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Greenhouse Production of Dianthus

Introduction

Dianthus is a common name often used for the genus *Dianthus* in the family Caryophyllaceae, which has more than 300 species and from which carnations, pinks, and Sweet Williams are among the most familiar. Species within the genus may be biennials, perennials, or short-lived perennials grown and sold as cut flowers, potted flowering plants, or bedding plants, or used as elements in mixed containers. Individual species may have common names such as clove pink, maiden pink, cheddar pink, cottage pink, or grass pink. Interestingly, the word "pink" in the common name does not refer to the typical flower color but rather to the frilly margins of the flower petals that appear to have been trimmed with pinking sheers.

Types

In a horticultural sense, dianthuses often are loosely classified as carnations, pinks, or Sweet Williams. However, the names can be very confusing because breeding efforts to achieve larger flowers with a wider range of colors and a wider range of environmental tolerance is not strictly a taxonomy-based system. Many cultivars belonging to different types may be bred from one or more of the common garden species (Table 1). There also are many cultivars that do not belong to or have not been classified as any of the above three types. This publication will focus on dianthus types commonly grown for greenhouse production in market flats or containers and used primarily as bedding or flowering pot plants.

Dianthus barbatus

Sweet Williams are an old fashioned favorite of gardeners and have a biennial life cycle. Their leaves are sword-shaped, 2 to 3 inches long, born on short petiole, and have a prominent midrib. Flowers are ½ inch across and are produced in dense clusters that come in a wide range of colors, including many bicolored cultivars. They are vigorous biennials in cool climates, but they may be perennials in warmer climates. Older cultivars will not flower until the following year. However, breeding efforts have produced new cultivars that do not need a cold period and flower the first year from seed; therefore, they can be grown as annuals. Modern cultivar series may be tall for cut flower purposes or shorter for pot and bedding applications (Table 2). Newer *Dianthus barbatus* interspecific cultivars on the market possess the best characteristics from two species and have larger flowers, a longer flower time, a greater summer heat tolerance, and produce sturdier stems. These include the Bouquet, Melody, and Amazon series.

Dianthus chinensis

Chinese pinks have been used for more than 2,000 years in Chinese herbal medicine. Gardeners primarily grow this

Table 1. Important *Dianthus* Species Used in American Gardens

Scientific name	Common names	Life cycle	USDA Hardiness zone
Dianthus alpinus	Alpine pink	perennial	3 to 7
Dianthus barbatus	Sweet William	biennial	3 to 9
Dianthus chinensis	Chinese pink, Indian pink, rainbow pink	annual in many areas	7 to 10
Dianthus deltoids	Maiden pink	perennial	3 to 8
Dianthus gratianopolitanus	Cheddar pink	perennial	3 to 8
Dianthus plumarius	Cottage pink, grass pink	perennial	3 to 8

Mainly compiled from Galbally and Galbally (1997).

Table 2. Series and Cultivars of Dianthus for Bedding Plant, Cut Flower, and Pot Culture in Greenhouse Production.[1]

Series / cultivar	Company source	Garden height (inches)	Comments
	Dianthus barbatus		
Barbarini Series	S&G Flowers	8 to 10	Mix of 7 colors
'Carousel'	American Takii	20 to 24	Cut flower; dark red
'Forerunner Mix'	Ernst Benary	19	Color mix
Heritage Series	American Takii	16 to 20	Bedding or cut flower; 4 colors
King William Series	Grimes Seeds	18 to 24	Cut flower; 6 colors
'Indian Carpet'	Ernst Benary	9	Color mix
Noverna Series	Fred Gloeckner	10 to 14	8 colors
'Pinnocchio'	Grimes Seeds	8	Dwarf color mix; double flowers
'Roundabout'	Grimes Seeds	6	Mix of red, pink, and white flowers in solid and eyed types
'Summer Beauty Mix'	Bodger Seeds		Mix of pink, red, and white flowers on compact, bushy plants
'Super Duplex Mix'	Ernst Benary	19	Color mix
Sweet Series	PanAmerican Seed	18 to 38	Cut flower; 7 colors
'Wee Willie'	PanAmerican Seed	5	Dwarf; early
	Dianthus chinensis (interspecific)		
Amazon Series	PanAmerican Seed	18 to 24	Bedding or cut flower; 5 colors; single flowers
Award Series	Grimes Seeds	12	17 colors
'Baby Doll'	Bodger Seeds	10	Mix of white, pink, and crimson flowers
Bouquet Series	PanAmerican Seed	18 to 24	Bedding, cut flower, or 4-inch pot; 6 colors; single flowers
Carpet Series	American Takii	6 to 8	7 colors
Charms Series	Goldsmith Seeds	8 to 10	6 colors; 'Charms Crimson,' a Fleuroselect Gold Medal Winner
'Corona Cherry Magic'	PanAmerican Seed	8 to 10	Mix of colors; All-America Selections Winner; single flowers
Diamond Series	Sakata Seed	6 to 7	Mix of 7 colors; flats; spring or fall
Diana Series	Grimes Seeds	8 to 10	13 colors
Double Gaiety Series	Bodger Seeds	12	Many colors
'Duchess Mix'	S&G Flowers	8 to 10	Mix of light pink, pink, light carmine, and light violet
'Duke Mix'	S&G Flowers	8 to 10	Heat- and frost-tolerant; mixture of rose, carmine, crimson, and violet
Dynasty Series	PanAmerican Seed	16 to 20	Double flowers like miniature carnations; 13 colors
'Festival'	PanAmerican Seed		1½-inch flowers; carmine with rose flowers
'First Love'	American Takii	18 to 22	Cut, bedding, and color magician flowers; single flowers
Floral Lace Series	PanAmerican Seed	8 to 10	Large, early, single flowers; 13 colors
'Hearts of Fire'	Ball Seed	8 to 10	Mix of reds and whites, both solid and picotee; single flowers
Ideal Series	S&G Flowers	8 to 10	Bedding or pot; high cold and heat tolerance; 20 colors; single flowers
Ideal Select Series	PanAmerican Seed	8 to 10	Very cold-tolerant; 8 colors; single flowers

'Magic Charms Mix'	Grimes Seeds	6 to 8	Mix of red, white, and pink shades
Melody Series	Sakata Seed	16 to 18	Interspecific hybrid; 3 colors; single flowers
'Merlot Mix'	Ball Seed	10 to 12	Mix of lavender and burgundy shades; single flowers
'Merry-Go-Round'	Sakata Seed	6 to 7	Pure white color with scarlet center
'Panda Mix'	PanAmerican Seed	8 to 10	Single flower mix of solids and bicolors from white to crimson
Polor Series	American Takii	8 to 12	8 colors
Prize Series	Grimes Seeds	6 to 8	7 colors
'Rainbow Loveliness'	Grimes Seeds	9	Flowers lacy and deeply serrated
Rosemarie Series	Bodger Seeds	6 to 8	Pot, low border, or edging plant
'Rosy Red'	Grimes Seeds	8	Bright cherry with light center
Sundae Series	Grimes Seeds	6 to 8	6 colors
Super Parfait Series	PanAmerican Seed	8 to 10	2 colors; large flowers; early; flats and 4-inch pots
'Supra Purple'	Grimes Seeds	10	Unique, lacy flowers
Telstar Series	American Takii	8 to 12	11 colors; single flowers
'Tutti Frutti Mix'	Ball Seed		Color mix in salmon hues; single flowers
'Valentine'	PanAmerican Seed	8 to 10	Red flower; white picotee border; Christmas and Valentine's Day pots
'Velvet N'Lace'	Grimes Seeds	12 to 15	Fringed; double; bicolor

[1] This table is not exhaustive but includes series and cultivars widely available on the U.S. market.

[2] Names enclosed in single quotes are single cultivars. Names without quotes are series of cultivars.

short-lived perennial as an annual for their 1-inch diameter flowers and mild, spicy scent. Leaves are opposite and basal, forming a dense crown, often united at the base, forming a sheath about the stem, and are 1 to 3 inches long and ¼ inch wide, usually with ciliate margins, and medium green (not gray-green like other *Dianthus* species). Chinese pink flowers are formed on many individual stems with one, or rarely two to three, flowers per stem. Petals are deeply toothed toward the tips and rose lilac in color with a purplish center. Few modern cultivar series comprised of pure *Dianthus chinensis* are on the market today, but they include the Parfait and Valentine series (Table 2). Their flowers may be fringed; solid or bicolor; and red, pink, white, or purple in color.

Dianthus (interspecific)

These interspecific hybrids comprise the vast majority of cultivars on the market today. These crosses resulted from breeding efforts to improve the poor heat tolerance of pure *Dianthus chinensis* cultivars. In addition, these plants flower more freely and tolerate more heat and frost than either of the individual species. The flowers also are larger and are produced in terminal clusters. Plant height varies from a few inches to 18 inches; however, most are 10 to 15 inches tall. The flowers can be single, semi-double, or fully double, and they vary from 1½ to 2½ inches in diameter. Some cultivars exhibit a flowering trait called color magician. These flowers open as white or a pale color and darken to their mature color with age. These plants appear to produce multi-colored flowers on the same plant, such as dianthus 'First Love.'

Greenhouse Production

Greenhouse production of bedding dianthuses are started from seed, and the plants may be finished in market flats or in small containers, while miniature carnations are started from rooted cutting and are finished in containers.

Bedding Dianthus

Plug Production

Growers must decide whether to buy finished plugs or to grow their own from seed. They also face many challenges with growing their own plugs. These challenges include costs of labor, equipment, and growing facilities; poor germination percentage; and poor seedling vigor. Therefore, care and planning are necessary to produce the maximum number of transplantable seedlings. For the best results in starting dianthus seed, purchase high-quality seed from a reputable supplier. In planning the number of seed to order for production, consider that there are 26,000 to 34,000 seeds per ounce, depending on species and cultivar.

Dianthus seedlings can be produced in 406- to 288-cell plug flats. Choose a plug flat size to accommodate production scheduling and space utilization needs. Plug flats can be seeded with an automated seeder, such as

a rotating drum seeder, a shaker seeder, or a negative pressure seeder. Dianthus seeds are very small, which can cause problems in an automated seeder, resulting in multiple seeds per cell or empty plug cells and low germination percentages. Purchasing pelleted seed greatly reduces these problems, but it also reduces the number of seeds per ounce.

Sow seed in a plug flat filled with a well-drained, disease-free germination substrate with a pH of 5.8 to 6.2 and an electrical conductivity of 0.75 millimhos per centimeter (2:1 extraction method). Light is not required for germination of dianthus seeds; therefore, sow the seeds directly on the surface of the substrate, and cover them with a thin layer of fine grade vermiculite. Vermiculite helps to retain adequate moisture around the seed during germination.

Stage 1

Allow 3 to 4 days for radicles to emerge at 70 to 75 degrees F, and maintain about 95 percent relative humidity. Keep the germinating substrate moist but not saturated. Dianthus seed is very sensitive to high fertility in the germination mix. Keep ammonium levels at less than 10 parts per million. Move the flats out of the germination chamber on time to ensure quality of finished plugs. If left in the germination chamber too long, the seedlings quickly will show stretch.

Stage 2

As cotyledons emerge, reduce relative humidity levels, increase day temperature to 65 to 70 degrees F, and decrease night temperature to 60 degrees F. For the best root development, reduce substrate moisture levels once the radicles emerge, allowing the soil to dry slightly before watering. Continue to keep ammonium levels below 10 parts per million. At this stage, begin fertilizing with 50 parts per million nitrogen using a 14 0 14 formulation or any other low ammonium fertilizer source twice weekly. As the true leaves develop, increase the fertilization rate to 100 parts per million. To prevent disease, irrigate early in the day to ensure that foliage is dry by nightfall. This stage requires about seven days.

Stage 3

Reduce temperatures to 60 degrees F during the day and 55 degrees F at night. High temperatures will reduce crop time during this stage but will increase stretching. In this case, apply Bonzi spray at 6 parts per million to keep the plugs more compact. Allow the substrate to moderately dry between irrigations, but avoid wilting. This promotes root growth and controls shoot stretching. Keep the substrate pH at 5.8 to 6.2 and the electrical conductivity at less than 2.0 millimhos per centimeter. Fertilize at 100 parts per million, alternating between a 20 10 20 formulation and a 14 0 14 formulation. If you observe stretch, alternate the 14 0 14 with clear water instead of using the 20 10 20. Bonzi, B Nine, and Cycocel can be used to control plant height.

Dianthus chinensis

Growing On (Stage 4)

If you purchased the plugs, carefully examine the seedlings for incorrect nutrition or insect and disease problems. Remove several seedlings from each flat, and examine the roots for black or brown discoloration, which indicates possible disease or watering problems. Plants should be an appropriate size for transplanting because overgrown seedlings are difficult to grow into high-quality plants, and plants that are too small are difficult to transplant and slow to establish.

Transplant one seedling per cell in market flats. Generally, use one seedling for 3- to 4-inch pots and up to 3 seedlings for a 5- or 6-inch pot. The number of seedlings to transplant into containers larger than 4 inches depends on how quickly the grower desires a finished product and on the cost per seedling. Use only new, unused containers in dianthus production.

Immediately transplant because holding plugs in the greenhouse for too long can result in stunted growth and premature flowering. Keep the crown above the soil line when planting. Because of their upright growth pattern, plants in pots can be grown pot tight. Immediately and thoroughly water newly transplanted seedlings. Dianthuses have a higher tolerance for drier conditions than many bedding crops, so allow the substrate to dry slightly between watering. Watering too frequently can cause a higher potential for disease problems and yellowing of the foliage. A broad spectrum fungicide drench is highly recommended immediately after transplanting.

Growing Media and Fertilization

Use a well-drained, disease-free potting substrate with an initial nutrient charge and a pH of 5.8 to 6.5. Fertilize to an electrical conductivity of 1.5 to 2.0 millimhos per centimeter (2:1 extraction method) after transplanting. Early fertilization is important for a shorter crop time. For the first several weeks after potting, fertilize with 200 parts per million nitrogen using a 20 10 20 every third time the substrate requires irrigation. Afterward, alternate between a 20 10 20 and a 14 10 14 or equivalent at 200 parts per million. During the final week or two, only use a 14 0 14 and reduce the rate to 150 parts per million nitrogen, or only use water, depending on the substrate electrical conductivity. The electrical conductivity should be 1.5 to 1.8 millimhos per centimeter at visible bud and 1.2 to 1.5 millimhos per centimeter at finish. Using a low phosphorus fertilizer regimen similar to the one outlined above helps keep plants compact and prevents stretching. Dianthuses require adequate calcium in the fertilization program. If young plants show leaf tip necrosis, it is likely caused by a calcium deficiency. Have a substrate and tissue analysis performed, and if there is such a deficiency, use a calcium based fertilizer only for two to three weeks. Boron deficiency also can be a problem with dianthuses. Apply boron as Borax at a rate of 0.25 ounce per 100 gallons once 3 to 4 weeks after potting. Recommendations for tissue analysis nutrient levels are shown in Table 3.

Temperature and Photoperiod

Dianthuses are typically grown for the fall or early spring market. During fall production, keep plants cool by providing light shade and good ventilation with evaporative cooling. To establish the plants, provide 65 to 75 degrees F day temperatures, and 60 degrees F night temperatures for the first two weeks after transplanting. Finish with temperatures at 60 to 70 degrees F during the day and as low as 55 degrees F at night. However, night temperatures below 60 degrees F can delay flowering in cultivars in the Amazon and Bouquet series.

Provide as much light as possible while controlling temperatures. Thirty to fifty percent shade may be needed in late summer or early fall to control high temperatures. The best quality dianthus is achieved when plants are grown with high light of 5,000 to 9,000 foot candles. Plants grown under low light conditions become grassy, spindly, and stretched. Dianthus is considered to be a qualitative long-day plant. Therefore, if flowering plants are desired during short days in the winter months, provide supplemental lighting or night interruption lighting (50 foot candles from 10:00 p.m. to 2:00 a.m.) to stimulate flowering and improve crop uniformity. However, such lighting may cause plants to stretch and may require additional growth retardant applications.

Plant Growth Retardants

Dianthuses are very responsive to growth regulators. Growers should experiment with concentrations and application timing to find the best application schedule for their growing conditions. Generally, Bonzi is sprayed at between 20 to 30 parts per million once plants resume growth after transplanting in the final container. If more applications are necessary, apply 10 to 14 days apart at 20 parts per million. For a similar effect, you may substitute a tan mix of B Nine at 5,000 parts per million and Cycocel at 1,000 parts per million spray for the Bonzi spray.

Scheduling

Scheduling of dianthus production depends on many factors, including the cultivar, plug and final container sizes, season of the year, and growing conditions (light intensity, temperature, fertilization, application of plant growth retardants, etc.). Average production time in plug flats for most cultivars is 4 to 6 weeks. From transplanting to first flower takes an additional 5 to 6 weeks in market flats and 1 to 2 weeks longer in 4-inch pots. Develop consistent cultural practices for each crop, and keep detailed records on each crop.

Table 3. Recommendations for Tissue Analysis Nutrient Levels of Dianthus.

Percent					Parts per million				
N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
3.2 to 5.2	0.2 to 0.3	2.5 to 6.0	1.0 to 2.0	0.2 to 0.5	100 to 300	50 to 150	25 to 75	10 to 30	30 to 100

From Dole and Wilkins (1999).

Miniature Carnations

Traditionally, miniature carnations *(Dianthus caryophyllus)* were marketed in small containers for sales in early spring or early fall. Today, new cultivars have widened their use as pot plants, spring plants, summer garden plants, and as an element in mixed containers. Breeding of new cultivars has resulted in a wide range of cultivars with bright and distinctive flower colors, different flower shapes, and compact to medium growth habits. These dianthuses are cultivars of *Dianthus caryophyllus* that must be propagated from vegetative cuttings because hybrid seeds are not available.

Propagation

Growers may start pot carnations by ordering unrooted cuttings to root in-house for production or by ordering rooted cuttings that are transplanted to the finishing container. Order high quality, disease-free materials from specialized propagators because they maintain stock plants that are true to type and use culture indexing to eliminate diseases. Unrooted cuttings can be rooted in plug flats under intermittent-mist facilities and then transplanted to finishing pots. When labor availability is a greater concern than greenhouse space, it is more desirable to stick unrooted cuttings directly into finishing pots for rooting. Rooted cuttings can be directly transplanted to finishing pots.

Everything associated with propagation should be sanitized. Only use sterile substrate and new plugs flats or pots. For propagation in plugs, used a well-drained, well-aerated substrate with a good water-holding capacity. Root development usually is adequate for transplanting in 4 to 5 weeks after propagation begins. Transplant as soon as the cuttings are well-rooted. Use one cutting for 3½- and 4-inch pots and two cuttings for 4½- and 5-inch pots. When using larger pots or baskets, three or more cuttings will reduce crop time, and the plants will have better finished shapes than when using fewer cuttings.

Growing On

The potting substrate should be coarse and well-drained and have high water holding and high cation exchange capacities. Use sphagnum peat moss and pine bark or other bulk components with a high organic matter content. Drainage-promoting components may be perlite or vermiculite. Adjust the pH with dolomitic limestone to a target of 6.2 to 6.5 according to substrate test.

Miniature carnations can be grown almost pot tight, which maximizes the use of greenhouse space. In the balance between space and labor, putting the pots in final space can save labor for spacing but initially requires more greenhouse space.

Use frequent liquid fertilizer at 250 to 200 parts per million nitrogen as soon as the roots reach the pot margins. Maintain a media electrical conductivity at around 1.4 millimhos per centimeter. When plants show signs of stretch, consider one or a combination of the following methods: 1) Alternate the use of fertilizer and water; 2) Use low phosphate or no phosphate fertilizer; or 3) Use plant growth retardants (see the plant growth retardant section).

Watering, Light and Temperature

Carnations tolerate dryness much better than saturated media, so allow the substrate to dry up moderately between watering. Do not allow plants to wilt because it will stunt plant growth. To reduce the chance of disease, water early in the morning so that the foliage dries before evening.

Carnations demand high light to grow well. Low light conditions (under 4,500 foot candles) will prolong crop time and can cause poor branching. Daytime supplemental lighting is helpful during low-light seasons of the year. Flowers are induced when the plant has developed seven fully grown leaf pairs and when the day length is 13 to 14 hours long and of sufficient intensity.

For early markets from Valentine's Day until early April, keep the night temperature at 68 degrees F for the first six weeks, and then lower to 64 degrees F eight weeks before the market date. For flowers marketed in April and later, start with 68 degrees F for the first six weeks, and then reduce the night temperature to 60 degrees F. Combined with fertilization and plant growth retardant application, temperature is important for accelerating or delaying flowering for a particular marketing date. Short day lengths and cool temperatures extend crop time, while long day lengths and warm temperatures shorten crop time.

Plant Growth Retardants

Plant growth retardants often are not needed for early crops until April. For later crops, spray 2,500 parts per million B Nine or 50 parts per million Bonzi as needed. To avoid stretching of the flower stems, spray shortly before buds are visible, and moisten plants only slightly.

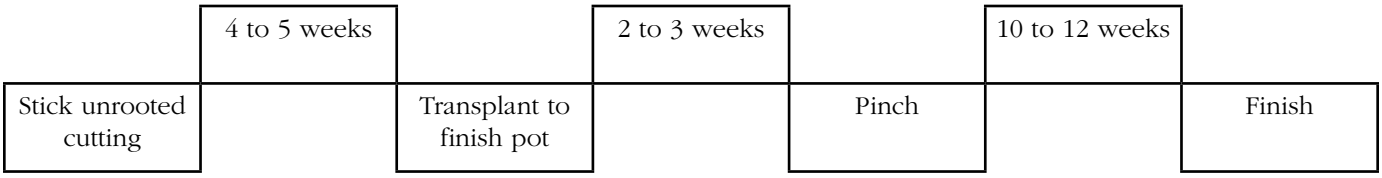
Pinching

Two to three weeks after transplanting, give the plants a soft pinch by removing just enough tissue to remove the growing point, while leaving four to six leaf pairs. Basically, each leaf pair yields a flowering shoot. If too many leaf pairs remain, stem quality and growing speed may be dramatically reduced.

Scheduling

The timing of miniature carnations depends on several factors, including cultivar, environmental conditions, pot size, and cultural practices. Generally, unrooted cuttings in 4-inch pots need 20 to 22 weeks for an early market and 16 to 18 weeks for market after April. Ordering rooted cuttings reduces crop time by 4 to 5 weeks. Depending on pot size, stick unrooted cuttings between weeks 32 and 38 for an early marketing. A general outline of a 4-inch miniature carnation greenhouse production schedule is in Figure 1.

Figure 1. A 4-inch miniature carnation greenhouse production schedule



Insects and Related Pests

Insects and pests can be a problem during dianthus production. Spider mites can be a problem during hot, dry weather, particularly on *Dianthus barbatus*. *Dianthus chinensis* and hybrids are susceptible to thrips and aphids during production. Aphids, red spider mites, and thrips are the most frequently encountered insect pests with *Dianthus caryophyllus*.

Diseases

Dianthus barbatus may have problems with *Fusarium* or *Rhizoctonia*. Leaf spot caused by *Alternaria* can become a problem on *Dianthus chinensis* and its hybrids. *Dianthus caryophyllus* is susceptible to several diseases largely because of their low tolerance to high substrate and air moisture levels. *Alternaria, Botrytis, Fusarium,* and *Rhizoctonia* all are common problems during production. To prevent major outbreaks, frequently scout for problems, and immediately and aggressively control diseases.

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