Section 9

Dwarf Carnation

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The development of dwarf carnations for pot plant production has long been the goal of many plant breeders around the world. Some of the earliest known breeding work on dwarfing carnations for pot plants was accomplished, to a degree, by the Steven Bailey Carnation Specialists of Sway-Hants in England in the early 1960s (Bailey, 1973).

In the early 1970s, the Sakata Seed Company of Yokohama, Japan, was actively engaged in several breeding programs including garden carnation dwarfness when Professor Goldsberry visited them. The visit led to more than 25 years of trials involving many seed-produced bedding plant annuals, pot plants, and cut flowers under Fort Collins, Colorado climatic conditions. After the *Dianthus caryophyllus* type dwarf carnation plants were introduced in 1974, selections were made and a small "hobby" breeding program was initiated with a goal of developing a pot carnation that would fit into an ongoing mini pot project (Goldsberry, 1987).

In 1983, the dwarf carnation breeding program grew in earnest. Funds including the Yoder Brothers "Bill Duffett" grant were obtained, special student projects were initiated, plant criteria were firmly established, and a project was outlined. Germplasm from carnation sources including Samen Mauser, Sluis and Groot, and Goldsmith seed companies was incorporated. Several germplasms from Dutch and American spray-type *D. caryophyllus* were also used.

In 1987, approximately 10 seedling selections were vegetatively propagated and sent to greenhouse test sites in different parts of the United States. From these selections, the Colorado Majestic Mountain™ (CMM) series was introduced. Its cultivars were named after eight of the 52 mountain peaks in Colorado that are 14,000 feet or higher in elevation. The following cultivars were patented from 1987 to 1989: 'Crestone' – white with purple picotee edge; 'Lindsey' – light pink; 'Maroon Bells' – maroon; 'Quandary' – red and white variegated; 'Redcloud' – red sport out of 'Quandary;' 'Shavano' – dark pink; 'Sneffels' – lavender pink; and 'Snowmass' – a white (Goldsberry, 1988).

Early in the 1970s, the Sakata Seed Company introduced an F-1 hybrid, seed-grown dwarf, red double named 'Juliet,' as well as other mixed colors. As breeding and selection continued, a new series was introduced in the early 1980s; many growers are presently producing Sakata's seed-grown, double 'Lilipot' mix in 4-inch pots for garden plantings. Neither *D. caryophyllus* lines are adapted to indoor use.

The Goldsmith Seed Company of Gilroy, California, also developed a *D. caryophyllus* line called the 'Knight' series in the early 1980s. That series of seed-propagated varieties proved to be somewhat tall and made an undesirable pot plant. Breeding work continued and in 1992, the 'Knight' series was discontinued and replaced by the 'Monarch' lines of *D. caryophyllus*. The 'Monarch' series is better suited for pot plants and definitely for bedding plant use.

Some European pot carnation breeders have been developing dwarf pot plants from other *Dianthus species*. Dr. Flavio Sapia of the Hybrida organization, Sanremo, Italy, introduced a cultivar named 'Milly' in 1985. It was developed by crossing an interspecific line of *D. chinesis* with a Japanese pot carnation line. Hybrida will be commercializing 20 pot carnation varieties of different colors in the near future (Sapia, 1997). Several other pot cultivars with *D. caryophyllus* lineage and of importance as a carnation pot plant have been developed, including 'Lanny' which was bred by the Klemm organization in Stuttgart, Germany. The Pinkie-Sunny family and 'Kopo' cardinal and scarlet were developed by P. Kooij. 'Pink Dancer' and 'Show Girl' are from Hilverda b.v. Both organizations are in Aalsmeer, Holland (Yoder Brothers, 1988). Yoder Brothers initially marketed the CMM and European dwarf carnations for pot plants, but dissolved the program in 1989. Today, the Messick Company, perhaps the leading broker of European pot carnation materials in the United States, markets several of them under the trademark Carinda™ carnations (Messick, 1997). Darrell Messick reports that many of the older European cultivars are diseased and a clean stock program is being undertaken. He noted that approximately 10 cultivars, including 'Pink Dancer' and 'Show Girl' – two of the better European cultivars, will be available in mid-1998.

The California Florida Plant Company began its dwarf carnation breeding program in 1987, under the direction of Walter Jessel. Its lines are also *D. caryophyllus*, and the first plants of the CFPC Adorables™ series were unexpectedly found in some crosses made for cut spray carnations. Continued breeding programs led to the CFPC Romance™ series, which are a little earlier and taller than the CFPC Adorables™.

Several of the Cal-Florida pot carnation cultivars can be used for window boxes, patio pots, and hanging baskets in geographical areas with somewhat cooler summer days and nights and high-light conditions (Figure 9-1).

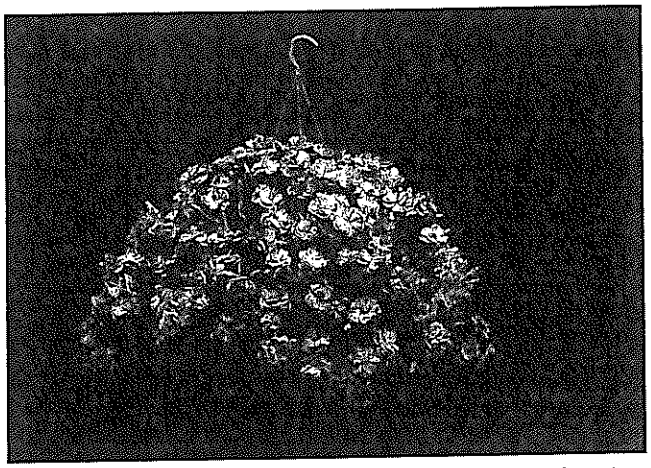

Figure 9-1. Potted carnation CFPC 'Dream' grown as a hanging basket.

Cultural Information

Propagative Materials

Vegetatively grown pot carnations are susceptible to many of the same diseases as their cut flower counterparts. Years of research on carnation cut flower stock plant production, disease control, micropropagation, and clean stock programs are detailed in a book on carnation production by Holley and Baker (1991). Valuable information on carnation cut flower mutations, clonal testing, selecting, and cutting production is also found in the book. The information is equally applicable to pot carnation culture. The described "clean stock" criteria must be maintained in order to have quality vegetative cuttings and ultimately superior pot plants. John Dixon, head grower for Skagit Gardens, Mount Vernon, Washington, recommends that all pot *Dianthus species* be cultured, indexed, and reselected every two to three years to ensure the availability of "clean" cuttings and vigorous plants (Dixon, 1997).

Storage

Rooted cuttings/plugs should be stored in a cool place until potted. They can be refrigerated (33 to 34°F) for one to two weeks, but don't let them dry out. If plugs are held in the greenhouse and become root bound, they make poor plants.

Pot Sizes

Azalea-type pots are recommended for aesthetic proportions (Figure 9-2).

4.5-inch pot	1 plug/rooted cutting
5- to 5.5-inch pot	1 plug/rooted cutting
6- to 6.5-inch pot	3 plugs or rooted cuttings placed at the outer edge of the pot.

Figure 9-2. Single *Colorado Majestic Mountain*™ 'Lindsey' in a 4-inch azalea pot and three plants in a 6-inch pot.

Choose plugs or cuttings of uniform size and development when more than one plant is placed in a container. Although the original intent of having a "mini pot" (4-inch) carnation still has merit and provides a well-proportioned finished product, it has become evident that such a pot is not practical because of inadequate water retention for both the grower and consumer. If the plants happen to dry out upon reaching the full-flowering stage, the pots often tip over.

Some of the CFPC Adorables™ and CFPC Romance™ cultivars have been used in "Belden"-type baskets. Growers should evaluate which cultivars do best in their geographical areas.

Potting

The planting depth is very important for carnation plants. They should only be deep enough to secure the root ball/plug and be "firmed in." Care is needed to avoid root breakage during firming. It is best if the "crown" of rooted cuttings or top of the plug is visible after potting. Plugs planted too deep often do not survive.

Fungicide Drench

A drench to minimize stem and root rot problems is recommended after planting. See the pot carnation pest section and consult a local Extension agent for the latest recommendations.

Spacing

Pots can be held pot to pot for the first seven to eight weeks after potting. For finishing, 4.5-inch pots should have a final spacing of three per square foot; 5-inch pots at two per square foot; and 6-inch pots spaced at one and one-half per square foot for finishing.

Pinching

A well-proportioned flowering plant depends on a properly timed and positioned initial pinch of the rooted cuttings to stimulate initial vegetative rather than flower bud development. All pot carnations require at least one pinch. Even though all nodes and leaf pairs cannot be seen at planting time, the propagator hopes to supply rooted *D. caryophyllus* plants with at least eight or nine nodes. The top six leaf pairs must be removed with the "pinch," because all these nodes are reproductive. The seventh and older nodes yield vegetative buds and will make the finished plant (Figure 9-3). The three or four leaf pairs left on the plant should provide three to four good vegetative breaks. Under proper pinching and growing conditions, quiescent buds of some cultivars often develop, resulting in four to seven vegetative breaks and a full, well-branched plant (Goldsberry, 1988).

When premature buds form, they must be carefully removed. Such a procedure is not a second pinch. A true second pinch, removal of the terminal growth of any shoots resulting from the initial pinch, will delay flowering of the resulting shoot by several weeks and may "overload" the plant and extend the total bench time six to eight weeks.

Next to watering, the pinch is the most important aspect of producing a well-proportioned and desirable pot carnation; experience will be the best teacher.

Watering

Like all pot crops, the type of growing medium used for the pot carnation and stage of plant growth will determine the watering frequency. As a general rule, water plants when the soil starts to feel dry to the touch but definitely before the plant wilts. The moisture content maintained in the medium will determine, to a degree, the plant height at flowering and timing for scheduling purposes. If *D. caryophyllus* plants wilt when they approach flowering, some stems may break at the main nodes.

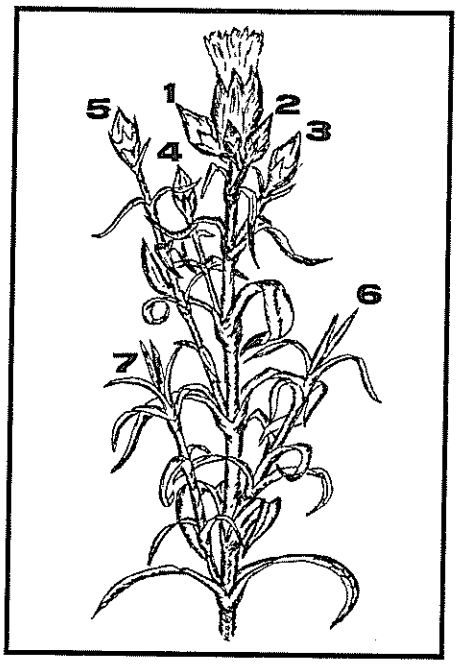

Figure 9-3. Anatomy of a dwarf carnation (*D. caryophyllus*) flowering stem. Terminal bud and five lateral buds (1-5); break 6 is an indeterminate shoot, and 7 is the first vegetative shoot. There are usually two to four quiescent shoots that are in axils below shoot 7.

Dwarf carnations have been grown on water mats and even watered with an overhead sprinkler system. Care must be taken when overhead watering is used. Splashing water is one of the fastest ways to spread carnation diseases. For example, one Florida pot carnation producer lost thousands of pot carnations to disease problems within days in the late 1980s. He was growing them on the ground and using a sprinkler watering system. If overhead sprinkling is considered, plants should be grown on benches or possibly on a weed barrier/large gravel ground cover with a periodic fungicide application. Plants with opening buds should be removed from growing areas with overhead watering systems. Water on flowers could not only lead to disease problems but might provide just enough weight to also break the stems at the nodes, especially on weaker products.

Fertilization

Most pot carnations have been developed and grown using a year-round continuous feed program. The CMM series was developed using a standard cut carnation nutrition program. The final feed at the end of the hose approximated (Goldsberry, 1988):

N = 200 ppm	Ca = 82 ppm	Zn = .3 ppm
P_2O_5 = 52 ppm	Mg = 18 ppm	Fe = .11 ppm
K_2O = 220 ppm	B = .6 ppm	

It should be noted that all fertilizer applications should include minor elements, especially boron because it is essential to good carnation growth. Limited and excess B levels both contribute to poor plant growth.

Cal-Florida provides a suggested fertilizer program for its CFPC Adorables™ and CFPC Romance™ lines. It involves rotating applications of 20-20-20 (ammonium nitrate, calcium, and potassium nitrate) and finish with a 10-30-20. Yoder (1988) recommended a constant feed of a standard 20-5-30 commercially prepared carnation fertilizer with minor elements at a level of 200 ppm N. If additional N is required, Yoder recommended nitrate forms of nitrogen for better control of growth and improved quality. Excellent pot carnation growth can be expected with a medium pH range of 5.5 to 6.5 and soluble salt readings approximating 200 mhos x 10^{-5}.

Scheduling

Pot carnations do not respond as uniformly as mums. During winter months, at least three weeks will be required to clear a bench from late summer pinches. In the summer, one to two weeks may be required. The irregular flowering of individual pot carnations is due to differences in pinch locations on the plants, air temperatures, and possibly moisture uniformity. The *D. caryophyllus* plants will normally flower 12 to 14 weeks following a spring, summer or early fall pinch. Pinches made in late fall through February require 18 to 16 weeks, respectively, to flower.

When a center bud is removed, at least two more weeks of bench time will be required before side buds show color. "Repinching" any extraneous side shoots may require three to four extra weeks on the bench.

Each grower must establish his or her own schedule for all types and cultivars of pot carnations, based on detailed records created from their specific environmental conditions and cultural procedures.

Disbudding

The *D. caryophyllus* cultivars have been designed and developed without a "disbudding" requirement, so minimum labor will be involved in the final product. The "master" pot carnation grower should monitor the crop daily. Premature budded shoots will have to be removed and extra vigorous breaks periodically "repinched" in order to shape and develop a pleasing finished pot.

Growth Regulators

Generally, chemical growth retardants are not needed for any species of dwarf pot carnation. However, applications may be desirable to "tone" some *D. caryophyllus* types. Cal-Florida has indicated that its plants never need a chemical treatment.

In 1987 and 1988, Valent Corporation asked Colorado State University to evaluate the use of Uniconazole (Sumagic™) on standard and spray types of cut carnations in anticipation of developing a desirable pot carnation. After that approach proved unfeasible, Sumagic™ and other available retardants were trialed on the CMM series and plant responses were evaluated. Pobudkiewicz and Goldsberry (1989a, 1989b, 1989c) determined the most effective stage of any retardant application during late fall or winter was six weeks following a pinch, when the new growth was 2 to 4 inches long. The best plants were obtained when 15 ppm a.i. Sumagic™ or Bonzi™ was applied six weeks following the pinch when vegetative laterals were 3 to 4 inches long. Cycocel™ significantly retarded plant height, but not to the desired degree. It was evident in all studies that plants treated with Sumagic™ had darker colored foliage, an increased number of vegetative breaks, improved symmetry, and were generally more aesthetically pleasing.

DIF Considerations

The concept of establishing the height of greenhouse-grown plants by controlling the differences (DIF) between day and night temperatures was in its infancy when the cultural techniques for the dwarf pot carnations were being established. Since the carnation is a cool temperature crop and the recommended night growing temperatures to be maintained are 10 to 15°F lower than the day temperatures, various degrees of stem elongation should occur according to the research and plant responses reported by Heins, et al. (1988). Although no "DIF" research has been conducted on any *Dianthus* species, it probably plays a large part in the greenhouse culture of all members of the family.

Pot Carnation Pests

Diseases

Carnations in general are susceptible to a number of stem diseases and root pathogens. Although no problems have been observed when crops are grown under well-developed sanitary conditions, the application of a systemic fungicide shortly after potting

is recommended. Care should be taken not to have any fungicide or insecticide residue on the foliage when buds are at the "pea-size" stage.

Botrytis may be a problem on buds and open flowers of some varieties in certain environmental conditions.

Insects

The dwarf carnation, like its cut flower counterpart, can easily play host to red spider mites, aphids, and thrips. Once thrips enter the opening buds, they are almost impossible to control. Use a preventative program for thrips, and watch for other insects.

Environmental Aspects

Media

A loose, well-drained growing medium is a must. A pasteurized medium consisting of 1 part soil, 3 parts sphagnum peat, and 3 parts no. 8 perlite (volume-to-volume) works well, as do most of the soilless products. Cal-Florida uses a redwood sawdust, bark, peat, perlite, and coarse sand mixture.

Starting Climate

After "watering in" plugs or rooted cuttings, mist the plants frequently for the first three to four days, but not after sundown. Good growth will be promoted with day temperatures held near 75°F and 58 to 62°F at night during the first week of production.

Growing Temperatures

Once plants are established, the temperature regimes will determine the crop quality and flowering schedule. Carnations are cool-temperature plants, and if they are grown with mums, poinsettia, lilies, or other warm-temperature plants, plant development will be poor. The Colorado Majestic Mountain™ carnations were developed in 54 to 56°F night and 60 to 62°F day "heat to" temperatures, with cooling started at 70°F during summer and winter. Yoder (1988) recommends maintaining day temperatures at 70 to 80°F during the day and 52 to 58°F during the night for the CMM and European carnation cultivars. Cal-Florida recommends 58 to 60°F night and 65 to 75°F day temperatures for their CFPC Adorables™ and CFPC Romance™ pot cultivars. Lower temperatures can delay the crop one to two weeks, and higher night temperatures contribute to uneven flowering. Some growers have produced quality plants by growing them in 60°F night temperatures until the secondary buds reach "pea" size, then reducing the temperatures by 4 to 5°F to finish the crop.

Carbon Dioxide

The CMM carnations were developed using 600 to 1,000 ppm CO_2 during daylight hours and periods of no forced ventilation. CO_2 fertilization can shorten the flowering time at least one week and will provide more "breaks," resulting in a fuller plant.

Light

Carnations are high-light requiring plants. They should be grown in the brightest greenhouses. The minimum light level of 4,000 footcandles will provide fair plant growth, but 5,000 to 6,000 footcandles are better. Some greenhouse shading in certain geographical areas may have to be used during summer months to help manage temperatures.

Photoperiod Treatments

Long-day treatments on cut flower carnations during winter months hasten flowering (Holley & Baker, 1991). Similar results should be expected on pot carnations, but the plant height may be affected. Preliminary studies at Colorado State University (Goldsberry, 1988) indicated that short-day treatments during summer months increased the number of vegetative breaks but delayed flowering.

A well-grown, carnation plant (*D. caryophyllus*) is one that has been properly watered and well fed, plus grown in appropriate temperatures and light intensities. Such a plant is characterized by having relatively broad, greenish blue leaves which are curled downward on the outer halves of the leaves (Figure 9-4, page 52).

Marketing Dwarf Carnations

It is recommended that pot carnations be marketed when the first terminal bud starts to open and one or two other buds are nearing color. There has been a general tendency for most cut flower *D. caryophyllus* species to emit ethylene, which under some "enclosed conditions" causes the flowers to "go to sleep." It has been reported that the CMM, CFPC Adorables™ and CFPC Romance™ series will also become "sleepy" if they are shipped in the open flower condition in tightly closed boxes. Therefore, they should be shipped when the first flower bud starts opening. Aside from potential ethylene damage, it is advisable to ship them before they are in full flower, to help reduce flower breakage. Buds

and flowers of *D. caryophyllus* species are somewhat brittle and may break without care during handling. Sleeving is recommended, especially for florist shops.

Prime dwarf carnation pot plants can be held in 34 to 40°F refrigerator temperatures for one to two weeks, but watch watering ... they will dry out.

Postproduction Considerations ... Home, Office, And Garden

Light Requirements

The continued development of pot carnation flower buds is related directly to the amount of light the plant receives after it leaves the greenhouse. All fully developed buds will open in most artificially illuminated offices and well-lighted areas of the home, providing 10 to 14 days of enjoyment. As flowers complete their flowering cycle and start wilting, they should be carefully cut off with scissors just above the next bud or flower. Attempts to break off a shriveled flower will usually result in breaking off the total cluster of buds and flowers.

New bud initiation and the development of immature buds require high light intensities to ensure their continued progress. Squeeze small buds to determine if they are developed. If they are hollow, light is inadequate. Also, if buds fail to continue developing and flowers are not opening, light intensity is probably the limiting factor. A south, west, or east window exposure will provide the greatest amount of light in the Northern Hemisphere and extend the useful life of a pot carnation. Plants placed in direct window sun can be abused due to drying of the growing medium. A lack of uniform soil moisture, plant nutrients, or low light can all prevent good plant performance.

Watering

Pot carnations will use more water than you anticipate. They should be watered when the soil starts to get dry to the touch. Smaller pots may require daily watering. Don't leave plants sitting in a dish of water ... root rot may result.

Temperature

Studies have shown that the CMM carnations perform well in home temperatures ranging from 60 to 72°F. Since the carnation is a "cool" crop, air-conditioned areas with high light should increase the effective life of the product.

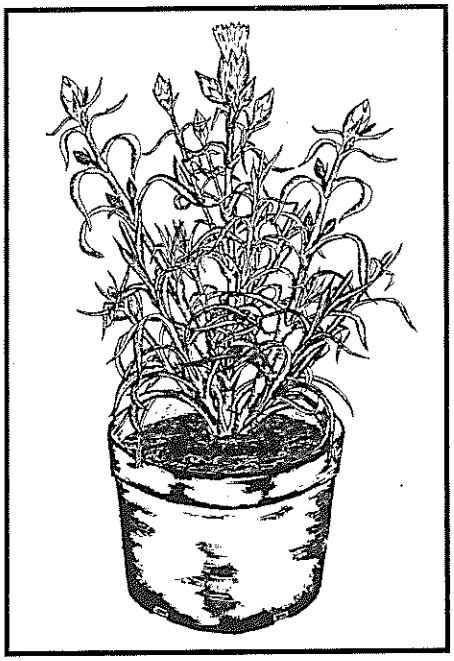

Figure 9-4. Saleable pot carnation (*D. caryophyllus*) with terminal bud of the primary stem ready to open. Once a terminal bud has started shriveling, it should be removed with scissors so the surrounding buds will develop easily. Once all buds on a stem have opened, the stem should be removed just above the next lateral vegetative shoot.

Fertilization

If the plants were properly fertilized during the greenhouse stage, adequate nutrients are present for a two- or three-week period in the office or home. Where adequate light intensities are available for continued plant development, a weekly fertilization program with a complete fertilizer is appropriate.

Scent

The clove or honey scent associated with some pot carnations is apparently linked to the temperature of the flower petals. While plants are in the greenhouse or garden, the scents are very evident. However, when plants are located in the home or office without exposure to solar radiation, the fragrance disappears almost completely.

Perpetual Longevity

Aside from the useful aspect of the dwarf carnation as a flowering pot plant in the home or office, it can be used in flower gardens as a perennial in the cooler geographical areas. Spring planting is recommended. The soil ball should be gently broken open around the edge, planted in a well-drained soil, and watered daily for at least five days, then water as

needed. Most pot carnations appear to do well where summer night temperatures remain in the 60°F range, days are less than 90°F, and winter temperatures are above -10°F. They should not be mulched, but watch winter watering.

Author's note: The source of CFPC Adorables™ and CFPC Romance™ dwarf carnation cultivars is California Florida Plant Company. Information on the availability of the Colorado Majestic Mountain™ series is through Donath Lake Farm. For information about the future availability of the European dwarf pot carnations in the United States, contact the Messick Company or Skagit Gardens.

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