

Quick-cropping perennials

Increased understanding of the physiology of flowering in perennials is allowing growers to bring plants to market much more efficiently.

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Understanding the flowering physiology of herbaceous perennials is important for producing a uniform flowering crop. Since a flowering plant is more marketable than a vegetative plant, predictable flowering of herbaceous perennials has become a priority for many commercial perennial growers. In the last decade, floriculture research at Michigan State University has focused on identifying the flowering physiology of hundreds of herbaceous perennials. Recently, we have focused

on using our knowledge of flowering physiology to develop a concept known as quick-crop perennial production.

The fundamental goal of the quick-crop perennial technique is to optimise the production of herbaceous perennials by understanding the environmental and cultural requirements for both vegetative and reproductive growth, which is necessary for efficient and rapid production. Our approach has been to apply strategies similar to those used in vegetative annual production: start with uniform, vegetative cuttings and programme these cuttings in plugs to rapidly flower at the final grower.

The quick-crop perennial production system for vegetatively-propagated perennials has five main phases: stock plant production and management; propagation; bulking (i.e., allowing plants to increase in mass); vernalisation; and forcing to flower. At each stage of production, the environmental conditions are optimised to ultimately produce a quality, uniform flowering crop. Quick-crop production can also apply to seed-propagated perennials, but our research has focused on vegetatively-propagated perennials.



The larger the plant at bulking, generally the larger it will be at flowering.

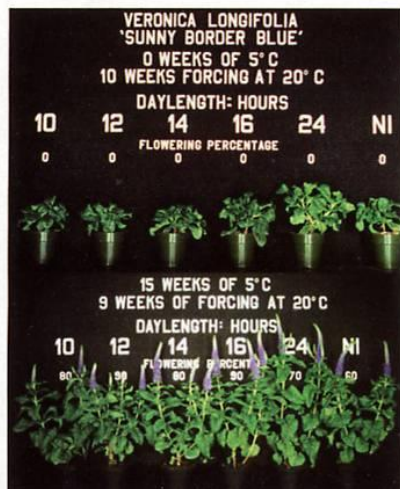


Figure 1. *Veronica 'Sunny Border Blue'* is an example of a cold-requiring day-neutral plant (category 1). Plants remain vegetative without exposure to cool temperatures (top), which is desirable for stock plants. Flowering occurs following a cold treatment, regardless of photoperiod (bottom).

Stock Plant Production

The fundamental goal of stock plant management is to produce vegetative cuttings. The successful production of vegetative stock plants hinges on our knowledge of the flower induction requirements for a particular perennial species. Most temperate herbaceous perennials can be classified

into four flower induction categories:

1. Cold required, day-neutral plants
2. Cold required, long-day plants
3. No cold required, photoperiodic (usually long-day) plants
4. No cold required, day-neutral plants



Figure 2. *Gaura 'Whirling Butterflies'* is an example of a no-cold-requiring, long-day plant (category 3). Plants flower without cooling under photoperiods greater than 10 hours. Therefore, photoperiods of 9 to 10 hours are recommended to maintain vegetative growth for stock plants. NI = 4-hour night interruption.

The main objective with stock plants is to maintain vegetative growth without allowing them to go dormant. This can be successfully accomplished with the first three categories of plants, above.

Cold-requiring plants (categories 1 and 2) will remain vegetative as long as plants are not exposed to cool temperatures. For example, *Veronica* 'Sunny Border Blue' remains vegetative before a cold treatment, and flowers following cold, regardless of photoperiod (Figure 1). For some perennials "cool" temperatures can be as warm as 12°C (54°F) which means that extended durations (or nights) at these temperatures can elicit a flowering response. Perennial stock plants in the first two categories can be maintained under natural daylengths, or long days if supplemental lighting is desired to increase cutting productivity.

For photoperiodic species that do not require cold (cate-

gory 3), plants should be maintained under non-inductive photoperiods to ensure that cuttings are vegetative. For example, *Gaura* 'Whirling Butterflies' flowers without cooling under photoperiods greater than 10 hours (Figure 2). Since some long-day perennials can become dormant under extended periods of short days, the photoperiod must be controlled to ensure that stock plants neither go dormant from excessively short days nor prematurely flower from long days. For many long-day perennial species, a 12- or 13-hour photoperiod is optimum for maintaining vegetative stock. However, this is not true with all species, such as illustrated with *Gaura*, where the recommended photoperiod for vegetative growth is nine to ten hours.

Maintaining vegetative growth in plants that do not have a cold requirement or a photoperiodic response (category) can be a challenge. Some



Figure 4. Example of plugs arriving in flower when the plants were intended for planting and bulking.

common examples are *Scabiosa* and *Salvia* 'May Night'. *Scabiosa* 'Butterfly Blue' flowers without cooling when grown at warm temperatures (e.g., 20°C, or 68°F) under photoperiods from 10 to 24 hours (Figure 3). For these plants, we do not know of any temperature or light strategy that will inhibit flowering.

Stock plants are generally grown at moderate temperatures: 18°C to 20°C (64°F to 68°F). At higher temperatures, plant growth can be weak and leggy, and cuttings can be of low quality. If plants are grown too cool, growth slows and the length of the cutting cycle is increased. To ensure the production of high-quality cuttings, light quantity should be maximized during stock production (within the ability to control greenhouse temperature).

Cuttings should be harvested whenever they are of a marketable size (generally every four to five weeks). Continual harvests prevent the stock plants from becoming overgrown and ensure continued branching and cutting production. Properly maintained stock plants that are disease-, virus-, and insect-free produce healthy, vegetative cuttings.

Propagation

As during stock plant management, a key to success during propagation is to prevent premature flower induction (Figure 4). For perennial species that require a cold treatment for flowering, this is easily accomplished because no particular photoperiod is required during propagation. For photoperiodic plants, however, the daylength used during stock production should be maintained during propagation.

The use of appropriate-sized plug trays and a high-quality porous media are important. For most perennial species, a 50% peat/50% perlite mixture works well. Rooting in a "heavy" medium can be poor, particularly for soft, pubescent cuttings. The plug cell size used depends on the duration of bulking, which is based primarily on the finished container size.

The use of a rooting hormone (e.g., 1500-ppm liquid IBA dip) can reduce time to root and increase rooting uniformity. During the early stages of rooting, plugs should not be allowed to wilt. This is generally accomplished by providing cuttings with mist and high (90% relative) humidity. For rapid root formation without

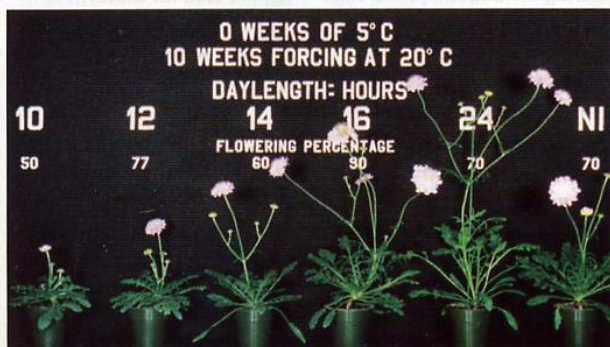


Figure 3. *Scabiosa* 'Butterfly Blue' flowers without cooling under all photoperiods studied, and is thus an example of a category 4 plant. For plants in this category, maintaining vegetative growth of stock plants is a challenge, and consequently cuttings are often reproductive. NI = 4-hour night interruption. Percentage flowering represents the proportion of plants that were in flower when the photograph was taken.

Table 1. Quick-crop production schedules for several popular herbaceous perennials. Production time is based on an average daily temperature of 20 °C (68 °F) and finishing in a 13cm (5") container). Flower induction categories: 1. Cold required, day-neutral plants; 2. Cold required, long-day plants; 3. No cold required, photoperiodic (usually long-day) plants; 4. No cold required, day-neutral plants. The minimum time required for the production of these flowering potted perennials from unrooted cuttings varies from 12 to 23 weeks.

Species	Flowering category	Propagate	Bulk	Vernalize	Force to Flower	Total
<i>Salvia</i> 'May Night'	4 (1')	3 wks	3 wks	0 wks	5 wks	11 wks
<i>Gaura</i> 'Whirling Butterflies'	3 (1')	2 wks	3 wks	0 wks	7 wks	12 wks
<i>Gaura</i> 'Siskyou Pink'	3 (1')	2 wks	3 wks	0 wks	7 wks	12 wks
<i>Achillea</i> 'Moonshine'	3	3 wks	4 wks	0 wks	7 wks	14 wks
<i>Achillea</i> 'Red Velvet'	3	3 wks	4 wks	0 wks	7 wks	14 wks
<i>Scabiosa</i> 'Butterfly Blue'	4 (3')	3 wks	4 wks	0 wks	8 wks	15 wks
<i>Scabiosa</i> 'Pink Mist'	4 (3')	3 wks	4 wks	0 wks	8 wks	15 wks
<i>Veronica</i> 'Red Fox'	1	3 wks	4 wks	6 wks	7 wks	20 wks
<i>Veronica</i> 'Icicle'	1	3 wks	4 wks	5 wks	8 wks	20 wks
<i>Leucanthemum</i> 'Snowcap'	2	3 wks	4 wks	5 wks	8 wks	20 wks
<i>Campanula</i> 'Birch Hybrid'	1	2 wks	4 wks	7 wks	7 wks	20 wks
<i>Veronica</i> 'Goodness Grows'	1	3 wks	4 wks	6 wks	9 wks	22 wks
<i>Veronica</i> 'Sunny Border Blue'	1	3 wks	4 wks	6 wks	9 wks	22 wks

'After extended periods of short days, flowering may be more rapid if provided with a cold period of 6 weeks.

'Plants grown at cool temperatures (<15 °C, or <59 °F) may flower faster under long days than short days.

excessive shoot growth, a media temperature of 25°C (77°F) and an air temperature of 23°C (73°F) are recommended.

If properly managed, cuttings of many herbaceous perennials can be removed from propagation in 17 to 20 days.

Bulking

Following propagation, plants are allowed to increase in size in the greenhouse to a size appropriate for the finish container size (known as "bulking"). During this phase, roots become fully established in the plug and the plants develop

adequate size for forcing.

Depending on space availability and plant species, bulking can occur in the plug flat or in the finish pot. Plants should remain vegetative throughout bulking by controlling the photoperiod (e.g., providing short days) when appropriate. During the bulking phase, high light intensities and moderate to cool temperatures (18 to 20°C, or 64 to 68°F) are recommended. Duration of bulking varies with the final desired plant size, but for many species, two to four weeks is often sufficient. The larger the plant at the end of bulking, generally the larger the plant will be at flowering.

Vernalisation

A fundamental concept of quick-crop perennial production is to provide the minimum, saturating duration of cold necessary for flowering.

The amount of cold required for complete and rapid crop flowering varies by plant species (Figure 5). Vernalisation can be delivered using a refrigerated cooler, or when conditions permit, naturally cool temperatures in a greenhouse or outdoors. Five to six weeks between 0°C and 5°C (32°F and 41°F) is often adequate to saturate a vernalisation response for many cold-requiring species. However, the optimum cooling temperature and duration varies by species. If the cooling period required is unknown, plants should receive at least six weeks of cold at 5°C (41°F).

As with the preceding phases, plants should remain vegetative during the vernalisation treatment. This often means providing short days (a photoperiod of less than 12 hours or less) for long-day plants. Some perennials do not require cold for uniform crop flowering, and therefore this step can be skipped for some species.

Forcing to flower

At this stage of the production cycle, plants are in the final container and the flowering process is promoted by a previous vernalisation treatment, by forcing photoperiod, or both. If plugs have been kept vegetative throughout propagation, bulking, and vernalisation, time to flower should be predictable and uniform throughout the crop. For the highest quality finished plants, moder-



Figure 5. *Campanula* 'Birch Hybrid' requires at least 6 weeks at 5 °C (41 °F) for rapid flowering. Shorter durations result in poor and delayed flowering, or no flowering at all.

(Photo courtesy of Leslie Finical)

ate temperatures are recommended, such as 16°C to 20°C (61°F to 68°F).

For long-day perennial species, a long day can be created with day-extension lighting to 16 hours, or by providing night interruption lighting (four hours from 10 p.m. to 2 a.m.). Photoperiodic lighting should be at least 2 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ or 100 lux at plant level. For day-neutral plants, no photoperiod control is necessary following vernalisation. To improve plant quality during low-light periods of the year, supplemental light should be provided.

Total time to flower for quick-crop production depends on the plant species. Table 1 provides the minimum duration of each quick-cropping step for several popular herbaceous perennials. Depending on the plant, the minimum production time (from unrooted cuttings to

flowering) can vary from as little as 11 weeks to as much as 23 weeks.

When grown at cool temperatures (<15°C, or <59°F), some species in Category 4 flower more rapidly under long days, and thus could be placed in Category 3. For example, flowering can be sparse and delayed in *Scabiosa* grown with low night temperatures and short days. For other plants, such as *Salvia* 'May Night' and *Gaura* 'Whirling Butterflies', exposure to extended periods of short days can inhibit subsequent flowering. In this instance, a cold treatment can accelerate flowering and improve plant vigour, and thus is recommended. ■

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