

# Considerations for finishing perennials from plugs

by Allen R. Pyle

Growing consumer demand for perennials is fueling the need for good cultural and production information, particularly scheduling perennials for specific sales windows and forcing perennials into bloom. Having discovered that “color sells,” growers increasingly want perennials in color – be it blooms or foliage – for multiple sales windows.

Plugs, both seed and vegetative, provide excellent options for perennial growers. The wide range of perennial plugs available gives growers numerous finishing options. With perennial plugs, growers can take advantage of several planting and finishing strategies to produce perennials for multiple sales windows.

## Why use plugs?

Perennial plugs, especially seed propagated plugs, are generally available over a long period each year, often longer than many other propagules. (Some items, notably vegetative material and cooled plugs – described below – have more seasonal availability.) Many suppliers produce perennial plugs year round.

Perennial plugs are economical compared to propagules like tissue cultured liners or bare root material. On the basis of economics alone, plugs can make up an important part of a perennial program, especially for small containers like 4” pots or flats.

Plugs are generally easy to transplant, both by hand or with automated transplanting equipment. In addition, plug trays can be held if necessary, for later transplant. It is possible to hold perennial plug trays for 1-2 weeks, and under cool temperatures (50-60° F), trays may be held for a few weeks longer. Cooled perennial trays can be held even longer, at temperatures of 38-41° F.

## Choosing a perennial plug

Deciding which plug is right for your perennial program can be challenging, given the range of material available. Base your decision of which plug to use on: your finish container, your desired sales window, your production goals (green vs. flowering sale), your production schedule, and your budget.

In general, larger plugs finish faster than smaller plugs, and larger containers take longer to finish than smaller containers. In gallon or larger containers, 2 or 3 plugs may be needed to rapidly fill the container, depending on the perennial species, plug size, and production schedule.

Choose a plug that matches your container and your production schedule, and fits your budget. For instance, if your budget is limited but you have sufficient time in your production schedule, you may be able to use small plugs to fill a large container. If time available to finish plants is limited, a larger (and more expensive) plug may be required. If your market will support producing the highest quality plants, consider using more plugs per container, to produce a fuller finish.

To produce perennials in bloom at the time of sale, you must understand the factors which trigger flowering for each species and cultivar you grow. The keys are to understand their photoperiod and vernalization requirements. See the scheduling tables below for details on the specific requirements of some commonly grown perennials.

## **Flowering vs. green sale perennials**

Although there is currently a great deal of interest in forcing perennials into bloom, you can be successful with perennials without forcing and without selling plants in bloom. Any perennial that fills its pot well is saleable green, as long as the tag and signage are good. A number of perennial species are grown specifically for their attractive foliage, and may even have non-showy flowers. Remember that forcing perennials to bloom out of season for a specific sales window is still somewhat experimental. It may take two to three seasons to fine tune a production schedule for a given species or cultivar.

Although there is much more information available today on forcing perennials into bloom, growers should still be cautious. Never expect someone else's "cookbook recipe" to automatically work perfectly in your system the first time you try it. Never expect a schedule for one cultivar to always work the same for another cultivar. And never expect that a schedule for one sales window will always work the same for another sales window.

Also remember that, as with annuals, blooms on a perennial are no guarantee of sale. Poorly grown flowering perennials may actually be less saleable than well grown green perennials. In addition, not all perennials are easy (or economical) to flower in a container, or look good as good flowering in a container as they do in the landscape. For instance, *Baptisia* (Wild Indigo, zone 3), *Digitalis x mertonensis* (Strawberry Foxglove, zone 4), most *Kniphofia* cultivars (Torch Lily, zone 5), *Papaver orientale* (Oriental Poppy, zone 2), and *Thermopsis lanceolata* (False Lupine, zone 2) may take 2 years of growth and 2 cooling periods to successfully vernalize. Many growers cannot justify the extra year of production time with these items.

## **Understanding vernalization**

"Vernalization" is a cold treatment which triggers flowering in some perennials. In effect, cooled plugs which flower when warmed up are vernalized. There are three keys to successful vernalization: 1) cooling a mature (not juvenile) plant, 2) cooling at the right temperature (generally no higher than 38-41° F average), and 3) cooling for right length of time (generally at least 8-10 weeks). If any one key factor is not satisfied, vernalization will not be successful.

The troublesome factor in vernalization is understanding juvenility – the age/size below which a given perennial will not respond to a cold treatment. The length of the juvenile period is not understood for all perennials, and can vary greatly among cultivars. The response when juvenile plants are cooled also varies. Some species flower in low percentages, while others do not flower at all. Still others require significantly more growing time to flower when juvenile plants are cooled, or flower non-uniformly. Remember that the term vernalized is still being used loosely in the industry, so don't expect all cooled plugs to be vernalized.

## **Understanding critical photoperiod**

Some perennials require long days (typically 14 hours or more of light per day) to flower. Depending on when they are grown, long day perennials may need artificial lighting to trigger flowering. Day neutral perennials flower under both long and short days, though in some species and cultivars flowering may be slightly accelerated under long days.

An excellent general lighting strategy for long day perennials is night break lighting – providing 4 hours of light from 10 pm to 2 am. (It is actually short nights, not long days, which are the trigger mechanism for long day perennials.) Just 10-15 footcandles of light are sufficient for the night break. Incandescent, fluorescent, metal halide, and high pressure sodium lights are all effective for triggering

flowering in long day perennials. Some stretching usually occurs when artificial long days are used to flower perennials, especially when incandescent light is used. Turning off lights once flower buds are visible helps to minimize the stretch.

## Types of perennial plugs

**Standard perennial plugs** are sold green and actively growing. These are the most widely available perennial plugs, and have year-round availability from many suppliers. They are a good choice for growers new to perennials, and can fit well into systems geared toward producing annual crops. Standard plugs are available in a wide range of sizes, from small (406 to 200 plugs per tray) to medium (128 to 72 plugs per tray), and large (50 to 32 plugs per tray).

Because they are available over such long periods, standard plugs can be finished for any sales window. However, if plants are to be sold blooming, cultivar choice is limited with standard plugs, since only varieties and species which flower without cooling are suitable. Standard plugs may take longer to flower, or be of somewhat lower quality at finish, than cooled plugs.

In general, perennials which flower without cooling will bloom 4-12 weeks after transplant from standard plugs (see table 1).

**Cooled perennial plugs** have been taken through a cooling period, and are dormant at the time of shipping, though the level of dormancy can vary. Cooled plugs have seasonal availability, typically late winter to early spring. Storing these plugs under artificial refrigeration may allow for sale later in the year. When using cooled plugs, remember that vernalization may not be guaranteed.

The cooling process causes the top growth of many species of perennials to die back. The roots, however, remain actively growing during cooling. Keep this in mind the first time you see a cooled tray of perennials!

Generally only medium and large plugs are available cooled, because small plants are more likely to be juvenile and therefore not successfully vernalize. Because it takes longer to produce them, cooled plugs have a premium price compared to standard plugs.

Cooled plugs are pre-conditioned for cool growing conditions (55-60° F or colder), but can also be grown warm (65-75° F). Roots develop very quickly from cooled plugs, often faster than standard plugs. However, top growth may initially be slower with cooled plugs than standard plugs, as plants emerge from dormancy. It may take 2-4 weeks longer to for plants to fill pots with cooled plugs than standard plugs, though plants are typically fuller at finish, with more breaks.

The key to success when using cooled plugs is understanding juvenility, and choosing the right plug size. Most perennials which flower the first year without cooling will be excellent cooled plugs, and will be vernalized in 128 cell plug. In general, cooled plugs flower 6-12 weeks after transplant, if they have been successfully vernalized (see table 2).

**Fall planting and overwintering** is an excellent strategy for finishing perennials, and results in high finish quality. Fall planting is an ideal finishing strategy if you have a market that will pay for the higher quality, or if you want to flower a wide variety of perennials. It is an excellent strategy for overcoming juvenility, and small, economical plugs can be used without jeopardizing finish quality. It may also help to spread out your transplant labor to a time when it is more available than in spring.

Fall planted perennials have a long crop time, and must be overwintered. Depending on the climate, this may require some type of winter protection or a protective structure to prevent losses. (Climates with average winter temperatures above about 40° F may not successfully vernalize fall planted perennials.) Be aware that rodent damage can cause significant losses when overwintering

perennials and that some items are very difficult to overwinter (e.g. Butterfly Weed, *Asclepias tuberosa*, zone 4 and Rose Mallow, *Hibiscus x hybrida*, zone 4).

In fall planting, transplant is done in late summer to early fall, when growing conditions are still good for plant growth. The goal is to get plants well established before cooling. Depending on location, transplant should ideally be completed by mid September to mid October. Cold night temperatures during plant establishment are fine, but day temperatures need to be adequate for growth (at least 45-50° F). If warm greenhouses and a good HID lighting system are available, transplant can be continued into late fall or early winter. Use 1 plug per pot, and provide 6-8 weeks growth before cooling.

Cool established plants for at least 8-10 weeks at 38-41° F or colder. When plants are warmed up, they generally flower in 6-12 weeks, when grown under the correct photoperiod, assuming that juvenility has been overcome. (See table 3.)

### Scheduling perennials which flower without vernalization

Some perennials flower well without going through vernalization. These items can therefore be produced for any sales window. Cooling may be beneficial for some perennials which flower without vernalization, decreasing bench time and/or increasing finish quality. This schedule is based on 128 cell plugs transplanted 1 per pot for quart and smaller containers, 3 per pot for gallon containers, grown at temperatures of 65-68 °F (unless otherwise indicated), under the proper photoperiod. Larger plugs may finish 2-4 weeks faster, and smaller plugs may finish 2-4 weeks slower. In gallon and larger containers, some species may require 1-2 additional weeks to bloom.

**Table 1A: First year blooming perennials which flower in 4-8 weeks from transplant**

Plant	Common name	Zone	Day*	Weeks to flower	Days bud to flower	Height (inches)
<i>Campanula rotundifolia</i>	Bluebells-of-Scotland	2	LD	5-6	10	12-14
<i>Centaurea montana</i>	Perennial cornflower	2	LD	7-8	24	12-16
<i>Cymbalaria muralis</i>	Kenilworth ivy	3	LD	4-5	7	12-16" long stems
<i>Dianthus barbatus</i> 'Rondo Mix' †	Sweet william	2	DN	7-8	20	6-8
<i>Dianthus deltoides</i> 'Arctic Fire', 'Zing Rose' †	Maiden pink	2	DN	7-8	14	4-6
<i>Dianthus x allwoodii alpinus</i> †	Allwood pinks	3	DN	7-8	16	8-12
<i>Lychnis x haageana</i> , <i>x arkwrightii</i> cultivars †	Haage champion	3	DN	6-7	15	8-12
<i>Malva sylvestris</i> 'Althea Zebrina'	High Mallow	3	LD	6-8	24	20-24
<i>Papaver nudicaule</i> † ‡‡	Iceland poppy	2	DN	6-8	14	12-24

Plant	Common name	Zone	Day*	Weeks to flower	Days bud to flower	Height (inches)
<i>Platycodon grandiflorus</i> 'Sentimental Blue' F1 ††	Balloon flower	3	LD	6-8	18	4-6
<i>Sagina subulata</i>	Pearlwort	4	LD	5-6	8	3-4
<i>Viola tricolor</i>	Johnny jump up	4	DN	4-5	7	6-8

\* Day length response. LD indicates that long days are required or beneficial for flowering. DN indicates plant is day neutral

\*\* Performs better when grown warm, 70-75 °F

† Provide additional 2-3 weeks for flowering when grown under short days

†† Pinch at transplant recommended to promote branching and better pot fill

‡‡ Perennial which prefers cool growing temperatures, and is not recommended for finishing in warm summer conditions

**Table 1B: First year blooming perennials which flower in 8-12 weeks from transplant**

Plant	Common name	Zone	Day *	Weeks to flower	Days bud to flower	Height (inches)
<i>Achillea millefolium</i> 'Summer Pastels', 'Colorado'	Common yarrow	2	LD	8-10	20	12-18
<i>Asclepias tuberosa</i> †† ‡	Butterfly weed	4	LD	8-10	20	12-14
<i>Campanula carpatica</i> 'Clips' Series, 'Uniform' Series ‡‡	Carpathian bellflower	2	LD	7-9	20	6-8
<i>Catananche caerulea</i>	Cupid's dart	3	LD	10-12	24	24-28
<i>Coreopsis grandiflora</i> 'Early Sunrise'	Tickseed	4	LD	10-12	28	18-24
<i>Delphinium grandiflorum</i> cultivars † ‡‡	Delphinium	3	DN	8-10	20	20-24
<i>Dianthus gratianopolitanus</i> 'Grandiflorus' †	Cheddar pink	2	DN	8-10	20	8-12
<i>Hibiscus x hybrida</i> 'Disco Belle', 'Southern Belle' ** ‡	Rose mallow	4	LD	10-12	45	24-30
<i>Lavandula angustifolia</i> 'Lady'	Lavender	4	LD	8-10	24	12-16
<i>Leucanthemum</i> ( <i>Chrysanthemum</i> ) <i>x</i> <i>superbum</i> 'Silver Princess', 'Snow Lady', 'White Knight'	Shasta daisy	4	LD	8-10	25	10-14

Plant	Common name	Zone	Day *	Weeks to flower	Days bud to flower	Height (inches)
<i>Lobelia x speciosa</i> 'Compliment' Series, 'Fan' Series	Red-leaved cardinal flower	6	LD	9-10	24	18-30
<i>Lobelia siphilitica</i>	Great blue lobelia	4	LD	10-12	20	24-32
<i>Lupinus x hybrida</i> 'Gallery' Series	Lupine	3	LD	8-9	14	20-24
<i>Oenothera missouriensis</i>	Missouri primrose	3	LD	9-10	24	10-12
<i>Rudbeckia hirta</i> cultivars	Black-eyed susan	4	LD	8-9	16	10-24
<i>Verbascum chaixii</i>	Nettle-leaved Mullein	5	LD	8-10	12	24-36
<i>Veronica subsessiliss</i> 'Blue Bouquet'	Long-leaf veronica	6	LD	9-10	20	16-18

\* Day length response. LD indicates that long days are required or beneficial for flowering. DN indicates plant is day neutral

\*\* Performs better when grown warm, 70-75 °F

† Provide additional 2-3 weeks for flowering when grown under short days

†† Pinch at transplant recommended to promote branching and better pot fill

‡ Difficult to overwinter, and using cooled plugs or fall planting is not recommended

‡‡ Perennial which prefers cool growing temperatures, and is not recommended for finishing in warm summer conditions

### Scheduling cooled plug perennials

Cooled plugs are well-suited for finishing under cool growing temperatures. These items are also suitable for fall planting, and will finish with a similar schedule (or up to 1-2 weeks earlier) when transplanted in fall and overwintered. Schedules are based on mature plugs cooled 10 weeks at 38-41 °F average temperature or colder, and 65-68 °F growing temperatures (unless otherwise indicated), under the proper photoperiod. In gallon and larger containers, 1-2 additional weeks may be required.

## 2A. Large plug required perennials

These perennials have a relatively long juvenility period and large volume plugs (deep 72 cell trays or larger) are recommended to ensure plants are vernalized.

Plant	Common name	Zone	Day*	Weeks to flower	Days bud to flower	Height (inches)
<i>Aquilegia alpina</i>	Alpine columbine	2	DN	6-8	10	10-14
<i>Aquilegia vulgaris, x hybrida (cultorum)</i> cultivars	Columbine	2	DN	6-7	10-12	10 - 18; 24 - 36
<i>Coreopsis grandiflora</i> ‘Sunray’, ‘Baby Sun’	Tickseed	4	LD	6-8	20	20-30
<i>Gaillardia x grandiflora</i> cultivars ***	Blanket flower	2	LD	7-9	20	10-18; 24-28
<i>Heuchera sanguinea</i> cultivars	Coral bells	3	LD	7-8	18	14-30
<i>Rudbeckia fulgida (var. sullivantii)</i> ‘Goldsturm’ **, ***	Orange coneflower	3	LD	12-14	30	18-24

\* Day length response. LD indicates that long days are required or beneficial for flowering. DN indicates plant is day neutral

\*\* Better performance when grown warm, 70-75 °F

\*\*\* Multiple plugs per pot recommended. Fuller plants and better pot fill when planted in fall and overwintered.

## 2B. Medium plug required perennials

Perennials in this table can be vernalized in medium size plugs (128 cells per tray or larger.)

Plant	Common name	Zone	Day*	Weeks to flower	Days bud to flower	Height (inches)
<i>Arabis caucasica</i> cultivars †	Rock cress	3	DN	3-5	7	4-6
<i>Astilbe chinensis</i>	Chinese astilbe	3	LD	12-15	30	8-16
<i>Astilbe chinensis var. taquetii</i>	Fall astilbe	3	LD	12	32	20-32
<i>Aubrieta x hybrida</i> ‘Grandiflora Mix’, ‘Whitewall Gem’	False rockcress	4	DN	9-10	7	6-8
<i>Bellis perennis</i> cultivars †	English daisy	3	DN	6-8	12	8-10
<i>Delphinium x belladonna</i> cultivars	Belladonna delphinium	2	DN	8-9	20	20-28
<i>Delphinium x elatum</i> ‘Magic Fountains’ series	Hybrid bee delphinium	2	DN	8-10	20	18-28

Plant	Common name	Zone	Day*	Weeks to flower	Days bud to flower	Height (inches)
<i>Dianthus barbatus</i> ‘Double Dwarf Mixed’, ‘Indian Carpet Mixed’	Sweet william	2	DN	8-9	12	6-8; 8-12
<i>Digitalis grandiflora</i> ( <i>ambigua</i> )	Yellow foxglove	2	DN	6-8	16	14-18
<i>Echinacea purpurea</i> cultivars **, ***	Purple coneflower	3	LD	10-12	24	36-48
<i>Geum chiloense</i> ‘Lady Stratheden’, ‘Mrs. Bradshaw’	Avens	5	DN	8-10	10	12-16
<i>Leucanthemum</i> ( <i>Chrysanthemum</i> ) <i>x</i> <i>superbum</i> ‘Alaska’, ‘G Marconi’ ***	Shasta daisy	4	LD	7-8	24	24-36
<i>Myosotis sylvatica</i> ‘Victoria’ series †	Forget-me-not	3	DN	5-7	14	6-10
<i>Physostegia virginiana</i> ‘Alba’	Obedient plant	2	LD	10-12	26	20-30
<i>Physostegia virginiana</i> ‘Rosea’	Obedient plant	2	LD	12-15	30	30-36
<i>Platycodon grandiflorus</i> ‘Fuji’ Series	Balloon flower	3	LD	10-12	30	24
<i>Polemonium caeruleum</i>	Jacob’s ladder	2	LD	4-6	12	20-26
<i>Primula x polyantha</i> ( <i>elatior</i> ), <i>x pruhoniciana</i> †	Polyantha primrose	3	DN	7-8	15	4-10
<i>Saxifraga x arendsii</i> ‘Purple Robe’	Arend’s saxifrage	4	DN	5-7	7	6-8
<i>Veronica spicata</i>	Spike speedwell	2	LD	6-8	18	18-24

† Perennial which prefers cool growing temperatures, and is not recommended for finishing in warm summer conditions

\* Day length response. LD indicates that long days are required or beneficial for flowering. DN indicates plant is day neutral

\*\* Better performance when grown warm, 70-75 °F

\*\*\* Multiple plugs per pot recommended. Fuller plants and better pot fill when planted in fall and overwintered.

**Table 3: Scheduling fall overwintered perennials**

Perennials in the following tables finish best when large plants are vernalized, either having long juvenility periods or producing better filled pots when plants with large root volume are cooled. Schedules are based on pots cooled at least 10 weeks at 38-41° F average temperatures or colder, and 65-68° F growing temperatures (unless otherwise indicated), under the proper photoperiod.

**3A. Spring blooming perennials**

Items which are day neutral, and generally bloom in early spring to spring once plants are warmed up.

<b>Plant</b>	<b>Common name</b>	<b>Zone</b>	<b>Day*</b>	<b>Weeks to flower</b>	<b>Days bud to flower</b>	<b>Height (inches)</b>
<i>Aquilegia alpina</i>	Alpine columbine	2	DN	6-7	10	10-14
<i>Aquilegia flabellata</i> ‘Cameo’ Series, ‘Mini Star’ **	Fan columbine	3	DN	4-5	7	4-8
<i>Aquilegia vulgaris, x hybrida (cultorum)</i> cultivars	Columbine	2	DN	6-7	10-12	10 - 18; 24 - 36
<i>Aurinia saxatilis</i> ‘Compactum’	Basket of gold	3	DN	5-7	10	10-14
<i>Doronicum orientale</i> cultivars	Leopard’s bane	2	DN	7-8	6	18 - 30
<i>Iberis sempervirens</i> ‘Snowflake’ **	Candytuft	3	DN	6-7	13	8 - 10

\* Day length response. LD indicates that long days are required or beneficial for flowering. DN indicates plant is day neutral

\*\* Vernalizes easily – make sure plants are well established before cooling, to prevent plants from flowering before filling out pots

### 3B. Summer blooming perennials

These perennials are typically long day plants, and will flower naturally in early to late summer once overwintered containers are warmed up. Providing long days (e.g. 4 hour night break lighting) will allow plants to be forced for earlier sales windows.

Plant	Common name	Zone	Day*	Weeks to flower	Days bud to flower	Height (inches)
<i>Achillea millefolium</i> cultivars	Common yarrow	2	LD	9-10	24	20-24
<i>Aster alpinus</i> cultivars	Alpine aster	2	LD	5-6	14	14-20
<i>Aster tongolensis</i> ‘Wartburg Star’	East Indies aster	3	LD	7-8	28	18-24
<i>Astilbe chinensis</i>	Chinese astilbe	3	LD	12-14	30	8-16
<i>Astilbe chinensis</i> var. <i>taquetii</i> ( <i>A. taquetii</i> )	Fall astilbe	3	LD	10-12	32	20-32
<i>Campanula glomerata</i> cultivars	Clustered bellflower	2	LD	7-8	24	18-24
<i>Campanula persicifolia</i> cultivars	Peachleaf bellflower	2	LD	10-12	30	36-42
<i>Coreopsis grandiflora</i> ‘Sunray’, ‘Baby Sun’	Tickseed	4	LD	6-7	20	20-30
<i>Echinacea purpurea</i> cultivars **	Purple coneflower	3	LD	10-12	24	36-48
<i>Gaillardia x grandiflora</i> cultivars	Blanket flower	2	LD	7-8	20	10-18; 24-36
<i>Heuchera sanguinea</i> cultivars	Coral bells	3	LD	7-8	18	14 - 30
<i>Lavandula angustifolia</i> ‘Hidcote Blue’, ‘Munstead Dwarf’	Lavender	4	LD	6-7	20	12-20
<i>Leucanthemum</i> ( <i>Chrysanthemum</i> ) <i>x superbum</i> ‘Alaska’, ‘G Marconi’	Shasta daisy	3	LD	7-8	24	24 - 36
<i>Lupinus x hybrida</i> ‘Minarette’, ‘Russell’ Series	Lupine	3	LD	10-12	14	24-36
<i>Oenothera fruticosa</i> ‘Youngii’	Sundrop	3	LD	9-10	20	24-36
<i>Potentilla megalantha</i>	Wooly cinquefoil	2	LD	8	10	4-8
<i>Rudbeckia fulgida</i> (var. <i>sullivantii</i> ) ‘Goldsturm’ **	Orange coneflower	3	LD	12-14	30	18-24
<i>Tanacetum</i> ( <i>Chrysanthemum</i> ) <i>coccineum</i> cultivars	Painted daisy	2	LD	7-8	18	24-36

\* Day length response. LD indicates that long days are required or beneficial for flowering. DN indicates plant is day neutral

\*\* Better performance when grown warm, 70-75 °F

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