Colorado Flower Growers Association, Inc.

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Reselection of Carnation Varieties

by
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Carnations are constantly mutating, usually to degenerate forms. Due to the highly heterozygous nature of most varieties, chances are good for mutant forms to arise. Most growers are familiar with the appearance of color sports. Much more frequent are sports for "off type" flowers and degenerate growth habits. There is no question that varieties do run out, if some system is not used to reselect them regularly and to propagate only from plants which produce the best flowers. Varieties have actually been improved by systematic selection.

How mutants arise

Mutations are of two types depending upon the tissue in which they occur. Somatic mutations arising as periclinal chimeras affect the outer layer of cells and can be propagated vegetatively, but will not be inherited through seed propagation. Sectoral chimeras involve the germ plasm, hence the change is carried in pollen grains or ovules and affects seedling populations grown from the mutant type. Mehlquist (1955) has shown that several color mutants from William Sim carnation have the same genotype and that these are somatic variants, probably periclinal chimeras.

In Figures 1, 2 and 3 the development of a periclinal chimera (bud sport) is shown diagramatically. The outer and inner layers of cells may be the same genetically, or there may be one or several dif-

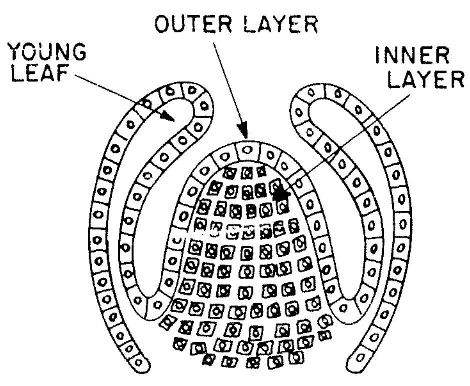

FIG.1

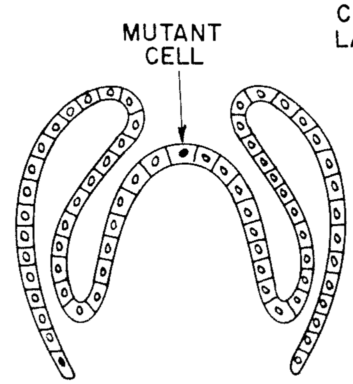

FIG.2

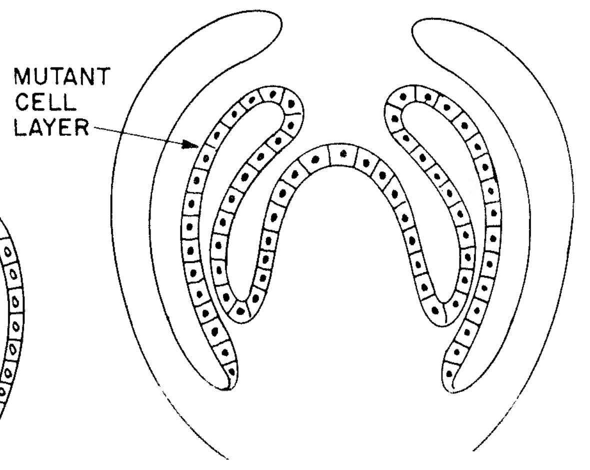

FIG.3

Sagawa and Mehlquist (1956)

Fig. 1. A normal shoot tip showing two regions-- outer and inner-- and a pair of young leaves.

Figs. 2 and 3. The development of a periclinal chimera. Fig. 2 shows one mutant cell in the epidermis which is represented with a black nucleus. Fig. 3 shows that the mutant cell has divided and the apical tip is now covered with a continuous layer of mutant cells. The black cell with the black nucleus could represent a cell bearing genetic changes which might bring about any one of many alterations in the plant's appearance.

ferent cells, or groups of cells, in the outer or inner layers. Changes in the outer layer may become periclinal chimeras while changes in the inner layer may lead to sectoral chimeras. For a mutation to become detectable a genetically changed cell must be in a position, such as an apical tip (Fig. 2), where it multiplies rapidly and leads to some change in the plant. After 10 years of reselection work with the Sim varieties, we can assume that they contain many genetically different cells. The frequency with which one of these different cells is in a position where it can influence the appearance of a part or a whole plant is high.

Projeny testing

A technique for reselection of carnation varieties has been used successfully at Colorado State University for the past ten years. To start a new variety, some 25 to 50 individual cuttings are grown as nucleus plants. Cuttings from each nucleus plant are planted in a producing bench in the environment nearest that which they would get in commercial greenhouses in Colorado. A coded tag is hung over a plant each time it produces an imperfect flower. Coding includes a different colored tag for each season and an abbreviated symbol descriptive of the imperfection. At the end of a flowering period, usually 9 or 12 months, tags are collected and compiled in a record for each selection. Tolerance limits must be set for each characteristic. The tolerance for sleepy or hollow flowers is zero, while occasional split or bullheaded flowers are tolerated. An excess of three per cent malformed flowers in well controlled temperatures is usually intolerable.

The flowering record for each clon supplies the basis for multiplying or discarding the nucleus plant. The plants which are saved are multiplied to two or three and the flowering test repeated the following year. In the meantime, these select nucleus plants are multiplied for mother stock. It has been said by some geneticists that 99 per cent of the mutations, either spontaneous or induced, are degenerate. The tendency for certain individual plants to produce degenerate mutants can be detected by progeny testing.

The size of a flowering sample from each nucleus plant has been standardized at Colorado State University to one 5-plant row across a greenhouse bench. Tags are hung over the plants which produce the "off type" flowers, although totals for the five plants are used as a basis for evaluation of the clon. In 12 months of flowering, one row produces from 100 to 125 flowers. Where space and time are less of a premium, five of these rows arranged at random throughout a greenhouse, would be more reliable.

Evaluating the flowers cut from progeny tests is a meticulous and time consuming job. In addition to the flowers actually tagged, notes should be made on growth habits, apparent stem strength and diameter, flower form and depth, serration of petals, petal burn or fading, and any other good or bad points that influence commercial value. The cutter could very well be a master judge; at least, he should be very familiar with carnations.

Degenerate mutants

Many "off type" flowers are expressed quantitatively. Environment affects their degree of expression. The number and type of petals is the most common characteristic illustrating this problem. The first selections of the variety Mamie brought into the clonal selection program at CSU produced flowers in the entire gamut from semidouble to hollow to normal to slab-sided to bullheaded. Of some 20 selections the first year, only two produced a high percentage of flowers with desirable petalage. Some selections produced semidouble flowers, others a high percentage of malformed flowers, including slabsides, bullheads, and split calyxes.

To go into the anatomy of malformed flowers briefly, auxiliary whorls of peta-

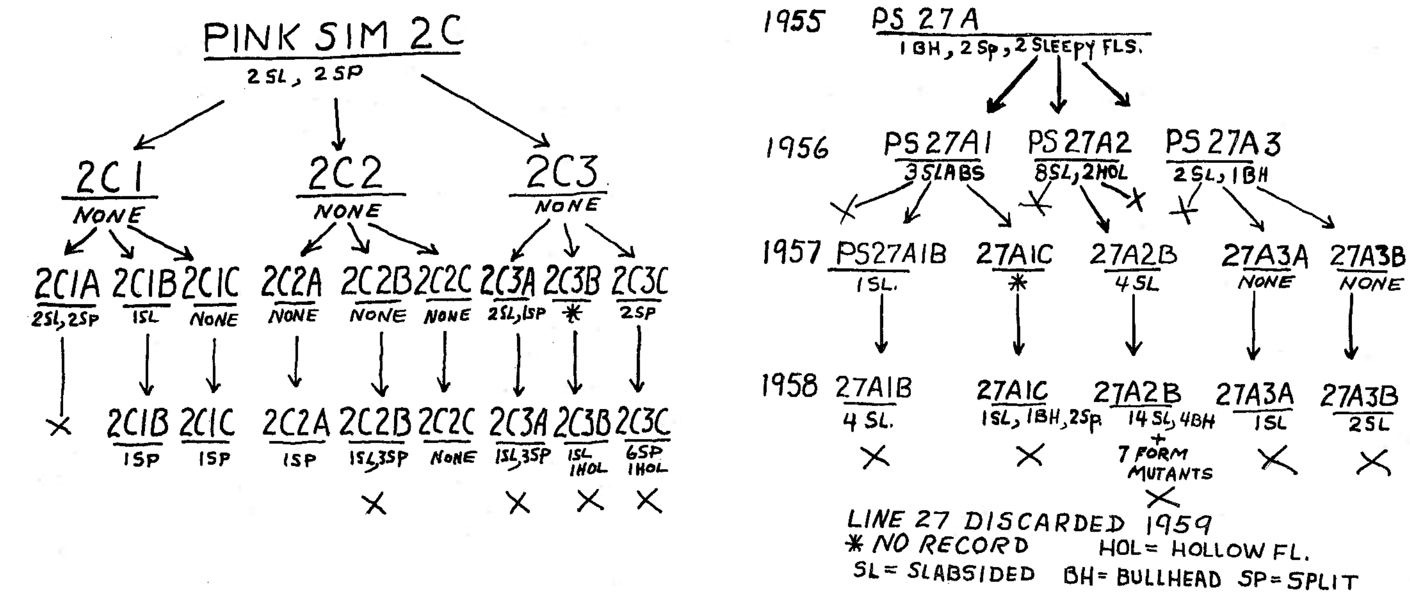

Fig. 4. Four-year yield of undesirable flowers per 5-plant progeny from two original selections and their sublines.

loids are produced around the ovary of the flower. The capacity for producing these rudimentary flowers is in all good carnation varieties, including the Sim sports. Some varieties, and even selections within varieties, produce these extra whorls of petaloids much more freely than others. Occasional selections may have hollow flowers at one season and bullheaded ones at another. Factors other than genetic which contribute to the production of malformed flowers are age and vigor of the plant, time of year, and chilling of the buds 3 to 5 weeks before the flower is cut. Fig. 4 shows 4-year flowering records for 2 selections of Crowley's Pink Sim grown in a similar environment each year. 27A should have been discarded after the 1955 season. Selection 2C has proven an outstanding line, although each year sublines from this must be discarded (X in chart), notably sublines 2C2B, 2C3A, 2C3B, and 2C3C after the 1958 season.

In selection work at Colorado State University, lines are constantly being discarded because of the production of too many malformed flowers. However, some slabsidedness must be tolerated in order to have full flowers. The William Sim variety was rigorously reselected away from malformities and splits during the 1953 season. All resulting selections produced hollow flowers which greatly reduced their weight and desirability. It cannot be emphasized too strongly that selection for petalage and low yield of malformed flowers is most efficiently done in the environment where the resulting plants are to be grown.

Flower form

The shape of a carnation flower is one of its most decorative assets. Depth of flower and height of crown can be influenced by selection and environment. High temperatures cause many varieties to lose center petalage and depth of flower. Some clons tend to produce flat centered flowers with shortened center petals in almost any environment. A number of forms occasionally appear as mutants, including anemone-shaped and almost reflex flowers. These mutants are rather easily identified.

Flower size

Larger or smaller than normal flowers are sometimes produced by certain lines. The last flowers on a crop are normally smaller and are usually borne on weaker stems. The selector must be alert to locate entire plants or progenies that produce smaller flowers. Small flowers on large stems should always be tagged.

The Sim varieties mutate to large flowers which are tetraploid and diploid. The tetraploid plants usually have shortened internodes and heavy stems, with sparce yield. The diploid flowers may be just as large as tetraploids, but they are produced on heavy stems of normal length. Yield is considerably reduced on these large flowered diploids and there is somewhat more tendency for the flowers to be bullheaded. These large flowered mutants are easily selected out and fixed.

Color

Since Sim varieties of carnations are a mixture of several somatic tissues with regards to color, a color mutant may arise at any time depending upon which tissue becomes the apical growing point. When mutants are periclinal and involve the somatic tissue, mutation can occur freely from dominant colors to recessive and back to dominant. All growers of Sim varieties observe this with the varieties Mamie or Gayety, and to a lesser extent with other Sim color sports.

The variety Gayety has been a good subject for selection since it varies from light splotched to heavy splotched to red. Plants propagated from light splotched selections usually produce a few dark splotched flowers, but few if any red. The progeny of dark splotched selections usually contains many red flowers. Constant selection for light splotched lines eliminates most of the red flowered plants.

The variety Mamie is even more unstable for color. The degree of red splotching on white background is less variable, but the progeny of one plant has produced flowers of red, white, salmon, and red markings on both white and light salmon backgrounds, and this in a progeny of only 5 plants.

Color breaking, petal bleaching, petal serration and burning, and color intensity are other aspects of flower color all of which are influenced by environment, however careful selection can enhance or help to avoid these characteristics.

Sleepiness

The inward curling of petal edges detracts seriously from the value of carnation flowers. The principal cause of sleepiness in carnation is ethylene or other toxic gases in the atmosphere. High day temperatures also cause sleepiness, the expression of which varies with clons. During the summer and fall of 1954, the progenies of 14 single plant selections of Pink Sim were grown in clonal test rows. Six of the 14 selections produced sleepy flowers at some time during the test period, with one selection producing almost 50 per cent sleepy flowers. After discarding the 6 clons which produced sleepy flowers, the progeny tests the following summer were free from sleepiness. Air conditioning and more accurate temperature control has greatly decreased preharvest problems of sleepiness.

Habit of growth

Originally the carnation was a long day plant, blooming in June and July. Through hybridization and selection it lost day length sensitivity. Mutants back to long day plants can occur on all carnation varieties taking one of two usual forms: 1) grassy, or 2) base branching dwarfs. Both habits flower in long days and usually produce inferior blooms. They are easily recognized and eliminated from carnation stock.

Fasciations, in which many breaks come from a common point, are rather common on mother blocks. Apparently these occur when a bud has been injured or split by the removal of a cutting. Although cuttings grow slowly in a fasciated group, they will produce normal plants. Fasciated growths are usually removed from mother plants as soon as observed.

The number of branches and "apparent productivity" also vary with different selections. One obvious mutant form with a free branching habit was selected from the variety Mamie. This selection sported to

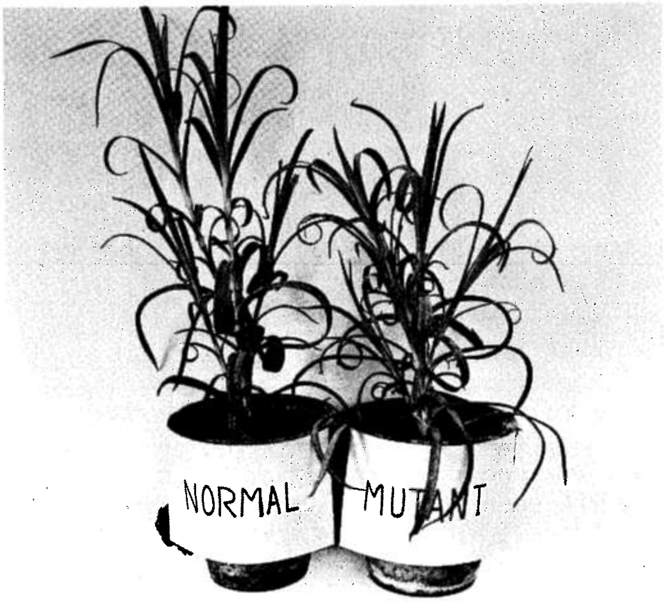

Fig. 5. A mutant involving height of branching and number of branches.

other colors and appeared sufficiently promising that yield tests were set up. The difference in number of branches on young plants (Fig. 5) was carried through the entire life of plants.

Four replicated 2-row plots of this "productive" mutant were compared with normal Pink Sim during the 1958 season. The "productive" mutant was productive of branches only-- its flower yield being almost 8 per cent less than a variety with normal branching habit.

Table 1. "Productive" Mamie compared to normal Pink Sim.

	Grade					
	Design	Short	Stand.	Fancy	Mean grade	Total yield
Mamie	38	47	345	300	4.24	730
Pink Sim	86	92	257	351	4.11	786

Height of branching varies with cultural practices and environment as well as with variety. Differences in height of branching within varieties are also heritable. This characteristic can affect the final height of the plant and especially the length of stem on the first crop of flowers. Present selections which have different branching habits are Elliott's White Sim and Colorado White Sim.

Plant height either for shorter or taller plants can be accomplished by selection. Most selections have the same number of internodes so plant height is in most cases due to length of internode. Hill's Improved Red Sim is several inches taller than other Sim varieties. With present cultural methods the Sim varieties have more height than is needed so selection for shorter growing clons should be worthwhile.

Oddities

Many mutants which take the form of oddities have arisen from carnations. These are usually easy to recognize and, with the aid of clonal testing, are traceable to definite selections in the nucleus block. Mehlquist (1941) described a lazy virescent type that has since arisen in Sim varieties. The stems are weak and the leaves have less chlorophyll, are grayish in color, with distinct lighter longitudinal stripes on both leaves and stems. There is some tendency for the leaves to twist and the flowers are small and hollow. This mutant usually arises as one branch or part of plant and is particularly damaging in a mother block.

A degenerate mutant (Fig. 6) showing the same leaf scorch as calcium deficiency was traced to one nucleus plant of White Sim. All cuttings from this plant showed the same symptoms as well as small, hollow flowers. Cions from this clon were grafted on healthy seedling understocks to test for possible virus or root deficiency. The trouble was not transmitted to the understock nor was it corrected by having a strong root system.

Fig. 6. A scorched leaf mutant very similar to calcium hunger symptoms. Flowers on this mutant were small and hollow.

A "greasy" mutant from one Red Gayety line had partial loss of bloom from the stem and foliage, with leaves somewhat ridged and twisted. The stem was thin and the flower small with irregularly shortened petals of a frosted color. This mutant occurs in various degrees depending upon the percentage of mutant tissue in a given stem. The "greasy" mutant has also been found in other Sim varieties and has been called "scimitar leaf" in England. At Colorado State University all original lines from which this sport arises are discarded.

A mutation involving the calyx and petals was discovered in White Sim in 1958. Successive layers of calyx lobes on the bud gave every appearance of a green pine cone. Some flowers on the plant had petals whereas in others the entire calyx and corolla were green overlapping sepals.

The flowers are 100 percent bull-headed and flattened on another abnormal type which has recently arisen in White Sim. The free production of very thin branches is also a characteristic of this degenerate. Since many of the mutant forms take on characteristics similar to those caused by viruses in other plants, virus diseases are always suspect until they can be proven not the causal agents. The grafting technique is one of the best for this purpose. A virus caused malady can be transmitted to a healthy plant by means of graftage.

Other mutants which have been found on Sim varieties in the clonal testing program include albino, green and white variegated, yellow green (minus the waxy covering on leaves), and extreme dwarfs (Mehlquist, 1941).

Literature cited:

Mehlquist, Gustav A. L.
1941. Inheritance in carnation, Dianthus caryophyllus II. Inheritance of nine abnormal types. Proc. Amer. Soc. Hort. Sci. 38:699-704.

Mehlquist, Gustav A. L., Dorothy Ober and Yoneo Sagawa
1955. Somatic mutations in the carnation, Dianthus caryophyllus L. Carnation Craft No. 29. January-February.

Sagawa, Yoneo and Gustav A. L. Mehlquist
1956. Radiation--a new tool in carnation breeding. Carnation Craft No. 37. November 1956.

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