.8 and 6.2. Growing media pH was controlled mainly by this method. ** EC was controlled by altering fertilizer concentrations. If EC was lower than 0.5, fertilizer was applied on the higher end of the 100-200 ppm range. If EC was higher than 0.8 using a 2:1 water-to-media dilution method, fertilizer was applied on the lower end of the 100-200 ppm range, depending on how much greater the value was than the target value of 0.8.
**Indoor postharvest performance**

'Blue Clips' campanula has been grown extensively in Europe as a flowering pot plant, and this study found it to have superior indoor performance. At room temperature (72°F) and under light levels comparable to those encountered indoors, 'Blue Clips' and 'Birch Hybrid' had a good flower show for up to two weeks. Flower quality diminished after 10 to 14 days of postharvest treatment. Newly developed flowers were smaller with less intense coloration, and fewer of these flower buds opened. Although the flowers were ornamental, asymmetrical foliage detracted from the overall appeal of 'Birch Hybrid.'

**Garden performance**

'Blue Clips' showed no negative effect in garden performance as a result of forcing or postharvest treatment. All treatments performed equally well. Cutting back foliage at planting did not improve garden performance. As a result, plants can be forced successfully for an early market date, to be used first indoors, or they can be marketed for outdoor use only.

On June 1, 1999, control plants began to flower along with plants programmed to flower on the same date. Plants that were cut back at planting reflowered two weeks later during week 25 (June 22).

Plants not cut back at planting flowered continuously throughout summer and all plants produced flowers until week 31 (Aug. 1). Control plants continued to flower until week 33 (Aug. 15).

Foliage and plant quality initially declined in response to postharvest treatment. Forced plants showed a lower percentage of flowers. However, this seemed to be corrected by cutting back foliage at planting.

In 2000, plants that were cut back showed a decrease in overall plant quality during the flowering period. Flowering for all plants peaked during week 26 (June 27) and flower quality ranged from average to good (3-4). Percentage of plants in flower ranged from 70 to 100 percent. Total flowering time was six weeks ranging from week 25 to week 30 (June 20-July 25).

'Birch Hybrid' can be successfully marketed for indoor and outdoor use with the suggestion that foliage be cut back at planting. Programmed forcing had no effect on garden performance on these plants in 1999 and 2000 when the plants were cut back at planting.

Initially after planting in 1999, 'Birch Hybrid' plants flowered for two weeks. Cutting back the foliage at planting helped produce a second flush of flowers and produced plants with better overall quality from July to September. Plants that were cut back reflowered week 28 (July 8). Plants that were not cut back reflowered two weeks later during week 30.

'Blue Clips' (left) and 'Birch Hybrid' (right) campanulas had a good flower show for up to two weeks when placed indoors.
time was four weeks from week 20 to 23 (May 13-June 9).

In-store sales study

Four-inch potted flowering ‘Blue Clips’ were sold in floral departments of three retail supermarket chain stores from May 5-20 and from June 16-July 1, 2000. The purpose was to determine whether repositioning campanula as an indoor flowering pot plant would add to floral department sales or detract from sales of more traditional flowering pot plants.

Sales for all 4- and 4%-inch flowering potted plants stocked in three supermarket floral departments in Grand Rapids, Mich., were recorded weekly and compared with unit sales from three stores in the same market where campanula were not sold (control). Sales for campanula were similar to those of traditional flowering potted plants frequently stocked in floral departments.

Unit sales for stores that did and did not stock campanula were similar. Therefore, adding campanula to the pot plant mix did not detract from or jeopardize sales of similar indoor flowering plants but could expand sales in this product category.

### Campanula ‘Birch Hybrid’

<table>
<thead>
<tr>
<th>Schedule date</th>
<th>Production activity</th>
</tr>
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</table>
| Week 3        | Receive 72-cell plugs and follow optional protocol for receiving plant material in the research greenhouses, which includes:  
- Spray with 8 ounces of Avid per 100 gallons.  
- Drench with Marathon 60WP.  
- Drench with 8 ounces Truban/Cleary’s 3336 per 100 gallons.  
- After providing the above treatment, place the plugs in a 41°F cooler. |
| Week 12       | Remove plants from cooler and transplant one plug per 5½-inch container using a high-porosity growing mix. Place plants under four hours of night interruption lighting at 68°F. |
| Week 12-18    | Every month, drench plants with a preventive fungicide treatment. Plotting graphs of plant height vs. week number can be used to monitor growth. |
| Week 12-18    | An adequate application of fertilizer is begun at each watering. Maintain growing medium pH between 5.8 and 6.2 and electrical conductivity between 0.5 and 0.8 (EC measured using 2:1 distilled water:media method). Adjustments may be made, depending on plant performance. Plant growth can be graphed weekly along with pH* and EC.** |
| Week 12-18    | Monitor for insect and disease problems. Use yellow sticky cards. Treat with appropriate insecticides if:  
- Five thrips are found on one card in one week.  
- Five whiteflies are found on one card in one week.  
- Any aphids are found in the greenhouse. |
| Week 18       | Ship to market. |

* pH was controlled by incorporating sulfuric acid into the irrigation water. Water pH was kept between 5.8-6.2. The growing media pH was controlled mainly by this method.  
** EC was controlled by altering fertilizer concentrations. If the EC was lower than 0.5, fertilizer was applied on the higher end of the 100-200 ppm range. If the EC was higher than 0.8, fertilizer was applied on the lower end of the 100-200 ppm range, depending on how much greater the value is than the target value of 0.8.

### Campanula carpatica ‘Blue Clips’

<table>
<thead>
<tr>
<th>Schedule date</th>
<th>Production activity</th>
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| Week 51       | Receive 72-cell plugs and follow optional protocol for receiving plant material in the research greenhouses, which includes:  
- Spray with 8 ounces of Avid per 100 gallons.  
- Drench with Marathon 60WP.  
- Drench with 8 ounces Truban/Cleary’s 3336 per 100 gallons. |
| Week 51       | Every month, drench plants with a preventive fungicide treatment. Plotting graphs of plant height vs. week number can be used to monitor growth. |
| Week 10       | If plants have fewer than nine to 12 nodes, increase growth by providing them with a 12-hour photoperiod before cooling. After reaching adequate size, place the plants in a 41°F cooler. Cold treatment is not required, but enhances flowering. |
| Week 10-18    | Remove plants from cooler and transplant one plug per 5½-inch container using a high-porosity growing mix. Place plants under four hours of night interruption lighting at 68°F. |
| Week 10-18    | An adequate application of fertilizer is begun at each watering. Maintain growing medium pH between 5.8-6.2 and electrical conductivity between 0.5 and 0.8 (EC measured using 2:1 distilled water:media method). Adjustments may be made, depending on plant performance. Plant growth can be graphed weekly along with pH* and EC.** |
| Week 12-18    | Monitor for insect and disease problems. Use yellow sticky cards. Treat with appropriate insecticides if:  
- Five thrips are found on one card in one week.  
- Five whiteflies are found on one card in one week.  
- Any aphids are found in the greenhouse. |
| Week 18       | Ship to market. |

* pH was controlled by incorporating sulfuric acid into the irrigation water. Water pH was kept between 5.8-6.2. The growing media pH was controlled mainly by this method.  
** EC was controlled by altering fertilizer concentrations. If the EC was lower than 0.5, fertilizer was applied on the higher end of the 100-200 ppm range. If the EC was higher than 0.8, fertilizer was applied on the lower end of the 100-200 ppm range, depending on how much greater the value is than the target value of 0.8.
AQUILEGIA

Aquilegia (columbine) is successfully marketed in Europe as an indoor flowering plant. It has demonstrated it can perform both indoors and in the garden. The compact cultivars are particularly well suited for indoor use and their wide color range should make them appealing to many consumers.

Indoor postharvest performance
At room temperature (72°F) and under light levels that would be encountered indoors, Aquilegia Cameo Mix held a good flower show for one to two weeks. Flowers remained intact during most of the evaluation period and few signs of deterioration were evident during the first 10 days. Its large flowers and delicate foliage made Cameo Mix more attractive and colorful than many other container-grown perennials.

Garden performance
Cameo Mix plants performed well in garden performance trials, even after two weeks in a postharvest environment. It should be well-suited for planting after use in the home. Though great as a container plant, Cameo Mix has a compact habit and has less impact in the garden than other aquilegia varieties.

Overall, for both years, there was no benefit to cutting back foliage at planting. In the first year, the foliage of plants that received postharvest treatments deteriorated by late summer. However, plants in all treatments survived and reflowered with no difficulty.

After initial planting, all plants stopped flowering around June 10 (Week 24). In the second year, peak flowering for all plants occurred at the end of April (Week 18), and flower quality ranged from good to excellent. Outdoors the second year, total flowering time was four weeks, from April 22 to May 19 (Weeks 17 to 20). All aquilegia, including Cameo Mix, reseed readily and this can be used as a means of renewal since aquilegia is generally a short-lived perennial.

Marketability
Aquilegia is already successfully marketed in Europe as an indoor flowering pot plant. It can be considered for home and garden use because of its adequate indoor postharvest longevity and outdoor performance.

We believe compact aquilegia cultivars, like Cameo Mix, have great potential as indoor flowering potted plants. Its compact habit and relatively large flower size compared to its foliage make it adorable in a small container. Cameo Mix adequately fills a 4-inch pot, or smaller and would be ideal for miniature pots.

The colors found in Cameo Mix, particularly rose and blue, are striking. Blue is a hot color in the garden...
and would probably be a desirable color for indoor use as well. Rose flowers make a striking contrast with the delicate green foliage and should have great appeal to the traditional flowering pot plant consumer. Even though the postharvest longevity of Cameo Mix is seven to 10 days, this is a reasonable amount of time for a consumer to enjoy a flowering potted plant indoors. Cameo Mix is quite striking up close, making it suitable for a desk or kitchen table.

### Aquilegia flabellata Cameo Mix

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<th>Schedule date</th>
<th>Production activity</th>
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| Week 51       | Receive 72-cell plugs six to eight weeks after they have been sown and follow optional protocol for receiving material in the research greenhouses, which includes:  
• Spray with 8 ounces of Avid per 100 gallons.  
• Drench with Marathon 60WP.  
• Drench with 8 ounces Truban/Cleary’s 3336 per 100 gallons. |
| Week 51       | Transplant one plug per 4-inch pot using a high-porosity growing mix. Place plants under natural days to increase size. Maintain 68°F average daily temperature. |
| Week 6        | Place plants in a 41°F cooler. |
| Week 13       | Remove from cooler and place plants in a greenhouse under natural days. Maintain 68°F average daily temperature. |
| Week 13-18    | An adequate application of fertilizer is begun at each watering. Maintain growing medium pH between 5.8-6.2 and electrical conductivity between 0.5-0.8 (EC measured using 2:1 distilled water:media method). Adjustments may be made, depending on plant performance. Plant growth can be graphed weekly along with pH* and EC**. |
| Week 13-18    | Monitor for insect and disease problems. Use yellow sticky cards. Treat with appropriate insecticides if:  
• Five thrips are found on one card in one week.  
• Five whiteflies are found on one card in one week.  
• Five leaf miners are found on one card in one week.  
• Any aphids are found in the greenhouse.  
Every month, drench plants with a preventive fungicide treatment. |
| Week 13-18    | Plot graphs of plant height vs. week number to monitor growth. |
| Week 18       | Ship to market. |

* pH was controlled by incorporating sulfuric acid into the irrigation water. Water pH was kept between 5.8-6.2. The growing media pH was controlled mainly by this method.  
** EC was controlled by altering fertilizer concentrations. If the EC was lower than 0.5, fertilizer was applied on the higher end of the 100-200 parts per million range. If the EC was higher than 0.8, fertilizer was applied on the lower end of the 100-200 ppm range, depending on how much greater the value is than the target value of 0.8.

### Aquilegia x hybrida ‘Bluebird’

<table>
<thead>
<tr>
<th>Schedule date</th>
<th>Production activity</th>
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| Week 49       | Receive 72-cell plugs eight to 10 weeks after they have been sown and follow optional protocol for receiving material in the research greenhouses, which includes:  
• Spray with 8 ounces of Avid per 100 gallons.  
• Drench with Marathon 60WP.  
• Drench with 8 ounces Truban/Cleary’s 3336 per 100 gallons. |
| Week 49       | Pot into 5½-inch pots using a bark-based high-porosity growing mix. Place plants under natural days to increase size. Maintain 68°F average daily temperature. |
| Week 2        | Place plants in a 41°F cooler. |
| Week 11       | Remove from cooler and place plants in a greenhouse under natural days. Maintain 68°F average daily temperature. |
| Week 11-18    | An adequate application of fertilizer is begun at each watering. Maintain growing medium pH between 5.8-6.2 and electrical conductivity between 0.5-0.8 (EC measured using 2:1 distilled water:media method). Adjustments may be made, depending on plant performance. Plant growth can be graphed weekly along with pH* and EC**. |
| Week 11-18    | Monitor for insect and disease problems. Use yellow sticky cards. Treat with appropriate insecticides if:  
• Five thrips are found on one card in one week.  
• Five whiteflies are found on one card in one week.  
• Five leaf miners are found on one card in one week.  
• Any aphids are found in the greenhouse.  
Every month, drench plants with a preventive fungicide treatment. |
| Week 11-18    | Plot graphs of plant height vs. week number to monitor growth. |
| Week 18       | Ship to market. |

* pH was controlled by incorporating sulfuric acid into the irrigation water. Water pH was kept between 5.8-6.2. The growing media pH was controlled mainly by this method.  
** EC was controlled by altering fertilizer concentrations. If the EC was lower than 0.5, fertilizer was applied on the higher end of the 100-200 ppm range. If the EC was higher than 0.8, fertilizer was applied on the lower end of the 100-200 ppm range, depending on how much greater the value is than the target value of 0.8.
**ECHINACEA**

_Echinacea purpurea_ 'Magnus' is already a favorite outdoor perennial plant. It was chosen as the 1998 Perennial Plant of the Year by the Perennial Plant Association. Application of plant growth regulators could help this plant become a popular indoor flowering plant as well.

**Indoor postharvest performance**

At room temperature (72°F) and under light levels that would be encountered indoors, _Echinacea purpurea_ 'Magnus' held flowers for at least one week in the interior environment. The large pink disk and yellow ray flowers are quite distinctive and attract attention.

_Echinacea_ had an unexpectedly nice aroma indoors and has great potential as a container plant. However, producing a uniform crop from seed can be a major problem. Plant growth regulators are needed to prevent 'Magnus' from getting too tall. Overall, it is a very nice plant and is easily identified by consumers. If height control is possible, it should be a winner in the home and garden.

**Garden performance**

All treatments of 'Magnus' performed equally well in garden performance trials, even after two weeks in a postharvest environment. This species may be forced successfully for an early market date, to be used first indoors, or they may be marketed for outdoor use only.

For both years of testing, there was no benefit to cutting back the foliage at planting. For the first two weeks after planting, overall plant quality was reduced due to postharvest treatment in combination with the cutting back at planting. However, they recovered from these effects by the end of June (week 25). All treatments survived and reflowered with no difficulty.

After initial planting, the plants stopped flowering around June 15 (week 25). In week 30 'Magnus' began to reflower for eight weeks. In the second year, peak flowering for all plants occurred during weeks 29 and 30 and flower quality during this two-week period ranged from average to excellent. Outdoors the second year, total flowering time was eight weeks, from weeks 26 to 34.

**Marketability**

_Echinacea purpurea_ 'Magnus' was selected as the 1998 Perennial Plant of the Year by the Perennial Plant Association. Its showy flowers have been popular in many gardens and now could have a new place as a flowering pot plant. There are few distinctive choices for flowering pot plants with a pleasant fragrance.

The concern with echinacea has to do with the variability in seed and seed sources and the need to apply plant growth regulators to keep the plants compact in pots. Growers forcing echinacea for the garden market might want to consider using PGRs for indoor market sales.

**Forcing notes**

_Echinacea_ plants can show great variability in size and performance. A longer photoperiod of 13-14 hours for seedlings, although not necessary, can promote flowering, but may also cause some plant height variability at flowering. Plants exposed to shorter photoperiods (i.e., 10 hours) produce smaller leaves and do not flower.

One strategy to induce flowering is
to provide 20-30 minutes of night interruption lighting during the middle of the night (i.e., around midnight). This method of lighting causes flower initiation and plants are somewhat shorter than if a longer, more traditional night lighting duration is used. The lights can be turned off once the plants begin to bolt, which takes seven to eight weeks, depending on the temperature and size of the starter material. The optimum temperature is between 68°F-73°F constant day and night.

All treatments of *Echinacea purpurea* 'Magnus' performed equally well in garden performance trials (left), even after two weeks in a postharvest environment (right).

### Echinacea purpurea 'Magnus'

<table>
<thead>
<tr>
<th>Schedule date</th>
<th>Production activity</th>
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</table>
| **Week 1**    | Receive 128-cell plugs three weeks after they have been sown and follow optional protocol for receiving material in the research greenhouses, which includes:  
  • Spray with 8 ounces of Avid per 100 gallons.  
  • Drench with Marathon 60WP.  
  • Drench with 8 ounces Truban/Cleary's 3336 per 100 gallons. |
| **Week 1**    | Singulate plug seedlings and place in greenhouse under natural days or 12-hour photoperiod. Maintain 68°F average daily temperature. |
| **Week 4**    | Plant into 5½-inch pots using a high-porosity growing mix. Drench with 8 ounces of Banrot per 100 gallons. |
| **Week 4**    | Place under a 20-minute night interruption period from 12:15 a.m.-12:35 a.m. |
| **Week 4-18** | An adequate application of fertilizer is begun at each watering. Maintain growing medium pH between 5.8-6.2 and electrical conductivity between 0.5-0.8 (EC measured using 2:1 distilled water:media method). Adjustments may be made, depending on plant performance. Plant growth can be graphed weekly along with pH* and EC**. |
| **Week 4-18** | Monitor for insect and disease problems. Use yellow sticky cards. Treat with appropriate insecticides if:  
  • Five thrips are found on one card in one week.  
  • Five whiteflies are found on one card in one week.  
  • Five leaf miners are found on one card in one week.  
  • Any aphids are found in the greenhouse.  
  
  Every month, drench plants with a preventive fungicide treatment. |
| **Week 4-18** | Plot graphs of plant height vs. week number to monitor growth. |
| **Week 14**   | Place plants under short days (less than or equal to 12 hours) to slow stem elongation. |
| **Week 18**   | Ship to market. |

* pH was controlled by incorporating sulfuric acid into the irrigation water. Water pH was kept between 5.8-6.2. The growing media pH was controlled mainly by this method.

** EC was controlled by altering fertilizer concentrations. If the EC was lower than 0.5, fertilizer was applied on the higher end of the 100-200 ppm range. If the EC was higher than 0.8, fertilizer was applied on the lower end of the 100-200 ppm range, depending on how much greater the value is than the target value of 0.8.
GERANIUM DALMATICUM

Geranium dalmaticum is a compact, long-lived garden plant. Its final height of 6-8 inches makes it ideal for use as an indoor flowering plant. Starter material, adequate cooling and moderate growing temperatures can all impact flower quality.

Indoor postharvest performance

Indoor performance in the postharvest treatment was monitored for 14 days by measuring flower and plant quality. Overall, G. dalmaticum plants performed well in the postharvest environment.

At room temperature (72°F) and under light levels that would be encountered indoors, G. dalmaticum held a good flower show for seven to 10 days before flowers began to senesce. Once flowers senesced, the petals freely dropped from the plants but were not considered a nuisance.

Newly developed flowers lacked pigmentation and were pale in comparison to the original flowers that developed in the greenhouse. However, flowers remained ornamental and did not detract from overall plant quality.

The foliage looked good throughout the postharvest evaluation. Plants continued to produce leaves even when grown in the low-light environment. Plants are fairly drought tolerant and overall appearance in postharvest conditions should remain acceptable for an extended period beyond the 14-day postharvest treatment.

Garden performance

Garden performance data were collected on several key features of the plant including flowers, foliage and overall plant quality. Quality data were rated on a five-point scale and were based on the All-America Selections' standards (5=excellent, 4=good, 3=average, 2=poor, 1=unacceptable). Data were collected weekly until first frost (Oct. 1, 2000).

Garden performance of G. dalmaticum plants varied. Foliage quality and overall plant quality ranged widely for all treatments, although no consistent effects from forcing, postharvest treatment or foliage removal at planting were observed.

Plants were smaller than desired at transplanting and had not filled the 5-inch containers completely. In 2000, plants ceased blooming within the first week after planting (Week 23) and never reflorewered during the data collection period.

Several plants did not survive the first summer of planting. However, plants that did survive the first season reflorewered with no difficulty the following year.

Marketability

Geranium dalmaticum is a compact, hardy geranium that is typically long-lived in the garden. Small in stature with a final height of 6-8 inches, it is perfectly suited for 5-inch or smaller containers.

One of the limitations to marketing G. dalmaticum in bloom is its relatively short flowering time. The initial flush of flowers is generally maintained for three weeks after which plants will produce additional flowers, although sparingly. Although G. dalmaticum is a typical spring-blooming perennial, plants could be scheduled to flower in fall and planted to bloom again the following spring.

The key to providing superior flowering G. dalmaticum plants is threefold: starter material, adequate cooling and moderate growing temperatures. Although juvenility is not a factor in flowering G. dalmaticum, divisions should be of sufficient size before the cold treatment. Plants require a minimum of six weeks of cooling at 41°F for flower initiation. Previous research has shown that plugs with 12 to 15 leaves before cooling produced nearly twice as many flowers as those having only six to eight leaves. Once plants have finished flowering they will not rebloom until after an additional cold period.

Flower quality and size is also influenced by growing temperature with larger flowers produced with cool to moderate greenhouse temperatures, less than 68°F. Plant growth regulators are not needed in the production of G. dalmaticum as plants are naturally compact and finished at 6-8 inches tall.
Flower size and quality are dramatically influenced by forcing temperature. The flower on the left is from a plant forced at 84°F. The flower on the right is from a plant forced at 62°F.

These plants received six weeks of cold (41°F), followed by a 16-hour photoperiod and nine weeks of forcing at 68°F.

**Geranium dalmaticum**

<table>
<thead>
<tr>
<th>Schedule date</th>
<th>Production activity</th>
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| Week 1        | Receive 72-cell plugs (seven to nine weeks after vegetative cuttings have been stuck) and follow optional protocol for receiving material in the research greenhouses, which includes:  
  - Spray with 8 ounces of Avid per 100 gallons.  
  - Drench with Marathon 60WP.  
  - Drench with 8 ounces Truban/Cleary's 3336 per 100 gallons. |
| Week 1        | Place plugs in a 41°F cooler. |
| Week 9        | Remove plugs from cooler and transplant one plug per 5½-inch pot using a high-porosity growing mix. Place plants under 4 hours of night interruption lighting. Maintain 68°F average daily temperature. |
| Week 9-18     | An adequate application of fertilizer is begun at each watering. Maintain growing medium pH between 5.8-6.2 and electrical conductivity between 0.5-0.8 (EC measured using 2:1 distilled water:media method). Adjustments may be made, depending on plant performance. Plant growth can be graphed weekly along with pH* and EC**. |
| Week 9-18     | Monitor for insect and disease problems. Use yellow sticky cards. Treat with appropriate insecticides if:  
  - Five thrips are found on one card in one week.  
  - Five whiteflies are found on one card in one week.  
  - Five leaf miners are found on one card in one week.  
  - Any aphids are found in the greenhouse.  
  - Every month, drench plants with a preventive fungicide treatment. |
| Week 9-18     | Plot graphs of plant height vs. week number to monitor growth. |
| Week 18       | Ship to market. |

* pH was controlled by incorporating sulfuric acid into the irrigation water. Water pH was kept between 5.8-6.2. The growing media pH was controlled mainly by this method.  
** EC was controlled by altering fertilizer concentrations. If the EC was lower than 0.5, fertilizer was applied on the higher end of the 100-200 parts per million range. If the EC was higher than 0.8, fertilizer was applied on the lower end of the 100-200 ppm range, depending on how much greater the value is than the target value of 0.8.
Pennisetum setaceum 'Rubrum' (purple fountain grass), which has been widely planted in Southern landscapes, is quickly gaining fans in the North. This warm-season grass could also become a popular indoor flowering plant if it can maintain its deep burgundy color and its height is kept compact.

**Indoor postharvest performance**

Indoor postharvest performance was monitored for 14 days by measuring flower and plant quality. Overall, 'Rubrum' plants performed well in the postharvest environment. At room temperature (72°F) and under light levels that would be encountered indoors, 'Rubrum' grows quickly. Newly developed leaves and flowers lacked pigmentation and were green in comparison to the purple growth that developed in the greenhouse. In some cases, flowers did not fully emerge from buds but overall remained ornamental and did not detract from plant quality.

We are testing plant growth regulator applications to limit the amount of new growth during shipping, retail display and indoor use. Plants are fairly drought tolerant, and overall appearance in postharvest conditions should remain acceptable for at least two weeks.

**Garden performance**

Garden performance data were collected in 2000 on several key features of the plant including flower, foliage and overall plant quality. Quality data were rated on a five-point scale and were based on All-America Selections' standards (5=excellent, 4=good, 3=average, 2=poor, 1=unacceptable).

Plants cut back at planting in 2000 took approximately six weeks to reflower in the garden, and many of the plants failed to flower by the end of summer. Plants that underwent the postharvest treatment, but did not have their foliage removed at planting, also took several weeks to recover once planted outdoors.

Etiolated growth that developed on plants during the postharvest treatment turned purple when planted in full sun outdoors. Foliage and overall plant quality of all treatments peaked for several weeks at the end of July through the first few weeks of August.

'Rubrum' is sensitive to temperatures below 50°F and can be quickly killed by frost injury. Recovery of cold-damaged plants can take sever-
When planted in flower, *Pennisetum setaceum 'Rubrum'* will bloom throughout summer until first frost.

Beige inflorescences tinged with red contrast dramatically with deep-burgundy foliage.

### Marketability

With deep-burgundy foliage and soft-beige plumes, *Pennisetum setaceum* 'Rubrum' is a dramatic, eye-catching ornamental grass that will sell itself in a retail setting. Challenges in producing and marketing 'Rubrum' lie in maintaining the burgundy foliage color and overall plant compactness during shipping and retailing.

Although mature plants form compact clumps 2-3 feet tall and wide, 'Rubrum' can be successfully grown and forced to flower in any size container. It will flourish and flower in 4-inch to 5-gallon or larger containers, although plant size is greatly restricted in smaller containers resulting in shorter, more compact plants.

### Pennisetum setaceum 'Rubrum'

#### Schedule date | Production activity
---
Week 52 & Bring in stock material from field, other propagator or own production area. Follow optional protocol for receiving material in the research greenhouses, which includes:
  * Spray with 8 ounces of Avid per 100 gallons.
  * Drench with Marathon 60WP.
  * Drench with 8 ounces Truban/Cleary's 3336 per 100 gallons.
Week 52 & Divide stock plants into two-or-three-tiller (shoot) divisions and cut back shoots to 6 inches. Cut back roots as well, leaving 2-3 inches of actively growing root intact.
Week 52 & Stick divisions into 38-cell plug trays using a peat-based growing mix. Place under short days. Maintain temperature at 73°F.
Week 52 & Begin an adequate application of fertilizer at each watering. Maintain growing medium pH between 5.8-6.2 and electrical conductivity between 0.5-0.8 (EC measured using 2:1 distilled water:media method). Adjustments may be made, depending on plant performance. Plant growth can be graphed weekly along with pH* and EC**.
Week 52 & Monitor for insect and disease problems. Use yellow sticky cards. Treat with appropriate insecticides if:
  * Five thrips are found on one card in one week.
  * Whiteflies are found on one card in one week.
  * Five leaf miners are found on one card in one week.
  * Any aphids are found in the greenhouse.
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  * Any aphids are found in the greenhouse.
Week 52 & Plot graphs of plant height vs. week number to monitor growth. Apply Sumagic as needed for height control. Research has shown 5 ppm of Sumagic applied as a foliar spray three weeks after planting is effective in Northern climates. Additional 5 ppm Sumagic applications can be made if needed.
Week 9 & Transplant one rooted plug per 5½-inch pot using a high-porosity growing mix. Place under 14-hour photoperiod or longer for nine to 10 weeks. Maintain 68°F average daily temperature or warmer.
Week 18 & Ship to market.

* pH was controlled by incorporating sulfuric acid into the irrigation water. Water pH was kept between 5.8-6.2. The growing media pH was controlled mainly by this method.

** EC was controlled by altering fertilizer concentrations. If the EC was lower than 0.5, fertilizer was applied on the higher end of the 100-200 ppm range. If the EC was higher than 0.8, fertilizer was applied on the lower end of the 100-200 ppm range, depending on how much greater the value is than the target value of 0.8.
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