

Herbaceous Perennials: Aquilegia (Columbine)



Figure 1a



Figure 1b

Figure 1a. *Aquilegia x hybrida* 'Origami Blue & White'. 1b. *Aquilegia x hybrida* 'Winky Double Red & White'.

by **CATHY WHITMAN, ART CAMERON, ERIK RUNKLE, and ROYAL HEINS**

ONE of the best-known and well-loved garden plants, aquilegias (commonly known as columbine) are a wonderful spring flower, and irresistible when sold in bloom. Even short-growing cultivars have a "wild-flower" appearance that is very appealing to the gardener. *Aquilegia* can be short lived, but they do make great container plants and garden plants, and have the added bonus that they attract butterflies and hummingbirds. Flower colors range from yellows to reds to purples and blues (Figure 1).

Aquilegias are a member of the ranunculaceae family (which includes delphinium, aconitum, anemone, and clematis). There are about 65 species in the Northern hemisphere, many native to the United States. *Aquilegia caerulea*, with its beautiful blue and white flower, is the state flower of Colorado and *Aquilegia canadensis*, with yellow and red flowers, ranges naturally from Texas to Nova Scotia. In the garden, species hybridize freely and there are many hybrids commercially available. The species range in cold hardiness from USDA zone 2 (*A. sibirica*) to zone 8 (*A. discolor*) and the

hybrids are generally hardy from zones 4 to 6. The species and older columbine cultivars are inherently variable, with long juvenility periods and extended vernalization requirements. Although many make excellent garden plants, it is not uncommon for many of these selections to take a year or more from seed to first flower.

For growers who desire a quick-crop approach to columbine production, new selections have been released that are compact with shorter juvenility requirements and, in some cases, little if any vernalization (cold treatment) requirement. These include *Aquilegia flabellata* cultivars such as Mini-Star and the Cameo series.

The primary production challenges with columbine are to ensure that plants have reached adequate maturity (size) before the cold period begins, and that they then receive adequate cold to fulfill their vernalization requirement. These size and cold requirements are different for different species and cultivars. New cultivars are constantly being re-

leased and we have observed that columbine cultivars marketed in the same series may have different juvenility or vernalization requirements. Still, when successfully forced, columbines make attractive container plants that can be enjoyed in the home before they are moved to the garden.

Propagation And Plant Size: The Juvenility Issue

Plants are available commercially as seeds, plugs, or as bare-root plants. Our research has been conducted with seedlings growing in plugs. All columbines are seed-propagated and after germination, seedlings are juvenile and will not

Schedule

Michigan State University researchers' seven-part series on herbaceous perennials covers topics from *Phlox paniculata* to chemical height control.

June: *Phlox paniculata*

July: Delphinium

August: Plant Growth Retardants

September: Digitalis

October: *Aquilegia*

November: Campanula

December: Summary Tables

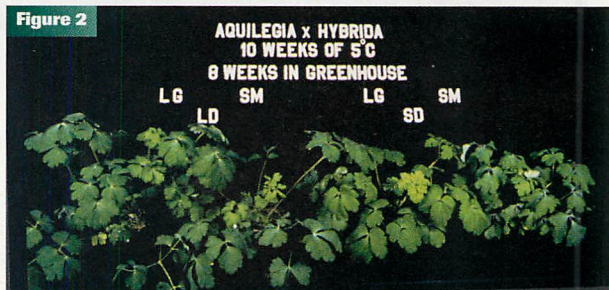


Figure 2. These may be a familiar sight: Nonflowering columbines, despite lengthy cooling and plenty of time in the greenhouse. Plants from a large (LG; 50-cell) or small (SM; 128-cell) plug did not flower under long days (LD) or short days (SD).

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flower even after exposure to conditions that induce flowering in mature plants. All species have a juvenility phase, which in many cases can last for months.

If columbines are not old enough (mature) before the vernalization period, they simply will not flower (Figure 2). The plants need to be bulked, i.e. grown for a period of time allowing them to increase in size and attain maturity. In our experience, it is more effective if seedlings are transplanted and bulked in larger containers rather than bulking them in the plug trays, especially when the plug size is a 72 or smaller. Pot-cooled plants generally have a higher flowering percentage and are larger in flower (Figures 3 and 4).

One way to quantify plant maturity is by counting leaves. The exact leaf number needed to reach maturity varies among cultivars. For 'Winky Double Red & White,' nine to 12 leaves were needed before plants were capable

of flower induction, and for 'Origami Blue & White,' seven to nine leaves were adequate. At 68°F, columbine plants take seven to eight days to unfold one leaf. Recommended leaf numbers before cooling are provided for some hybrids in Table 1.

Leaf count does not really tell the entire story; when we compared plugs and plants with the same leaf numbers, the flowering percentage for plug-cooled plants was lower than for pot-cooled plants. Evidently leaf number is not the only factor determining plant maturity. Even 50-cell plugs may not be large enough for some varieties. In one experiment, we compared bulking in 50-cell plug trays versus bulking in five-inch pots. Flowering of plants bulked in the 50-cell plug tray did not reach 100%, while all plants bulked in the five-inch pots did flower.

Cold Treatment

The majority of columbines require a cold treatment for flowering. In our experience, no native species will flower without vernalization, but several hy-

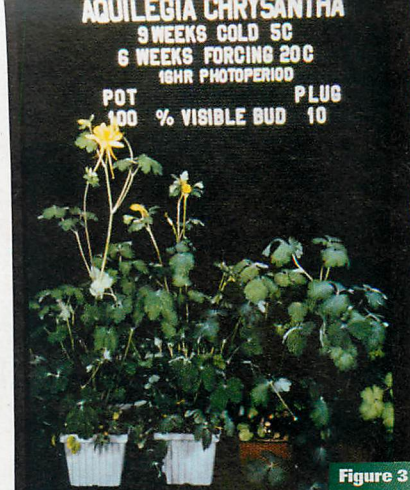


Figure 3. Effect of bulking on flowering of *Aquilegia chrysantha*. Plants were cooled either in their 72-cell plug trays (right), or established in five-inch pots for two weeks before cold treatment (left). Note the low flowering percentage when plants were cooled in the plug tray.

brids have been selected over the past decade with short cold requirements. Specific cooling durations for some of the hybrids are provided in Table 1.

Unfortunately, there is no reliable method to determine if a given columbine has received enough cooling. In warm winters, there is always a chance that plants will receive inade-

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quate amounts of cooling, which can have detrimental effects on flowering. Try to err on the side of over cooling if there is a choice.

Little is known about specific temperatures that are effective for vernalization. It is likely that columbine can perceive and accumulate “chilling” at temperatures in the 50s (°F), but we have not conducted specific experiments to verify this. In all our experiments, we have used 41°F as our standard vernalization temperature and cooled plants in controlled chambers, providing nine hours of light (25 to 50 footcandles) per day.

Photoperiod

Columbines are day-neutral and will flower under short days or long days. Photoperiod can affect stem elongation and plants grown under long days may be too tall. We suggest forcing under natural daylengths.

Media, Fertilization, And Irrigation

Plants in our experiments performed very well in a standard soil-less medium. Nitrogen levels of 125 ppm N in a constant liquid feed program were sufficient for healthy growth. We maintained pH levels between 5.8 and 6.2.

Lighting And Spacing

Aquilegia prefers moderate light levels. Supplemental light during periods of low light resulted in sturdier plants with more flowers, but plants grown without supplemental light were of acceptable quality when grown in the spring.

Plant Height Control

Some very compact columbine cultivars are the *Aquilegia flabellata* types that only grow about three to six inches tall, and the *Biedermeier* strain with a height of nine to 12 inches. Growth regulators are generally not needed for these varieties.

Other columbines can become quite tall and growth regulators may be needed. For *Aquilegia x hybrida* ‘Music Pink and White,’ B-Nine at 5,000 ppm or Sumagic at 15 ppm effectively controlled stem elongation (Figure 5).

AQUILEGIA FLABELLATA

MINI STAR

9 WEEKS COLD SC
6 WEEKS FORCING 20C
16HR PHOTOPERIOD

POT 100 % VISIBLE BUD PLUG 100



Figure 4



Figure 5

Figure 4 (top). Effect of bulking on flowering of *Aquilegia flabellata* ‘Mini Star.’ Plants were either cooled in their 72-cell plug trays (right), or established in five-inch pots for two weeks before cold treatment (left). Even though all plants flowered, transplant and bulking prior to cold improved plant appearance.

Figure 5 (above). The effect of plant growth regulators on height and flowering of *Aquilegia x hybrida* ‘Music Pink and White.’ The rates were: A-Rest at 100 ppm, B-Nine at 5,000 ppm, Bonzi at 60 ppm, Cycocel at 1,500 ppm, Sumagic at 15 ppm, and Florel at 500 ppm. Our objective in this experiment was to determine which compounds were effective for height control, not to determine specific rates. Plants were sprayed every two weeks until flowering. B-Nine, Sumagic, and Florel delayed flowering by two to four days.

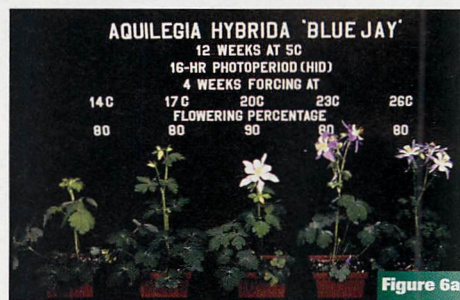


Figure 6a



Figure 6b

Figures 6a (top) and 6b(bottom). Effect of forcing temperature (from 57°F to 79°F) on development of *Aquilegia x hybrida* ‘Blue Jay.’ Plants flowered more quickly at higher temperatures, but flower size was reduced.

Cycocel at 1,500 ppm caused severe phytotoxicity. In our experiment, these compounds were applied every two weeks until flower. Our objective was

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to determine which chemicals were effective, not to determine specific rates. We encourage growers to perform their own trials to determine the best rates under their conditions.

Temperatures And Crop Scheduling

Once vernalized, columbine will go on to flower quite rapidly. Some varieties flower in as little as three weeks when forced at 68°F. Higher temperatures will hasten flowering, but temperatures above 80°F can delay flowering and may reduce flower number. We observed a dramatic decrease in flower size as temperature increased (Figures 6a and 6b). Therefore, a cool growing temperature will result in flowers with a greater impact. The majority of columbines are most attractive when forced at temperatures of 57°F to 68°F.

Disease And Insect Pests

We have had few problems with diseases or insects on aquilegia. Botrytis

did appear on some plants in the cooler. Some spider mites and a few whiteflies were present on plants in the greenhouse. Columbines can be susceptible to root rot, so as with many perennials, use a well-drained medium.

Gardeners often have to contend with leaf miners on columbines. Certain species are reportedly more resistant, but some years, most varieties in our trial gardens are affected.

Postharvest Concerns

Columbine plants flower for two to six weeks and this is very temperature dependent. Plants should be sold when they are just starting to flower. Their appearance declines as plants age in the container, though some people find the seed pods attractive. Deadheading can extend the bloom time.

Unfortunately, columbine will rarely reflower the first year in the garden, but survival and performance in subsequent years have been excellent. **GG**

About the authors: Cathy Whitman is a research technician, Art Cameron is a professor, Erik Runkle is an assistant professor and extension specialist, and Royal Heins is

Keys To Success

1. Select appropriate cultivars for your operation – for quick-cropping, choose cultivars with a shorter juvenile phase and reduced vernalization requirement.

2. Seedlings can be started in plugs, but transplant and bulk the plants in the final container before giving cold treatment when possible, if you wish to sell in flower.

3. Grow plants long enough (until they have enough leaves) before cold so that they pass the end of the juvenile phase. This is a tricky part because there are no obvious clues to tell a grower when the plants are mature and hence ready for vernalization

4. Provide an adequate duration of cooling, which can vary markedly among selections

5. Force at cooler temperatures and moderate to short daylengths for best quality and largest flowers

6. Research the flowering requirements of each specific cultivar, not just the series.

a professor, Department of Horticulture, Michigan State University, East Lansing, MI 48823. The authors wish to extend their thanks to former graduate student Leslie Finical for her research contributions. They also thank Beth Fausey, Dave Joeright, Mike Olrich, and generous industry supporters who made this work possible.

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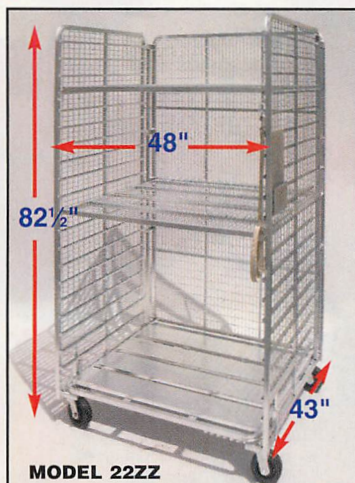
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AQUILEGIA TABLES

Table 1. Columbine tables – cultivars we have studied in our research program.

Columbine species hybridize freely. The last several years, breeders have emphasized uniformity, compact size, and shorter cold requirements. Cold treatment listed is the duration we have observed necessary for mature plants to rapidly and uniformly flower after the cold treatment.

Cultivar	Description	Height	Leaf # before cold	Weeks of cold (41°F)	Special considerations for flowering
<i>Aquilegia flabellata</i> 'Cameo Blue & White'	Very compact - performs great in a 4-5" container.	3-5"	≥5	9	Flowers readily, even without cold - though cold hastened flowering and increased flower#. Very tiny if not bulked.
<i>Aquilegia flabellata</i> 'Mini Star'	Very compact, cute in 4-5" container.	6-8"	7-9	9	Required cold for complete flowering - can cool as plug, but performance improved when cooled in final container.
<i>Aquilegia x hybrida</i> 'Bluebird'	Colorful and reliable bloomer - they forced readily as long as starting material was beyond juvenile stage.	13-16"	12-16	3	Best to transplant and bulk 4-6 weeks prior to cold treatment - when bulked, Even 3 weeks at 41°F induced 100% flowering.
<i>Aquilegia x hybrida</i> 'Crimson Star'	Reliable old favorite with striking large red and white flowers.	14-18"	≥12	6	Performance improved when cooled in final container.
<i>Aquilegia x hybrida</i> 'Origami Blue & White'	Large lavender-blue and white flowers; very floriferous and showy.	14-20"	7-9	5	Short cold requirement - though it can flower w/o cold. Probably safest to bulk and then give 5 weeks cold. Very uniform.
<i>Aquilegia x hybrida</i> 'Swan Burgundy & White'	Large dramatic flowers on tall plants; very striking.	20-24"	12-14	3	Performance improved when cooled in final container.
<i>Aquilegia x hybrida</i> 'Swan Yellow'	Many clear sunny yellow flowers, moderately tall.	12-16"	12-14	3	Performance improved when cooled in final container.
<i>Aquilegia x hybrida</i> 'Winky Double Red & White'	Lots of charming double flowers with short spurs. Compact sturdy plants, very uniform.	11-13"	9-12	10	Required bulking and 10 weeks cold to reach 100% flowering. Performance improved when cooled in final container.
<i>Aquilegia x hybrida</i> 'Musik White'	Lovely pure white flowers on moderately tall plants.	12-16"	≥14	12	Requires long periods of bulking and cold. Cold treatment < 12 weeks may be adequate, but we have not tested this yet.
<i>Aquilegia x hybrida</i> 'McKana Giants'	Classic favorite variety, a mix of colors.	15-20"	≥12	≥12	Requires long periods of bulking and cold.

Table 2. Columbine tables – species we have studied in our research program.

Species	Description	Height	Special considerations for flowering
<i>Aquilegia alpina</i>	Beautiful cool-blue flowers with hooked spurs - heat tolerant.	18-24"	Flowered irregularly - apparently a long juvenility requirement. Great garden plant in Michigan, but slow and difficult to force.
<i>Aquilegia caerulea</i>	State flower of Colorado - great blue and white flowers.	12-24"	Flowered irregularly - apparently a long juvenility requirement. Slow and difficult to force.
<i>Aquilegia canadensis</i>	Native to the eastern U.S. - a great red and yellow flower.	15-20"	Flowered irregularly - increasing cold durations increased flowering percentage and greatly decreased time to flower. Transplant into larger containers before cold treatment.
<i>Aquilegia chrysantha</i>	A wonderful yellow flower with long spurs.	15-20"	Flowered irregularly - increasing cold durations increased flowering percentage and greatly decreased time to flower. Transplant into larger containers before cold treatment.

These tables were accidentally left out of the "Herbaceous Perennials: Aquilegia" article in the October issue of *Greenhouse Grower* (page 80). Because they are so important to the content of the article, we have added them here. The GG editors apologize to the MSU researchers for the omission of these important tables. These tables will also be included in the final volume of *Firing Up Perennials*, due for publishing in 2004.

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