Section 22

Primula

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Introduction

Several primula species are produced and used as bedding plants and flowering potted plants. The name primula (or primrose) suggests the coming of spring, and primulas are among the first plants to start growth and flowering at the low temperatures of spring. Many gardeners have a special interest in growing, propagating and breeding the many different primula species. Primula is very popular in Europe as a flowering potted plant for late winter and early spring marketing. The interest and sales of primula are increasing in the United States. Primulas are sometimes used with other plants in potted arrangements or as potted plants that later can be planted outdoors in areas with moderate summer temperatures. However, the increased sales are due primarily to primulas being used as bedding plants during late winter and early spring in mild winter conditions. The most important primula species for potted plant and bedding plant production include *Primula vulgaris* Huds. (*P. acaulis* (L.) Hill, English primrose), *P.* x *polyantha* Mill. (polyantha primrose), *P. malacoides* Franch. (Fairy primrose), and *P. obconica* Hance. (German primrose). P. *sinensis* Sab. ex Lindl. is produced in limited numbers, and there is some interest in producing *P. denticulata* Sm. (Drumstick primula) as a flowering potted plant. *P. vulgaris*, *P.* x *polyantha,* and *P. denticulata* are considered hardy bedding plants, while *P. malacoides*, *P. obconica,* and *P. sinensis* cannot withstand frost.

Cultivars of *P. vulgaris* or English primrose are the most commonly produced potted primroses. At the Aalsmeer flower market in the Netherlands, *P. vulgaris* is on the top 10 list of indoor plants sold. This plant is also referred to as *P. acaulis* or acaulis primula. The word acaulis means stemless, and the leaves form a compact rosette. The flowers (sometimes with a fragrance) develop on short, individual flower stems in the center of the plant. The flower color was originally yellow. Through breeding efforts and the development of F_1 hybrids, *P. vulgaris,* cultivars are now available in many different colors (Figure 22-1). Cultural recommendations for *P.* x *polyantha* are similar to the recommendations for *P. vulgaris* although *P.* x *polyantha* is more vigorous growing. *P.* x *polyantha* develops flowers in a cluster on an extended main flower stalk. The flower colors are dominated by yellows and reds.

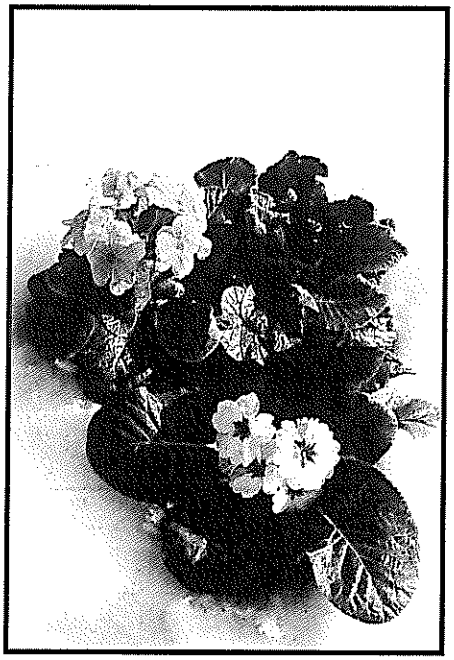

Figure 22-1. English primrose flowers are bright and showy colors including yellow, purple, and white.

The flowers of *P. malacoides* are arranged in a loose cluster or whorl with flower colors in white, pink, or lavender shades. Cultural procedures are comparable with those for *P. vulgaris*. *P. malacoides* is primary used as a flowering potted plant, since it is more sensitive to frost than *P. vulgaris* or *P.* x *polyantha*. *P. obconica* has leaves on longer stems, and flowers appear in loose upright umbels or clusters. Cultivars are available in many pleasing soft shades and pastel colors from white to blue, pink, and orange.

The leaves of *P. obconica* produce primin that may cause skin dermatitis. The risk for allergic reactions has limited the production of *P. obconica*. It is advisable to be cautious when producing, handling, and marketing *P. obconica* plants by wearing gloves and long sleeves to limit exposure. Cultivars that do not produce primin have now been developed, and production of *P. obconica* without the skin rash problem can become a reality.

The leaves of *P. sinensis* have a rounder shape than the other primulas discussed here, and the leaf margins are dentate or scalloped. The *P. sinensis* flowers form clusters and are in colors ranging from

white, pink, and red to blue. Pigments often color roots and the lower sides of the leaves red. *P. denticulata* is suggested to survive temperatures down to -30°F and has potential for marketing as a flowering potted perennial. Flowers appear in a dense globular cluster on a main flower stem. The flower color is white, to pale or reddish purple.

Propagation And Early Plant Development

Primula is propagated by seed. The size of the seed varies among the species. *P. vulgaris*, *P.* x *polyanthus,* and *P. sinensis* seeds are similar in size at 28,000 seeds per ounce. There are 175,000 seeds per ounce for *P. obconica*; *P. malacoides* has the smallest seed at 360,000 per ounce. Well-drained peat-lite media works well for seed germination and early seedling development. The pH should be in the range of 5.5 and 6.0 and the nutrient level should be low in the sowing media. To maintain moisture around the seed, a thin layer of media or vermiculite can be used to cover the seeds. Light is required for the seed of at least some of the species to germinate; therefore, only a thin layer of vermiculite or media should be used to cover the seed. *P. vulgaris* and *P.* x *polyantha* can be covered 7 to 10 days after seeding, because the seeds have started to germinate and the root radicle is emerging. The small seeds of *P. malacoides* and *P. obconica* easily dry out and should be lightly covered with vermiculite at seeding.

Primula seeds are relatively difficult to germinate. Germination is often erratic, and percent germination has not been outstanding, although seed quality and germination have improved. Good temperature control, even moisture, and high relative humidity are required conditions for satisfactory germination. Recommended germination temperature is 60°F for *P. vulgaris*, *P.* x *polyantha,* and *P. sinensis*; 60 to 65°F for *P. malacoides;* and 65 to 68°F for *P. obconica*. Germination is expected to be completed within two to three weeks after seeding. Temperatures for seedling development following germination are maintained at 60 to 65°F for *P. vulgaris*, *P.* x *polyantha,* and *P. malacoides;* and 65 to 68°F for *P. obconica*. The seedlings should have reached a suitable size for transplanting with three true leaves, about eight weeks after seeding. A single seedling is generally planted in 3- or 4-inch pots. Two or more seedlings are used for larger pots. The seedlings can also be planted into 1.25- or 1.5-inch cells as an intermediate step before the final transplant. The primula plug should be planted level with the media. Deep planting easily results in crown rot and other disease problems, and too high planting of the seedling results in floppy, poorly anchored plants. Well-drained media with a pH of 5.5 to 6.0 works well for primula production. Initial fertilizer content should be low and the organic matter high in the potting media. Immediately following transplant, the plants can be grown pot tight. The plants are spaced as the leaves start reaching the edge of the pot. Suitable final spacing for 4-inch pots is four pots per square foot.

An alternative to germinating and growing seedlings is to purchase primula plugs from a reputable propagator. Primula plugs are readily available in different cell sizes, plant ages, and cultivars. The time required for production is decreased, and the potential risks and problems during germination and early seedling development are eliminated.

Fertility Regimes

Start fertilizing as soon as the cotyledons start developing, about two weeks after seeding. The initial fertilizer rate should be low, at levels of 60 ppm nitrogen and potassium. The rate can be increased up to 200 ppm nitrogen immediately before transplanting. During the production phase following transplant, fertilizer rates of 90 to 100 ppm nitrogen (at each watering) from a complete fertilizer with micronutrients are suitable. Nitrogen in nitrate form is preferred. Too high nitrogen and fertilizer rates can easily result in the production of plants with large leaf and vegetative growth. Nitrogen in ammonium form may result in plants with unproportionally large leaves. Primulas are sensitive to high soluble salt levels that result in burned leaf margins. Micronutrient deficiencies or toxicities are common in primula production, and maintaining media pH between 5.5 and 6.2 is important for micronutrient availability.

P. obconica requires higher fertilizer levels than the other primulas discussed here. Nitrogen levels of 250 ppm with as high or higher levels of potassium are suitable to *P. obconica*. *P. malacoides* and *P. obconica* are most sensitive to high soluble salt levels, with symptoms of leaf edge necrosis. Leaching at regular intervals is recommended in the production of *P. malacoides* and *P. obconica* to avoid salt buildup.

The most common nutrient deficiencies in primula are phosphorus and iron. When phosphorus is deficient, newly developing leaves curl inward and lower leaves become bronzed with brown veins. Symptoms of iron deficiency are interveinal chlorosis on both old and new leaves. Regular monitoring of pH, soluble salts, and media nutrient balance through monthly soil tests is highly recommended.

Primula is a cool temperature crop, and venting is often limited during long periods of production. Under conditions with restricted venting, enrichment with CO_2 to 900 to 1,000 ppm has been reported to be beneficial for primula production.

Water

During germination and early seedling development, the media should never be allowed to dry out. The seedlings are, however, highly sensitive to overwatering and waterlogged conditions. When the plants of *P. vulgaris* and *P.* x *polyantha* have become established following transplant, they can be allowed to slightly dry out before being watered thoroughly again. *P. malacoides* and *P. obconica* are more sensitive to moisture stress, and the media should be kept evenly moist. Plants allowed to dry out or be grown at uneven moisture easily develop brown, dried leaf edges. High salt levels in the media result in symptoms similar to water stress in *P. malacoides* and *P. obconica*.

Temperature And Light Requirements For Flowering

Recommendations for flower initiation in *P. vulgaris* and *P.* x *polyantha* include exposure to 40 to 50°F. The temperature is dropped when the plants have developed 6 to 10 leaves and a well-established root system. To promote bud set, some growers increase the fertilizer rate and double the potassium rate in relation to nitrogen two weeks prior to temperature drop. As the flower buds become visible, the temperature can be increased to 50 to 55°F or maintained below 50°F (Figure 22-2).

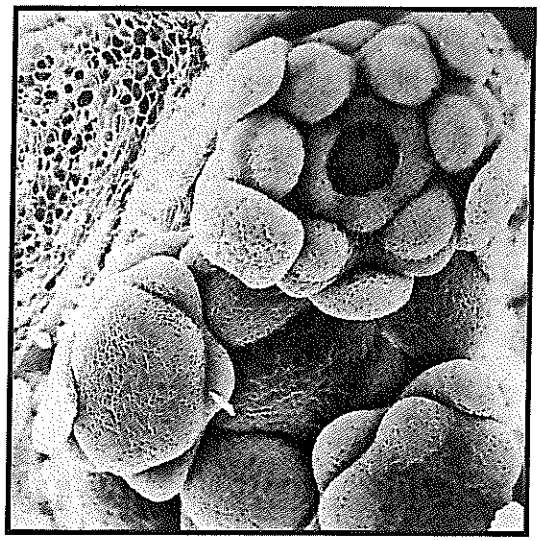

Figure 22-2. This is a scanning electron microscopy picture at 160x magnification of early flower bud formation in Primula vulgaris 'Dania.'

In recent studies with early cultivars of *P. vulgaris*, lowering the temperature to 46°F resulted in slower flower initiation than growing the plants at 54, 61, or 68°F. Flower initiation at 46°F was especially slow when combined with low light levels and short days. As the daylength increased from 8 to 14 hours and the light level from 2 to 10 $mol \cdot day^{-1}m^{-2}$, the rate of flower initiation at 46°F approached the rate of plants grown at 54 or 61°F. Two $mol \cdot day^{-1}m^{-2}$ corresponds to approximately 350 footcandles for 8 hours and 200 footcandles for 14 hours. Ten $mol \cdot day^{-1}m^{-2}$ corresponds to approximately 1,700 footcandles for 8 hours and 1,000 footcandles for 14 hours. Flowering was delayed about two weeks at 68°F and 10 $mol \cdot day^{-1}m^{-2}$ during a 14-hour day compared to 46, 54, or 61°F.

Although some suggest *P. vulgaris* flower initiation and development occur faster under short days, flower initiation was observed earlier as the daylength increased from 8 to 14 hours. Optimum daylength for fast flower initiation is likely longer than 14 hours for the early *P. vulgaris* cultivars. When natural daylengths are less than 12 hours, increasing the day by light extensions or night interruptions is recommended.

Daily irradiance is important in determining flower initiation efficiency, even though primula is considered to have relatively low light requirements. A minimum of 10 $mol \cdot day^{-1}m^{-2}$ is recommended during flower formation. Improving total daily light intensities during dark, cloudy, winter weather and keeping the temperature below 68°F are expected to improve rate of initiation and flowering. High natural light conditions may warrant shading to improve temperature control and prevent sunscald. Maximum light levels in primula production have been suggested at 3,000 footcandles.

There have been suggestions that primula flower initiation correlates to the appearance of a specific number of leaves. However, in *P. vulgaris*, flower initiation has been identified at plant sizes from 6 to 26 leaves. Flower bud formation was first observed in plants with six leaves when grown at 46°F, 14-hour daylength, and 10 $mol \cdot day^{-1}m^{-2}$. Plants having 26 leaves at flower initiation were grown at 68°F, 8-hour daylength, and 2 $mol \cdot day^{-1}m^{-2}$.

The most important condition for fast flower initiation and development in the early cultivars of *P. vulgaris* was long daylengths. Unsightly long and large leaves have been considered to develop especially under conditions with long days. Leaf length has been found to increase with increasing daylength, increasing light levels, and increasing

temperature up to 60°F. High levels of fertilizer and nitrogen in ammonium form are probably more likely, however, than are growing conditions of long days to result in plants with big leaves.

A drop in temperature for six weeks is recommended for flower bud initiation in *P. malacoides*. The temperature is dropped to 45 to 50°F when the plants have reached the desired marketable size. Following the six weeks of reduced temperatures, recommended temperature for flowering is 57 to 65°F. *Primula malacoides* will initiate flowers without a reduction in temperature, although the final plant and flower quality may not be as high.

P. obconica is grown at 65 to 68°F following transplanting. There are no recommendations or requirements for reduced temperatures to induce flowering. During the final stages of plant development prior to marketing, the temperature can be dropped to 59 to 65°F to improve plant quality, flower color, and size. *P. obconica* is not photoperiodic, although good total daily light intensities may shorten production time. During the summer, shading is required for temperature control and to avoid burning of the foliage.

Growth Regulators

Final plant height is normally not a problem in primula production. Slightly negative or zero DIF may be used if plant height and flower stem length are growing too long. B-Nine controls height in *P. vulgaris*, *P.* x *polyantha*, *P. sinensis,* and *P. malacoides*, but it is ineffective in *P. obconica*. Although B-Nine can be used to control plant height, proper spacing, temperature, and irrigation are the best methods for controlling stem elongation and plant height in primula.

Keeping Quality

Primulas are marketed when the first five to seven flowers have opened. A high quality primula should have flowers and remain attractive for 10 to 12 days. Primulas do best at 60 to 65°F. At higher temperatures and low relative humidities, keeping quality is limited. Silver thiosulfate (not cleared in the United States) has successfully been used to improve keeping quality of *P. vulgaris* to withstand transportation, high temperatures, and low relative humidities. *P. malacoides* and *P. obconica* especially need to be kept evenly moist at all times for good shelf-life performance. Proper care of *P. obconica* will result in continued flowering for two to four weeks. Following flowering, primulas can be planted as bedding plants at moderate outdoor temperatures.

Problems

Primulas are relatively pest free. Aphids, thrips, whiteflies, and caterpillars are the most commonly encountered pests. During germination and early seedling development, fungus gnats and shoreflies may become problems. Control of algae growth and pesticide use may be required to restrict the fungus gnat population during the early, sensitive stages of plant growth.

Low temperatures and high humidity are suitable conditions for the development and spread of *Botrytis*. Cultural control measures include good air circulation, sanitation, and irrigation practices. Deep planting covering the growing tip predisposes the plant to crown rot. Overwatering, especially of *P. malacoides* and *P. obconica*, may result in *Pythium* root rot. Symptoms of *Pythium* root rot include wilted plants with the roots turning brown and soft. *Ramularia* leaf spot has been observed in *P. acaulis* as brown, necrotic leaf spots that later may provide entry for *Botrytis*. Tomato Spotted Wilt Virus (TSWV) and Impatiens Necrotic Spot Virus (INSV) have been identified in primula. The symptoms include browning along the veins of the leaves and yellow mottling. There are no chemical controls of viral diseases. The best control of TSWV and INSV is to eliminate the insect vector spreading the virus. TSWV and INSV are spread by thrips.

Cultural problems include unattractive plants with long and large leaves. This problem can usually be traced back to high levels of nitrogen or high production temperatures. *P. vulgaris* sometimes fail to develop flowers. Exposure to cool temperatures before the plant has developed a good root system or high temperatures at sensitive stages of floral initiation are possible causes for blindness. Stress at any time during plant development has been suggested to cause the formation of extended flower stems in *P. vulgaris,* similar to the inflorescence of *P.* x *polyantha*.

Schedule

Total crop time varies with transplant size, pot size, environmental conditions, and species and cultivar produced (Table 22-1). Primulas do not all flower at the same time. Variations in flower time may be as much as two to four weeks.

Table 22-1. Suggested production schedules for primula.

P. vulgaris, P. x polyantha, and P. sinensis

Time	Cultural Procedure	Environmental Conditions
10 days	Sow seeds	60°F
	↓	
	Germination	
6.5 to 7.5 weeks	↓	60 to 65°F
	↓	
	Transplant 1/2 inch plug into 4 inch pots.	
14 to 20 weeks	↓	55 to 60°F
	↓	
	↓	At 6 to 10 leaves, drop to 40 to 45°F.
	↓	At visible bud, raise to 55 to 60°F
	↓	OR
	↓	maintain 55 to 60°F.
	↓	10-12 $mol \cdot m^{-2} day^{-1}$ and long days
	↓	(approximately 850 to 1,000
	↓	footcandles for 16 hours per day)
	Flowering	

Total crop time from seeding: 22 to 29 weeks (5.5 to 7 months).

P. malacoides

Time	Cultural Procedure	Environmental Conditions
12 days	Sow seeds	60 to 65°F
	↓	
	Germination	
6 weeks	↓	60 to 65°F
	Transplant 1/2-inch plug into 4-inch pots	
15 to 20 weeks	↓	60 to 65°F
	↓	At marketable plant size, drop
	↓	to 45 to 50°F for 6 weeks.
	↓	
	↓	Finish at 57 to 60°F.
	Flowering	

Total crop time from seeding: 23 to 28 weeks (6 to 7 months).

P. obconica

Time	Cultural Procedure	Environmental Conditions
1.5 to 2 weeks	Sow seeds	65 to 68°F
	↓	
	Germination	
11.5 to 12 weeks	↓	65 to 68°F
	↓	
	Transplant 1/2-inch plug into 4-inch pots	
12 to 16 weeks	↓	65 to 68°F
	↓	As the plants reach marketable size,
	↓	drop to 59 to 65°F.
	Flowering	

Total time: 25 to 30 weeks (6 to 7 1/2 months).