Juvenility: your perennial crop's age affects flowering

by Art Cameron, Mei Yuan, Royal Heins and Will Carlson

Groundbreaking MSU research reveals that some perennial plugs are just *too young* to flower

The last few years at Michigan State University we've studied flowering requirements for a wide range of herbaceous perennials whose flowering usually is regulated by two primary environmental factors: cold and photoperiod. We've established protocols for flowering perennials originally grown from seed in plug trays. In many cases, seedlings can be chilled in plug trays, transplanted and forced directly into flower either under natural days or long days, depending on the particular species requirements. However, we've encountered a number of instances in which seedlings wouldn't flower even after a significant period of cold followed by exposure to long days (after 10 weeks of cold, columbines didn't bloom, regardless of plug size [128 or 50] or photoperiod) (Figure 1). In addition, poppy, statice, alpine aster and columbine seedlings rarely bloomed, regardless of the treatments we used.

In one experiment, we tested the flowering response of coral bells (*Heuchera sanguinea*). To determine the effect of plant size, we used seedlings from 128- and 50-cell trays. None of the coral bells flowered when transferred directly to the greenhouse for forcing without a cold treatment (Figure 2). A second group of coral bells was chilled for 10 weeks, then forced under short days (nine hours) or long days

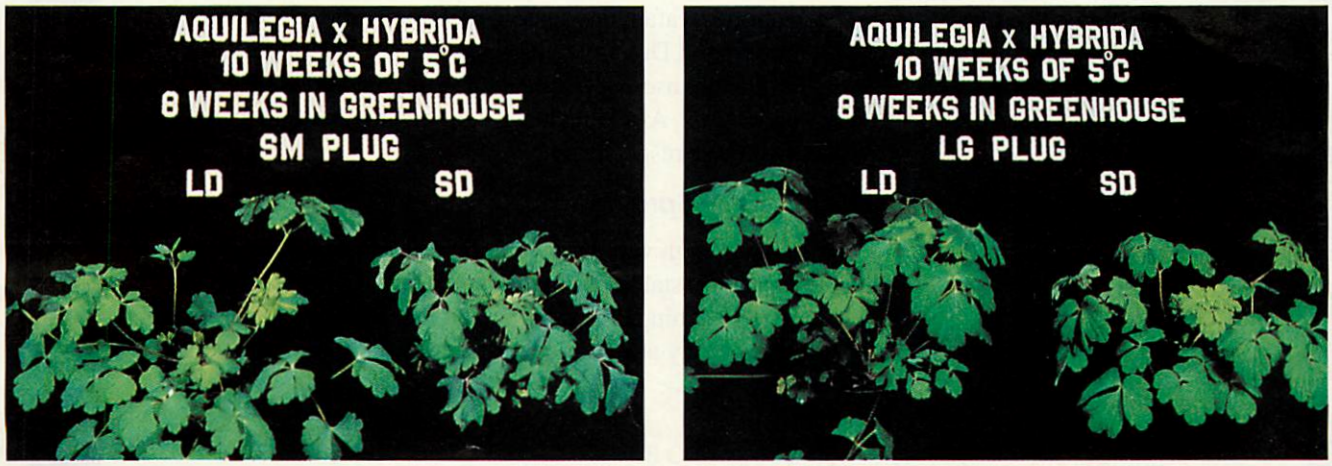

Figure 1. Columbine plants have a lengthy juvenile period. Plants didn't flower even after 10 weeks cold because they were still juvenile. 1A (left) "Small" seedlings were produced in 128-cell trays and had an average of seven leaves, while 1B (right) "large" seedlings were produced in 50-cell trays and had an average of 11 leaves.

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Table 1. Age requirements for flowering of a number of common herbaceous perennials. (In some cases, the specific minimum age has not been determined.)

Plant name	*Common name*	*Age requirements*
Achillea filipendulina Cloth of Gold	Yarrow	Plants with eight to 13 leaves flowered inconsistently.
Aquilegia—most species	Columbine	Extended juvenile period—for some species at least 15 leaves are required for consistent bloom.
Aster alpinus	Alpine aster	Plants require at least 15 leaves to flower consistently.
Astilbe arendsii	Astilbe	Plants with five to six leaves flowered very inconsistently.
Chrysanthemum coccineum	Pyrethrum	Plants require at least 15 leaves to flower consistently.
Coreopsis Sunray	Tickseed	Juvenile phase ends with about 16 leaves.
Delphinium grandiflorum	Delphinium	Plants with four to five leaves flower.
Echinacea purpurea	Coneflower	Plants with four leaves flower.
Euphorbia epithymoides	Cushion spurge	Plants with six to eight leaves failed to flower.
Goniolimon tatarica	Statice	Plants with 10 to 14 leaves failed to flower.
Heuchera sanguinea	Coral bells	Plants require 16 leaves to flower consistently.
Kniphofia uvaria	Red hot poker	Field-grown plants failed to flower—presumably a two-year juvenile period.
Lavandula angustifolia	Lavender	Most consistent flowering with 40 to 50 leaves.
Lobelia Compliment Scarlet	Cardinal flower	Plants with six to seven leaves will flower.
Papaver orientale Brilliant	Oriental poppy	Plants with 10 to 14 leaves failed to flower.
Physostegia virginiana	Obedience plant	Plants require at least 10 leaves to flower consistently.
Rudbeckia fulgida Goldsturm	Black-eyed Susan	Juvenile phase ends at about 10 leaves.
Veronica spicata Blue	Speedwell	Plants with six to eight leaves will flower.

(nine hours of light plus a four-hour night interruption from 10 to 2 using 20 f.c. of incandescent lighting). No plants from the 128-cell trays flowered, while plants from the 50-cell trays bloomed after cold, regardless of photoperiodic treatment. (Coral bells are day-neutral.)

Juvenility—a matter of age

Why didn't any of the columbines flower and only the 50-cell-sized coral bells flower in these experiments? It's a matter of age. Some plants were just too young to flower, even when provided with normally inductive conditions. Plant physiologists refer to these plants as juvenile. Coral bells seedlings from the 128-cell trays were apparently below the threshold age (juvenile), while those from 50-cell trays were above it (mature). This doesn't imply that all coral bells from 50-cell trays will flower, and it does not infer that all seedlings of different species from 50-cell trays will flower. It simply means that the seedlings from 50-cell trays were old enough to flower.

The juvenility period usually refers to early phases of growth when plants won't flower even if exposed to favorable conditions. The duration of the juvenile period in flowering plants varies widely. In many woody plants, it isn't uncommon for it to last several years. Notable examples include apples and other fruit crops. In fact, the juvenile phase can last 20 to 30 years in some forest trees.

In contrast, the juvenile period for most herbaceous perennials we've studied is less than one year and can usually be measured in weeks or months. Some exceptions include bulb crops, which can take two to three seasons to begin flowering.

Determining age—a practical approach

One thing is for certain: You can't tell the age of a herbaceous perennial simply by the size of the plug tray in which it is produced. Also, seedling age doesn't take into account the temperature or photoperiod under which seedlings are grown.

Different growers may use different methods of production, and these can influence the physiological age of seedlings. In fact, in different-sized plug trays we've received plants that were very similar in size, age and response to treatments.

In practice, one method of determining seedling age is to count the number of leaves or nodes that have been produced. Leaf counts have long been used to measure age in tracking the development of plants such as poinsettia and Easter lily. Leaf counts inherently include temper-

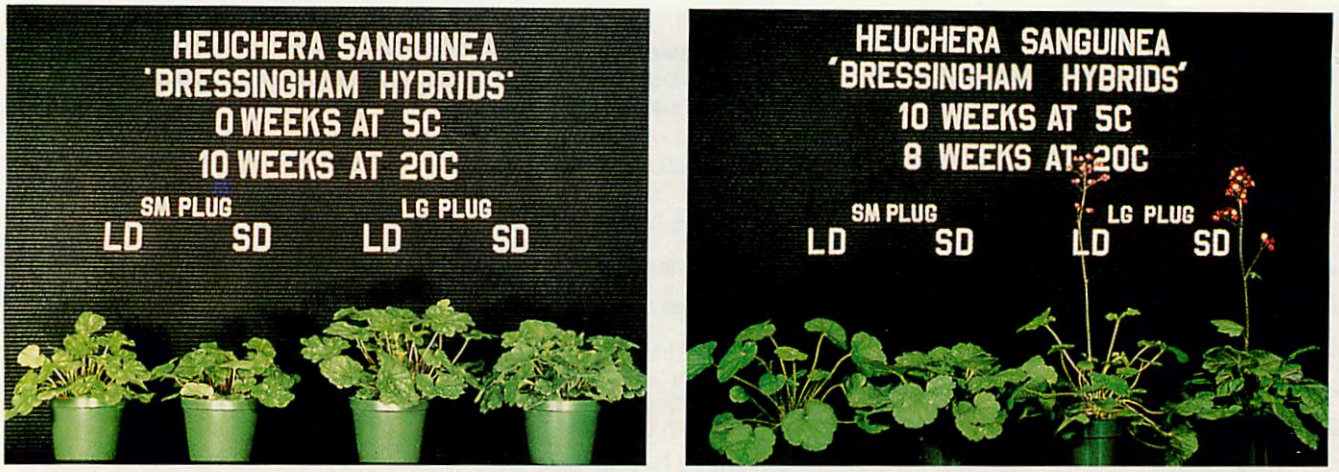

Figure 2. Only the "large" plug-grown seedlings of coral bells flowered and then only after 10 weeks of cold treatment. 2A (left) "Small" seedlings were produced in 128-cell trays and had an average of seven leaves, while 2B (right) "large" seedlings were produced in 50-cell trays and had an average of 14 leaves.

ature effects: Plants grow faster at higher temperatures and produce more leaves.

Growers have little information about the number of leaves needed for various herbaceous perennials to become mature. Table 1 includes information from two to three years of trials on the critical leaf number for perennials. Most of these plants have an obligate cold requirement. For some plants listed, we simply know that plants of a given age didn't flower in our experiments.

For a few of these perennials, we've conducted rather extensive trials to determine critical leaf number. For instance, we further examined the juvenility-period requirement for coral bells. Only plants with about 16 leaves flowered 100%. Note that seedlings from 128-cell trays, shown in Figure 1, had an average of seven leaves, while those from 50-cell trays had about 14 leaves. Thus, by coincidence, plants we initially tested were just over (128-cell trays) and below (50-cell trays) the threshold number.

If you want to get a general idea of a seedling population's age, it's best to count a random group of many individual seedlings and take the average. Also, count only leaves of single plants. Perennial producers will often seed two, three or even more seeds per cell, and it could be misleading to count all of these seedlings and assume the total is that of a single plant. In addition, counting leaves can be difficult after burn. Still, leaf counts are simple to perform and are generally a reliable means of estimating plant age.

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plants have received cold treatment because of senescence and winter

Not all herbaceous perennials have an extended juvenility period. Some, such as Carpathian harebells (*Campanula carpatica*), will flower in the plug trays if given long-day photoperiods. Others flower readily regardless of starting material age. However, for those perennials with a definite juvenility period, it's important that they reach minimum leaf counts before the beginning of the cold period. In many cases, this can be accomplished by growing plants under 12- to 13-hour photoperiods for several weeks before initiating cold treatment, ensuring more uniform flowering on larger plants. ❑

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