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Calyx Splitting of Carnations

by W.D. Holley

Much has been written on the causes of calyx splitting in carnation. The percentage of split calyxes has been recorded for almost every cultural experiment published on carnations. A review of the literature on carnations indicates that almost everything influences calyx splitting. Since it is recognized that the problem is due to a number of causes, several of which interact at times, there is a need for some clarification on this subject.

Since some varieties split more than others, the genetic factor was indicated as a contributing cause at an early date. Wagner (7) selected 12 splitting and 12 non-splitting plants from the variety Frosted Patrician. From February to May of the following year the "non-splitting" plants produced 11 per cent split calyxes while the "splitting" plants were producing 29 per cent. Selection work within the Sim varieties at Colorado State University (2) has shown that it is possible to select away from, or for calyx splitting. Selections made which are free from calyx splitting have fewer petals and are normally hollow centered.

Early writers on carnation recognized fluctuating temperatures as a primary cause of calyx splitting. Szendel (6) caused splitting on the varieties Sophelia and Spectrum Supreme by lowering the night temperature occasionally 10°F below that normally used. Short low temperature periods at wide intervals of time increased splitting more than frequent low temperature treatments. The colder the environment, the higher was the percentage of splits. Szendel also found that a prolonged period of extremely low temperatures increased significantly the number of petals.

Wagner (8) was unable to cause calyx splitting by low temperature treatment on the variety Frosted Patrician. He subjected plants to 40°F night temperatures for 1 and 3 nights at all stages between the 12th week after pinching to flowering, or 14 weeks later. The control plants which had not been subjected to cold temperature produced as many or more splits than any cold treatment. This experiment was later repeated on another set of plants with similar results.

Wagner observed that calyx splitting was always more serious in greenhouses than in controlled chambers constructed for his work. He then began tagging individual buds on the day they split and found waves of calyx splitting occurred on unusually warm days. Calyx splitting was most serious in winter and spring when calyxes were full of petals. A temperature of 12 to 15° higher than usual caused serious splitting.

The actual splitting of the calyx occurred from one to 12 days after calyx opening stage, with the average being 4.5 days. A stage of bud 2 to 6 days after the calyx opened was the tightest and was found to be the most sensitive to high temperature. On the average for April and May, the calyx split 13 days before the flower was cut, with some calyxes splitting 18 days before and a few splitting as late as 9 days before cutting.

Thus, we find from previous research that both high and low temperature can cause calyx splitting. Carefully controlled temperatures, on the other hand, have almost eliminated splitting in experiments by Hanan, and Manring. In accurately controlled compartments at 60, 65, 70, and 75°F day temperature, Hanan (1) produced 2.4, 1.2, 0.8, and 1.0 per cent split calyxes.

Manring (5) adjusted day temperatures seasonally from 70° in summer to 60° in winter in the same controlled temperature houses. He included slabsided and bullheaded flowers with splits to make up the group he called malformed flowers. In this environment Manring produced 3 to 7 per cent malformed flowers in 1-year White Sim or Red Gayety, and only 1 to 2 per cent malformed flowers on the same Red Gayety plants during their second year. Very few of the malformed flowers had split calyxes.

In another experiment Holley and Manring (3) studied the effect of chilling on Sim varieties. This low temperature effect caused the production of extra growth centers inside the calyx, thus the calyx contained too many petals and petaloid structures. This leads to a tightness in the calyx inducing at best slabsides, or bullheads, or finally splits. Malformed flowers were cut 3 to 5 weeks after chilling. Rapid drops in bud temperature of 10 degrees or more increased the number of growth centers in the calyx.

It is not known how fast the temperature must drop in order to stimulate growth center production. The normal gradual drop from day temperatures of 65 or 70° to a night temperature of 50-52° occurs over several hours and does not cause these ill effects. If this drop occurs within an hour or less, damage is serious. Interrupting the temperature drop with a period of heat at the half way point may eliminate the damage. This normally happens when the day thermostat takes over the job of heating from the sun. Tests are under way at this time to determine how much of a heating period is required to break a 10 degree drop in temperature in order to prevent growth center production in the calyxes. In other words, will a 10 degree drop from 70° to 60° interrupted by 15 minutes or more of heat at 65° prevent the production of bullheaded flowers? Or must the period of heating be longer? This is a problem arising out of automation in which temperatures are correlated with light.

Kohl (4) shed further light on this problem and pinned down the bud stage most susceptible to chilling. Carnations were grown at 60°F until the buds were 1/8 to 1/4 inch in diameter then transferred to 50°. These buds produced maximum flower weight and diameter when compared to buds grown at constant temperatures of 60°, or at 50°. Abnormally large, "bullheaded" flowers resulted when the buds were moved to the cooler temperature. The increase in weight of flowers was found to be the result of abnormal growth. The flowers transferred from 60° to 50° at the 1/4 inch bud size contained 3.5 auxiliary growth centers while those grown at 50° contained only 0.7 extra growth centers per flower. This work pretty well pins down the bud stage most susceptible to chilling injury at near 1/4 inch diameter: just prior to the disbudding stage. The number of growth centers was not increased significantly in buds transferred from 60° to 50° at the stage when buds were beginning to open.

Summarizing calyx splitting caused by temperature fluctuations we have the following:

Fast temperature drops of 10°F or more cause extra whorls of petals in the calyx crowding the petals, causing uneven opening, or splitting of the calyx. The temperature inducing this effect occurs 3 to 5 weeks before the flower is cut, or at about 1/4 inch bud diameter. If the calyx splits, it may split at any time from calyx opening to flowering, depending upon the number and stage of development reached by the growth centers. Regular and sudden temperature drops cause the continuous production of malformed flowers.

An unusually high day temperature of 10 to 15°F above previous day temperatures splits the buds during the time the temperature occurs. The bud stage most susceptible to heat is that from 2 to 6 days after calyx opening. The average time between calyx splitting from heat and cutting of the flower is two weeks.

A combination of chilling and heat may split almost all the calyxes when both causes are working at the same time.

The addition of the genetic factor to the heat and cold treatments gives us a more complete picture of calyx splitting. Some varieties, or mutants from varieties, have the ability to produce innumerable growth centers when the right environment (cold temperature) is supplied. Miller's Yellow is one of the best examples. The many sports of William Sim vary in their susceptibility to this production of extra growth centers within the calyx. These varieties also vary in petalage from many (Pink Sim and Tangerine) to a medium number (S. Arthur). Selections can be made within each variety for fewer petals and less calyx splitting, but these selections are usually less desirable because they are relatively hollow centered most of the year.

Selections or varieties having full flowers and many petals are most susceptible to calyx splitting caused by high temperature. The selector is treading a narrow path. If he selects for high quality and a heavy, full flower, the growing temperatures for these selections must be accurately controlled.

Temperature Control

Automatic ventilation either by fans or gravity has helped bring about better temperature control. Automatic heating when used properly gives us control of the temperature at night and on cold days. Calyx splitting may be a serious problem even when a grower has the best control equipment--unless it is used properly.

Delay of heating in the fall until night temperatures go into the 40's or even 30's supplies the cause for bullheads and splits 3 to 6 weeks later. Heating only to the night temperature and depending upon the sun (if present) to raise the day temperature is inviting trouble. Several cold days in a row followed by a sunny day can give a day temperature spread of 15 degrees or more and cause serious calyx splitting. Different day and night temperature settings are a must in modern carnation growing.

Fan ventilation during the winter months is a step forward in accurate temperature control; however, we are just now learning how to use fans for this purpose. The wide differential in temperature from intake to fan outlet can cause severe chilling of the buds near the intake leading to the continual production of malformed and split flowers in this area. Bringing the cold air in through a plenum, such as a perforated polyethylene tube or wind sock, evenly distributes this air and allows an even temperature from one end of the house to the other. Where these wind socks have been used, the splitting of calyxes due to bud chilling has been almost completely eliminated.

Another serious mistake in temperature control is an attempt to control air conditioning manually, especially in spring and fall when the amount of cooling needed may be much less than the capacity of the equipment. Houses become too hot when the system is not turned on soon enough. Fans and pumps are turned on, cooling is rapid, and undercooling is common if fans or pumps are neglected even for a few minutes. This is one sure way to split all calyxes.

Miscellaneous causes of calyx splitting

Under this category are included any combination of environments that cause a small calyx to be produced followed by large petals. The calyx is produced first. If it is small due to high temperature, nitrogen hunger, or any other cause, it will be easily split should the cause be corrected as petals are developing. Two common cases come to mind.

1). Soil nitrogen becomes deficient and plant growth is extremely hard. Most of the calyxes will split following the application of nitrogen. The flowers affected are usually those cut from 2 to 4 weeks after feeding.

2). Air conditioning is started after several weeks of hot weather. In this instance all of the flowers cut during the first month may be split.

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