Baker

CARNATION CULTURE IN HAWAII

DANIEL T. SHIGETA · UNIVERSITY OF HAWAII
COOPERATIVE EXTENSION SERVICE · CIRCULAR 395

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CARNATION CULTURE IN HAWAII

DANIEL T. SHIGETA

Carnation is one of the major field-grown floriculture crops in Hawaii. In 1959, carnation production for both lei and cut flower purposes amounted to $217,791, according to the preliminary 1959 Census of Agriculture. A total of 86 farms reported the sale of 20,113,500 carnations in 1959. For cut flowers, growers receive average prices ranging from $.70 to $1.00 a dozen, depending on quality. The average price of flowers for leis is $1.00 a hundred. Little fluctuation in price has been noted through the year, except that during the winter period, the price of flowers for leis usually increases to $1.50 a hundred.

Carnation production in Hawaii has a bright future. Considerable quantities are flown to Hawaii from the Los Angeles and Denver areas. To increase sales and offset mainland imports, growers in Hawaii must produce good, clean flowers of uniform quality and at a steady rate throughout the year.

The principal carnation-growing areas are in Kula, Maui, and in Wahiawa and Koko Head, Oahu. Considerable interest has been shown in growing mainland-developed hybrid carnations for the cut flower market. The cool evening and warm day temperatures of Kula and Wahiawa have been found to be well suited for

growing these hybrid carnations. In the warmer lowland area of Koko Head, carnations are grown only for leis.

Growing carnations in the field imposes many problems to the grower. Severe damage has been suffered from wind, rain, disease, and insects. In addition, dust from footpaths and nearby roads makes it difficult to produce clean, good-quality flowers.

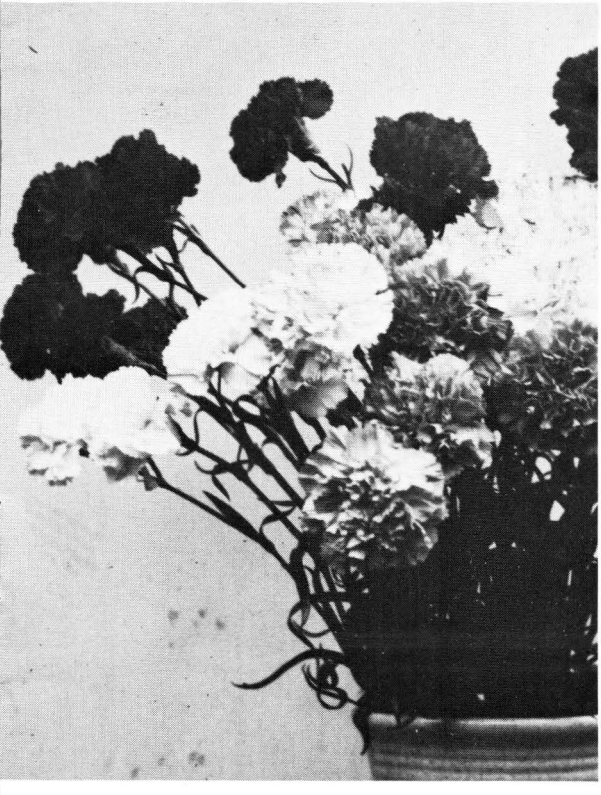
VARIETIES . . .

The more popular varieties grown in Hawaii include the following:

WHITE
Colorado White Sim, Improved White Sim
White Apollo
SALMON PINK
Salmon Sim
LIGHT PINK
Pink Sim, Portrait
RED
Cardinal Sim, Colorado Red Sim
YELLOW
Harvest Moon, Improved Miller's Yellow
VARIEGATED
Gayety, Peppermint Sim
SPECIALTY
Tangerine Sim

Many growers have found that Sim varieties perform very well under field conditions in Kula and Wahiawa. Lei producers normally grow the hybrid varieties listed above and do not remove lateral buds. Uniwai (dark pink), a sport developed at the University of Hawaii Agricultural Experiment Station, is grown by the low-elevation growers, such as those in the Koko Head area. This variety is not well adapted to high-elevation farms.

Figure 1. A field of Colorado White Sim.



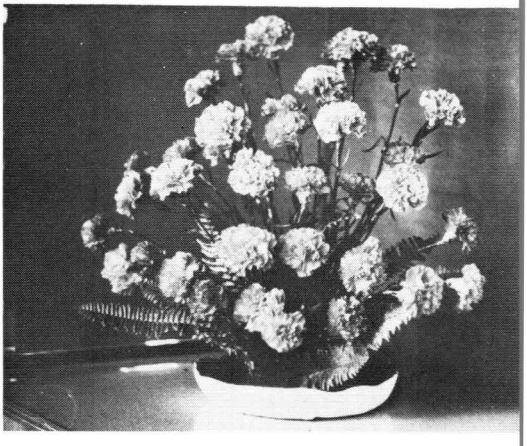


Figure 2 (above). A mixture of Gayety and Cardinal Sim.

Figure 3 (left). A mixture of four carnation varieties, with blossoms ranging in color from deep pink to deep red.

CULTURAL PRACTICES

TIME OF PLANTING...

In Hawaii, carnations are planted in the field all year. Very good yields in the spring can be obtained by planting in the field during the winter months. The largest demand for lei flowers is in May (May Day) and June (graduation time). Demand for cut flowers is high during Easter, Mother's Day, Japanese Bon Festivals, memorial Day, and other holiday seasons. Field plantings should be made 6 to 8 months before the time of greatest demand so that the plants are in peak production at the right time. With good cultural practices, production can be high for 2 to 2½ years before replanting becomes necessary. In Kula, a ¼-acre planting yields an average of approximately 50 to 65 dozens of cut flowers per week. The yield for lei flowers is usually 5 times greater than for cut flowers, since no disbudding is done.

Figure 4. M. Morimoto's planting of lei carnations in Kula.

Figure 5. Well-rooted cuttings ready for field planting.

PROPAGATION . . .

Many diseases affect carnation plants, so it is advisable to obtain good-quality rooted cuttings from reputable nurseries. The grower can produce his own planting material by maintaining a "mother block," or a special area free from diseases, with sterilized soil for growing cuttings only. Strong and healthy cuttings about 4 inches long (2 to 3 inches long in the lowlands) should be selected. It is recommended that the base end of the cuttings be dipped into SNA (sodium naphthalene acetic acid) rooting-growth regulator powder before planting them in a sterilized medium.

The growth regulator may be prepared by the grower. For 50 grams (1¾ ounces) of growth regulator powder (SNA) at 1,000 parts per million with fungicide:

1. Dissolve 50 milligrams of SNA in ¼ cup alchohol.
2. Add 50 grams of talc gradually to make a soft paste. Add more alchohol if the paste is too thick.
3. Add 5 grams of the fungicide (Fermate*). If paste is not soft, add more alchohol and mix well.
4. Let stand in a dry, cool, and dark place until thoroughly dry.
5. Pulverize into a fine powder before using.

Heavy garden soil with poor drainage is not conducive to rooting carnations. Vermiculite* or Perlite*

*Trade name. Any trade name or brand used in this circular does not constitute an endorsement of the product by the University of Hawaii Cooperative Extension Service.

Figure 6. For rooting carnation in loose garden soil, shade is provided for two weeks and gradually removed as cuttings become well-rooted.

Figure 7. A mixture of Perlite, Vermiculite, and soil is being used as a medium in T. Shibuya's mist chamber.

(sponge rock) are good rooting media (Figure 5). By using a mist chamber, the cuttings are exposed to direct sunlight (Figure 7). Photosynthesis then continues at a relatively high rate and disease problems are decreased. Misting time during summer months is two 4-second mistings per minute, and during winter months, one 4-second mistings per minute. Carnations are ready for transplanting in 3 to 4 weeks.

Fair to good results have been achieved by Kula growers who root carnations dipped in SNA growth regulator and planted in loose garden soil. Two applications of water with a sprinkler are made daily. Shade is provided for approximately 2 weeks and gradually removed (Figure 6). The cuttings are ready for field plantings in 6 to 8 weeks. Weekly applications of a fungicide are advisable.

SOIL REQUIREMENT AND PREPARATION...

Loose, well-drained soils, high in organic matter, are ideal for carnation growing. The optimum pH or soil reaction is between 6.5 and 7. Since carnations in Hawaii are grown in the field rather than in glass or plastic houses (bench culture) as on the mainland, control of soil-borne diseases is very difficult and has caused severe damage, especially in Koko Head. Before every field planting, fumigation with chloropicrin, Mylone*, or Vapam* is recommended. In fields with severe fusarium damage, methyl bromide has been used by some growers.

When using liquefied gas under pressure (methyl bromide), the area to be fumigated must be covered with a gas-proof material, such as plastic or polyethylene sheets (Figure 8). When using gas, do not plant until 72 hours have elapsed. When using liquid fumigants, plant 2 to 3 weeks later. Experimental work shows that light damage consisting of drying leaf tissue can result in Hawaiian soils when methyl bromide is used at the rate of 1 pound per 100 square feet. Growers in Kula have used methyl bromide with good results for weed and fusarium wilt control. Occasional light to moderate bromide damage has been experienced.

Post-planting applications of BBC* soil fumigant to control nematodes have been quite effective in Kula. At the rate of 5 gallons per acre or 6 teaspoons per 100 square feet, 70E water-soluble BBC gave good results when applied with a soil injector 6 inches from the plants at 12-inch intervals.

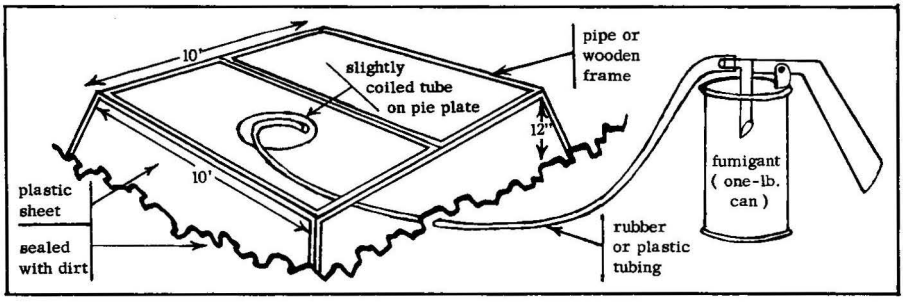


Figure 8. Sketch of gas fumigation layout using plastic sheet on pipe frames. The width and height may be varied to fit planting area. A larger frame may be used when applying gas from large cylinders or several one-pound cans.

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Added benefits of weed control are obtained with soil fumigations when methyl bromide and Tri-Zone are used. Chloropicrin and Mylone kill weed seeds but are not as effective as methyl bromide.

Vapam (sodium N-methylclithiocarbamate dihydrate) used at the rate of 1 quart per 100 square feet by hand injection or flood irrigation can control nematodes and soil insects very effectively. When used in drenching at the rate of 10 parts per million, Vapam has controlled certain kinds of Fusarium, Rhizoctonia, and Pythium (damping off). Seven to 10 days after the land has been treated, lightly break the soil crust to allow the gas to escape. In most soils, the crop may be planted in 14 days. If prolonged rains follow the application, it may take 20 days or more for the fumes to escape. Vapam at the rate of 75 to 100 gallons per acre has controlled Bermuda grass, nut grass, purslane, and other weeds and grasses.

FERTILIZER APPLICATION . . .

When transplanting the rooted cuttings in the field, fertilizer should be buried 1 inch deep beneath each plant. Ammophos (11-48) at the rate of approximately 2 pounds per 100 feet of row, or 1½ tablespoons per plant; or X-4(8-20-5) at the rate of 2½ pounds per 100 feet of row is recommended. Side dressings of 8-16-10 fertilizer at ½ to 1½ pounds per 100 square feet may be applied 4 to 6 weeks after transplanting. The frequency and amounts of fertilizers to apply throughout the crop period vary with the soil types and conditions.

It is recommended that periodic soil samples be taken to determine levels of potash, calcium, phosphorus, and pH. Suggestions of the type and amount of fertilizer to use and lime requirements are made in the soil reports. Most Hawaiian soils are more strongly acid than pH 6.5. Best results can be obtained from lime when it is applied well in advance of planting a crop or applying fertilizer. Six months is recommended, but when this is not practical, at least 30 days should be allowed between liming and planting.

SPACING AND SUPPORT SYSTEMS . . .

Three methods of spacing are popular with growers. Most popular is 8 inches between plants and 8 inches between rows. Some growers prefer 8 inches between plants and 10 inches between rows, while others claim that a tight 6×6 inches provides mutual support among stems. Two- and 3-row plantings in each bed with approximately 30 inches between beds is quite popular. In multiple-row beds, weed control and side dressings of fertilizer applica-

Figure 9. A well-spaced, supported planting by T. Watanabe. Note cross strings, which form 8 × 8-inch squares.

Figure 10. Wooden support frames used in a Wahiawa planting.

tions become more difficult. Growers of lei carnations prefer the 3- or 4-row beds.

For supporting carnations grown for cut flowers, stakes protruding at least 24 inches above ground with at least 3 strands of wire or string are recommended. Cross supports of string, wire, or thin bamboo spaced 8 inches apart will provide good protection against wind damage and prevent crooked stems (Figure 9). Lei flower producers in Kula usually use 2 strands of wire and no cross supports (Figure 11).

Mulching footpaths and beds with cane bagasse, wood shavings, or other suitable material is recommended to conserve moisture, reduce weed growth, and, most important, keep dust down to prevent the flowers from becoming dirty.

Figure 11. Easy field wiring is possible by using an Army surplus metal wire spool, as shown above by K. Suehisa.

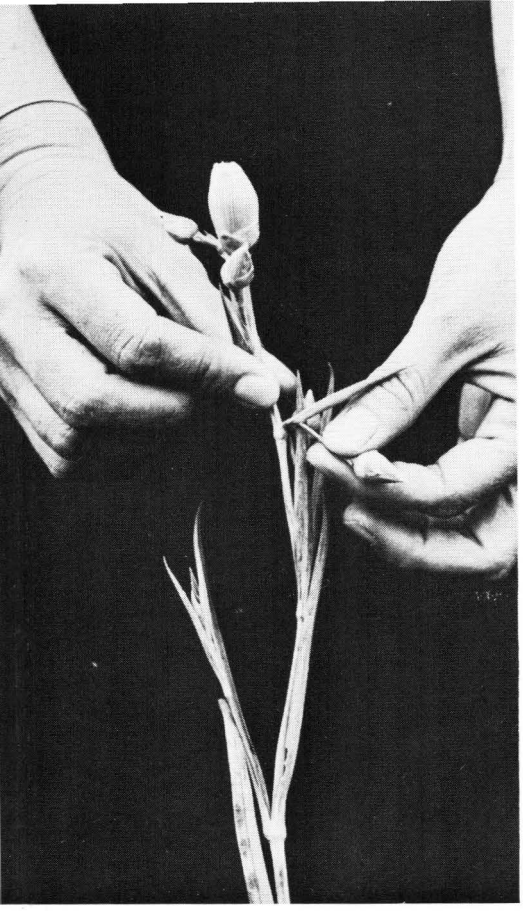

Figure 12. To disbud carnations, pull downward at the leaf joints of all lateral buds and slip growth.

PINCHING AND DISBUDDING . . .

Plants are pinched the first time about 3 to 4 weeks after planting. One or two of the resulting breaks or slips may be pinched again to produce a total of 4 or 5 branches to develop into flowers. Some varieties or strains produce more breaks or slips than others and therefore one pinching may be adequate.

Carnations grown for cut flowers should be disbudded in order to produce large blooms. Large buds and slip growth at leaf joints are removed by pulling downward while supporting the stem with the other hand (Figure 12).

SPLITTING CALYXES . . .

Splitting calyxes is one of the major problems in producing cut flowers. The petals droop at the split region and the result is an asymmetrical flower with reduced value. In the case of lei flowers, splitting is not a problem since the calyx is removed before the flowers are strung into leis.

Calyx-splitting is caused by a 10 degree or more drop below normal in night temperature, a high level of nutrients in the soil, and a low nitrogen level.[1] Splitting is also

[1] Kamemoto, H. and H. Y. Nakasone. *Carnation Variety Trial.* University of Hawaii Agr. Expt. Sta. Cir. 51, July 1956.

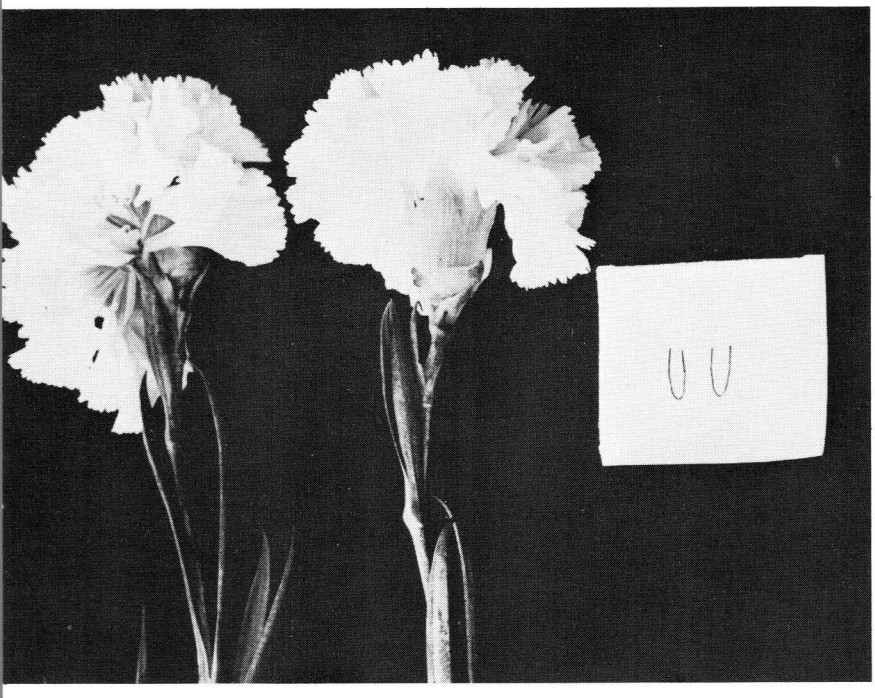

Figure 13. The split calyx of the left flower can be mended with a small wire staple, as shown in the right flower.

known to be an inherited characteristic, so that some varieties produce splits regularly while others produce them rarely, or not at all. To prevent splitting, some growers tie the calyx with Twistems* or apply a small rubber band at the advanced bud stage. Others mend the splits with tiny green wire staples (Figure 13).

*Trade name. Any trade name or brand used in this circular does not constitute an endorsement of the product by the University of Hawaii Cooperative Extension Service.

INSECTS AND DISEASES

CARNATION INSECTS . . .

The major insect pests on carnations are aphids, thrips, and red spider mites. Red spider becomes especially troublesome during the warm summer months. If a strict spray program is followed, these insects, as well as other occasional ones, can be controlled. The dilution tables given on the next page show insecticides and fungicides used in controlling insects. The insecticides and fungicides are compatible with each other and therefore may be mixed in the same tank to reduce spraying time.

TOXIC CHEMICALS . . .

The following safety precautions should be taken in handling and using parathion, phosdrin, and other toxic chemicals:

- Store the material under lock and key in a well-ventilated storage room outside the dwelling.
- When mixing and spraying:
  1. Wear a chemical cartridge-type respirator. Dust filter-type is not adequate protection.
  2. Wear natural rubber gloves and protective clothing.
  3. Mix only amounts recommended on container. Never make mixture stronger.
  4. Stay on the upwind while spraying. Avoid still, humid days for spraying.
  5. Dusting and fogging and knapsack-type applicators are not recommended for parathion.
  6. Do not eat, drink or smoke while spraying.
- After spraying parathion:
  1. Bury empty containers. Do not burn empty containers near populated areas.
  2. Change clothing and take a shower after spraying.
  3. Clean respirator thoroughly after each use. Wash with soap and water after removing the chemical cartridges.
  4. Change the chemical cartridges after 8 hours of use. Cartridges can be bought separately. A contaminated mask is more dangerous than no mask.
- Keep out of fields sprayed with parathion for 24 hours. If field must be entered before 24 hours, put on respirator, gloves, and protective clothing.
- Post poison warning signs around fields after spraying with any type of poison. This is required by State law.

FUNGICIDE DILUTION TABLE

Amount per 100 gals.		*Amount per gal.*
1 LB. Ferbam	76% w.p.* (Fermate)	2 TSP.
1 LB. Zineb	65% w.p. (Parzate, Dithane Z-78)	2 TSP.
1 LB. Captan	50% w.p. (Orthocide)	2 TSP.
2 LBS. Tribasic Copper Sulfate	53% w.p.	2 TSP.

*Wettable powder

INSECTICIDE DILUTION TABLE

Insect	*Control*	*Amount per 100 gals.*	*Amount per gal.*
Aphids	Malathion	2 LBS. 25% Malathion w.p.*	2 TSP.
	Lindane	1 LB. 25% Lindane w.p.	1-½ TSP.
	Dibrom	1 QT. Dibrom 8 emulsive	1 TSP.
Thrips	Diazinon	2 LBS. 25% Diazinon w.p.	1-½ TSP.
	DDT	2 LBS. 50% DDT w.p.	3 TSP.
	Lindane	1 LB. 25% Lindane	2 TSP.
Red Spider	Aramite	2 LBS. 15% Aramite w.p.	2 TSP.
	Chlorobenzilate	1 LB. 25% Chlorobenzilate w.p.	1 TSP.
	Kelthane	1 LB. 25% Kelthane w.p.	1 TSP.
	Sulfur	5 LBS. 95% Sulfur w.p.	3 TSP.

*Wettable powder

CARNATION DISEASES . . .

Carnation disease can be controlled best by following a strict preventive program. Careful selection of planting materials, good soil treatment, and complete spray coverage at regular intervals will prevent severe outbreaks of diseases. It is quite difficult and expensive to eradicate diseases after the crop has been damaged.

Carnation diseases can be grouped into three major classes:

1. Viruses
   a. Streak
   b. Mosaic
   c. Yellows
2. Bacterial diseases
   a. Bacterial wilt (Pseudomonas caryophylli)
3. Fungal diseases
   a. Fusarium wilt (Fusarium dianthi)
   b. Fusarium rot (Fusarium roseum)
   c. Rhizoctonia solani
   d. Sclerotium rolfsii
   e. Alternaria
   f. Septoria leaf spot (Septoria dianthi)
   g. Botrytis
   h. Rust (Uromyces)

Figure 14. Disease prevention is possible by spraying fields thoroughly at regular intervals. When using highly toxic chemicals, respirators, protective clothing, and rubber boots and gloves must be worn.

VIRUSES . . .

Carnation viruses cause mosaic, streak, and yellows. They are difficult to control in the field. Good insect control measures and careful selection of planting material are recommended as a control program.

BACTERIAL AND FUSARIUM WILTS . . .

The most important diseases of the carnation are bacterial wilt, caused by the organism Pseudomonas caryophylli), and fusarium wilt, caused by Fusarium dianthi. Both diseases are vascular in nature—that is, they are lodged in the stems of the plants. Their symptoms are remarkably similar. An early symptom is wilting of single branches or of groups of branches on one side of the plant (Figure 15). The foliage becomes grayish green, then turns light yellow or straw-color and dies. Symptoms may rapidly show on other parts of the plant. When conditions are right, usually in the heat of summer, the disease spreads rapidly and causes considerable losses in the bed. The symptoms may not show and the plants may look healthy for many months before the disease progresses enough to kill the plant. A complex of bacterial and fusarium wilts has been very destructive in Koko Head Valley.

Control measures must be practiced along two lines simultaneously. The first is to reduce the pathogen or disease population in the soil by fumigating, so that the healthy plants can be maintained. The second is to prevent the field from being reinfested with the disease organisms by using disease-free slips or cuttings. This is absolutely necessary in the control of wilt diseases because very frequently the pathogens are present in the vascular systems (within the stems) of apparently healthy plants. For this reason, only sources of cuttings which are known to be free of the wilt pathogens should be used. It is rec-

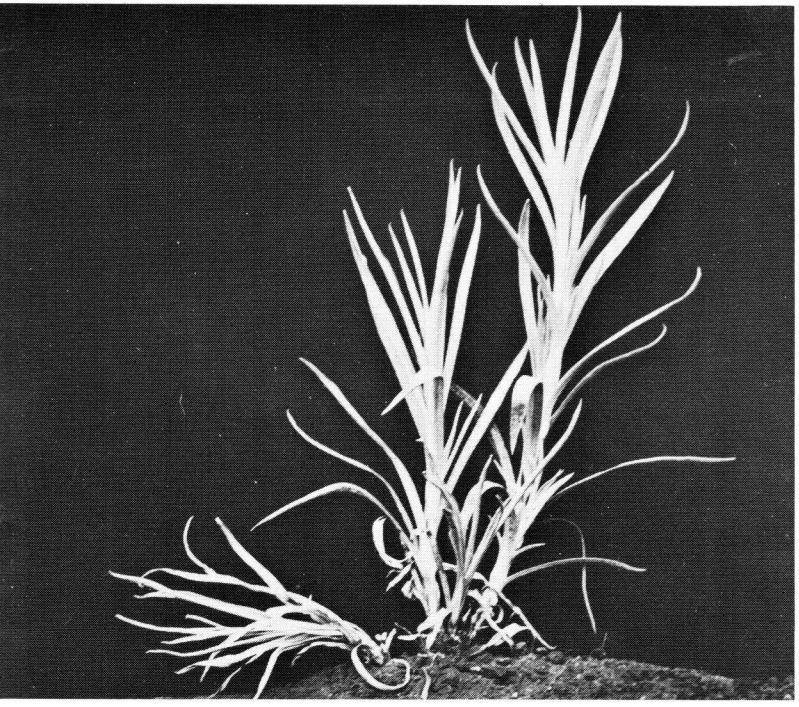

Figure 15. Fusarium wilt shows up in branches wilting, as shown above. Dry rot and girdling follow, and eventually the plant dies.

ommended that rooted slips from reputable nurseries be purchased at least every 2 or 3 years. When producing planting material in a "mother block," the same ground is used over and over with only chemical fumigants as pretreatments, making for difficult disease control and high accumulation of soluble salts. Unfortunately, at the present time, there is no absolute control measure over disease organisms.

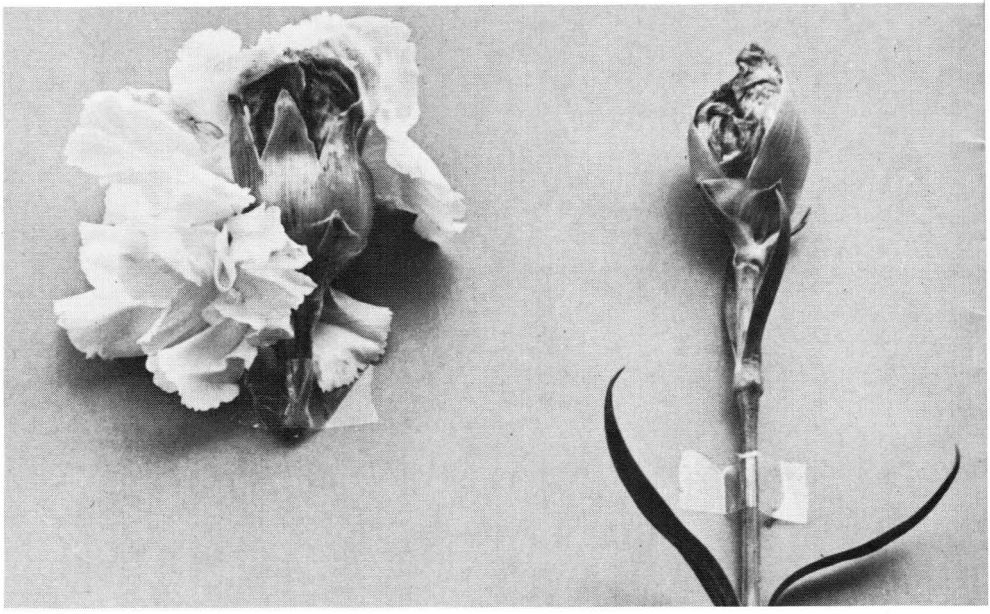

Figure 16. Alternaria damage consisting of brown, dry, shrunken areas laden with black spores can be seen on the blossom and bud shown above.

ALTERNARIA BLIGHT OR LEAF SPOTS . . .

Tiny purple spots on the leaves is the first symptom of alternaria. Later, these spots enlarge to form light brown, shrunken, dead areas in the center of the leaves. Infection in the leaf blade causes the leaf to constrict and twist. Often the tips of the leaves are killed. This disease also affects the stem and flowers. Stems are affected at the nodes. As the disease progresses, the stems become girdled and die. Dark brown spots with black deposits of spores appear on the flowers.

Injuries from chemicals and pests can contribute to attacks of alternaria. The disease can spread from plant to plant by water splashing in the field when irrigating or during rains. Spores of the fungus can be carried with cuttings, especially from contaminated areas. The disease also affects cuttings in the rooting beds and boxes as leaf spots or blight and as basal stem decay. The black deposit of spores generally associated with the disease is a diagnostic sign.

Spraying with zineb or Captan with a spreader-sticker added is recommended for control. Tribasic copper sulfate will also aid in controlling the fungus.

BORTRYTIS FLOWER BLIGHT . . .

Soft, water-soaked areas on the petals is an early symptom of bortrytis flower blight. Later, a brownish-gray organism can be seen growing over the top of the flower. This disease spreads very rapidly during high-humidity periods. Spraying with zineb is recommended.

SEPTORIA LEAF SPOT . . .

Septoria leaf spot is a disease which affects leaves, stems, and calyxes. Light brown, elliptic spots that have violet or purple borders appear and these spots unite to form irregular areas. The spots are dotted with black, pinpointed spore sacs of the fungus. Spraying with tribasic copper sulfate at the rate of 2 pounds per 100 gallons of water is recommended. Stop using this chemical after control is achieved, because the copper can have a toxic effect on carnations.

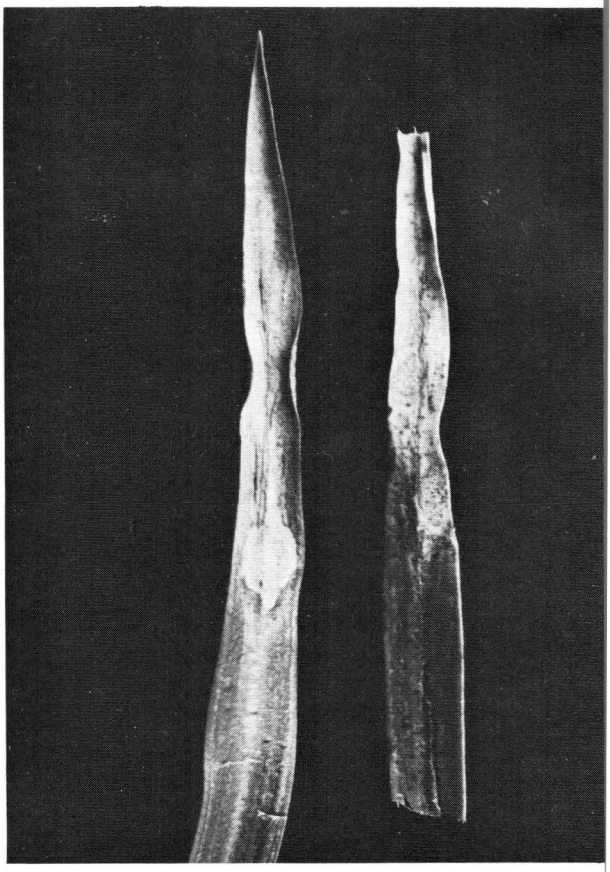

Figure 17. Dead areas overlaid with spores are usually symptomatic of septoria leaf spot. Leaf becomes twisted and often the tip is killed.

MARKETING CARNATIONS

MARKETING QUALITY . . .

The keeping or lasting quality of carnations is closely related to good cultural practices. Irrigation, consisting of regular, heavy watering, is important. Maintaining a good fertilizing program and following a strict spray schedule will enable growers to produce large-sized, good-quality flowers.

Consumers, of course, prefer flowers that are freshly cut. Cut flowers should therefore be kept in storage for the shortest possible time. The normal practice of growers is to harvest one day before shipment. The flowers are cleaned, graded, and packed during the afternoon and evening. It is important to put cut flowers in temperatures of 35° to 40° F. as soon as possible. The flowers should be stored under refrigeration at this low temperature at 85 to 90 percent humidity, if possible. Vacuum cooling units are ideal for rapid cooling. Within 40 minutes field temperatures of 74° F. can be lowered to 38° F.

Figure 18. When harvesting carnation, J. Yokoyama uses a basket with canvas strap so both hands are free to work and easy movements in the field are possible.

HARVESTING . . .

Carnations are harvested with a pair of sharp garden scissors or pruning shears.

Lei flowers are cut with about ⅛-inch of the stem remaining on the flower. Each branch of the carnation plant may produce up to 5 blooms. After the blooms are harvested, the branch is cut back to the node where a shoot or slip is developing. This may be from 8 to 12 inches below the bloom.

Carnations for the cut flower market are harvested as close to the main stem as possible, to provide a long stem on each bloom. It is better not to cut too low during the warm months so that an adequate number of breaks or shoots can develop for the next crop. When the plants are growing vigorously, flower stems may be cut longer and closer to the base of the plant.

PACKING . . .

Generally, flowers for lei purposes are packed for shipping in discarded fiberboard boxes, approximately 13×19×8 inches. "Breather" holes may be cut on the top and sides to help maintain the quality of the flowers. Approximately 200 large-sized blooms or 300 small-sized blooms are packed in each container.

Cut flowers are usually tied into bunches of a dozen each. One extra (13 flowers) is included in each bunch to compensate for any broken stems or other damage which may occur during shipment. The packing boxes are 16×41×8½ inches. Up to 15 dozens are packed in each box. Each dozen bunch is wrapped with tissue or newspaper to prevent the blossoms from bruising.

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