INFLUENCE OF TEMPERATURE ON FLOWERING OF GREENHOUSE CARNATIONS

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This is to certify that the

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Influence of Temperature on Flowering of Greenhouse Carnations (Dianthus Caryophyllus)

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Donald P. Watson
Major professor

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INFLUENCE OF TEMPERATURE ON FLOWERING
OF GREENHOUSE CARNATIONS

By

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INTRODUCTION

The size and quality of peduncle, calyx and petal as well as the yield of flowers are important to the commercial grower of carnations, *Dianthus caryophyllus*. A great varietal difference in growth habits of this plant is recognized (Beach, 1939). Commercial growers believe that the frequency of occurrence of splitting or tearing of the calyx tube is not uniform throughout the growing season. Szendel (1937) has shown that light intensity, temperature, humidity, soil nutrient level and balance, source of nutrients, and water relations either directly or indirectly influence the quality of the flowers and the frequency of splitting.

In the present investigation the influence of temperature on flowering was studied, attempting to maintain the other environmental influences as constant as is feasible under normal greenhouse growing conditions.

DISCUSSION OF PREVIOUS CONTRIBUTIONS

General factors influencing the production of flowers: There has been little scientific work reported on the effect of temperature on growth of carnations and splitting of the calyx. Szendel in 1937 and 1938 made a comprehensive report on calyx splitting. He compiled the early references to splitting as far back as 1869. These early reports related splitting to light (Allwood, 1926), humidity (Weston, 1908), fertilizer and soil (Bauer, 1935) rather than to the influence of temperature.

Conners (1917) maintained that heat, light, and moisture had a marked effect upon the character of plant growth.

According to Laurie (1948) splitting can be attributed to nutritional irregularities such as an excess or deficiency of nitrogen or phosphorous as well as a deficiency of lime. Underdevelopment of the calyx caused by weakening of the plant as a result of thrip or red spider injury, uneven temperature, insufficient light, or frequent light watering at low temperature is also suggested.

The influence of temperature on flower production: One of the earliest references to temperature effects was made by Wheeler (1908). He states, "It appears probable that the character of the manure, as well as the degree of forcing tends to affect the splitting of the calyx." By "degree of forcing" Wheeler probably referred to changes brought about by the temperature used in growing the crop. It is felt that Wheeler's hypothesis is not substantiated by sufficient data to be certain of this conclusion.

Conners (1917) failed to make much comment on the role of temperature but found increased splitting at the lower light intensities where it was likely that the temperature was lower also. The percentage of "splits" was high in December, January, and February when light intensity was low. These are the months when temperature is most likely to fluctuate and Conners made no mention of his control of temperature.

Szendel (1938) found an indirect relation between temperature and splitting. Using three temperature ranges, 40 to 50, 50 to 60, and 60 to 70° F. for his carnations, he showed that the higher temperatures reduced the number of split calyces. After nine weeks using the variety Sophelia he found that the calyces on 78, 23, and 11 percent of the flowers had split in the low, medium, and high temperatures respectively. In this same experiment there was an average of 71.5 petals on plants grown at the 40° compared to 68.6 petals on plants grown at the 60°F. night temperature. This experiment was conducted for nine weeks with ten plants per treatment. Szendel subjected carnation plants to 35° F. for periods of from 14 days to 75 days. An increase in the length of this treatment increased both the percentage of split calyces and the average number of petals per flower. This experiment was conducted over a longer period than the previous one but there were only four plants per treatment. Szendel also showed that a period of high temperature decreased the number of split calyces and that reducing the temperature from 50 to 40° F. twice a month would produce more splitting than would a constant 40° F. temperature.

Bauer (1947) suggested that splitting of the calyx might be traced to either irregular temperature or to excess quantities of fertilizer. Allwood (1931) stated that the chief causes of this fault are sudden changes of temperature and reduced light intensity.

Post (1942) showed that temperature above 50° F. hastened development of buds on carnation plants. Szendel (1938) found over 60 percent increase in production by raising the temperature from 50 to 60° F.

The influence of petal number and flower number on flower quality: Connors (1917) postulated that conditions causing slow development of the flowers tended to increase the number of petals in the flowers of plants that are unstable in the number of floral parts. There is little doubt that the double carnation has large fluctuations in the number of petals per flower. The presence of more petals per flower would be likely to cause more mechanical pressure on the calyx. Connors merely suggested this as

a reason for an increase in the percentage of splitting during periods of low light intensity or cold temperature.

Bailey (1941) states that with "higher than normal" temperatures, the growth of carnations becomes weak, the flowers are fewer and of poor quality. The weak growth and poor quality are in agreement with Post (1942) and Szendel (1938) but they did not find a reduced number of flowers.

PROCEDURE

This work was begun on September 15, 1949. Four hundred and fifty large field plants of *Dianthus caryophyllus*, varieties Victory Red, Ida, White Briry, and Puritan were divided equally and planted in three houses as illustrated in Figure II. One house was maintained at each of the following temperatures at night: 40, 50 and 60° F. The soil in each house was maintained at as close to the same nutrient level as was possible by soil tests (Spurway every 4 to 6 weeks), and the water content held within similar ranges. The flowers were cut and graded twice a week using the C. S. W. (Cornell Standard Weight) grading system (Figure I). In addition to the grade requirement, stem strength was considered. If the peduncle was not strong enough to support the flower in a vertical position when it was held at its proximal tip, the flower was designated as one grade lower than the C. S. W. system would require. Records were made of the grade and number of split calyces produced by each variety in each of the three plots (Figure II) in the 40, 50 and 60° F. greenhouses. The last cutting of flowers was made on June 19, 1950, 40 weeks after the experiment was begun.

The plants were removed from the benches the week following the last cutting and peat and manure were

CARNATIONS

CSW grade designation	Weight per flower (ounces)	Minimum stem length (inches)
Special	1 and over	24
Fancy	3/4 - 1	24
Extra	1/2 - 3/4	18
First	1/4 - 1/2	12
Second	Less than 1/4	12

Flowers should be bunched with like colors together. Stems should be reasonably straight, calyx not split, stems disbudded and suckered. Lower 1/3 of the foliage removed. Split calyces or those mended could be graded as normal but labled No. 1 and so forth.

1949 Project Sponsored by Society of American Florists and New York State Flower Growers

Figure I. CSW Grade Chart

Plot III

```
x  x  x  x  x)
x  x  x  x  x|
x  x  x  x  x|  Puritan
x  x  x  x  x|
x  x  x  x  x|
x  x  x  x  x)
x  x  x  x  x)  White Briry
x  x  x  x  x)
x  x  x  x  x   Ida
x  x  x  x  x   Victory Red
```

Plot II

```
x  x  x  x  x)
x  x  x  x  x|
x  x  x  x  x|  Puritan
x  x  x  x  x|
x  x  x  x  x|
x  x  x  x  x)
x  x  x  x  x)  White Briry
x  x  x  x  x)
x  x  x  x  x   Ida
x  x  x  x  x   Victory Red
```

Plot I

```
x  x  x  x  x)
x  x  x  x  x|
x  x  x  x  x|  Puritan
x  x  x  x  x|
x  x  x  x  x|
x  x  x  x  x)
x  x  x  x  x)  White Briry
x  x  x  x  x)
x  x  x  x  x   Ida
x  x  x  x  x   Victory Red
```

Figure II. Planting Diagram - 1949-1950

incorporated in the soil which was then sterilized at 180° F. for two hours. On June 25, 1950, the benches were replanted with plants from three-inch plant-bands. The varieties Wm. Sims, Northland, and Millers' Yellow were arranged as shown in Figure III. Records for the second year were taken similarly to the previous year except that individual plant records were made instead of a total for all of the plants of one variety in each plot. Yield records between November 19, 1950, and March 13, 1951, are presented here.

Microtome sections were made of split and normal calyces of the variety Millers' Yellow. Several calyces were torn by hand and sectioned for contrasting observations. The tissue was killed in Carnoy's fluid #2 for one and one-half hours, washed in two changes of 95 percent ethyl alcohol, embedded in paraffin, sectioned twelve microns in thickness, stained with Haematoxylin and Safranin, and permanent slides mounted in Canada balsam.

Plot III

x x x x x
x x x x x Millers' Yellow
x x x x x

x x x x x
x x x x x Northland
x x x x x

x x x x x
x x x x x
x x x x x Wm. Sims
x x x x x

Plot II

x x x x x
x x x x x Millers' Yellow
x x x x x

x x x x x
x x x x x Northland
x x x x x

x x x x x
x x x x x
x x x x x Wm. Sims
x x x x x

Plot I

x x x x x
x x x x x Millers' Yellow
x x x x x

x x x x x
x x x x x Northland
x x x x x

x x x x x
x x x x x
x x x x x Wm. Sims
x x x x x

Figure III. Planting Diagram - 1950-1951

RESULTS FOR FIRST EXPERIMENT

1949-1950

The data for the first year's experiment are presented in Table 1. The controlled temperatures used were not sufficiently accurate to produce dependable results. This work was preliminary and the results were used merely as a guide for the second experiment.

The total number of flowers cut was greater from the plants grown at 60° F. than from those grown at 50° F. N. T. (night temperature), but it was greatest from plants grown at 40° F. N. T. The large production in the 40° F. N. T. house may have occurred because the plants were in excellent condition in the spring when the temperature began to rise and the favorable temperature brought on heavy production. The temperature controls were only in effect for a short time before the warm weather started.

Using the 50° F. N. T. as normal (that temperature commonly used by growers in this area) the increase in production was 8.6 percent at 60° F. and 18.4 percent at 40° F. N. T. At a 60° F. N. T. growth was more rapid but it was spindly and weak.

The flower heads were not measured but they appeared to be smaller on plants grown at 60° F. N. T. than those

TABLE 1

INFLUENCE OF TEMPERATURE ON FLOWER PRODUCTION AND PERCENT OF CALYX SPLITTING OF CARNATIONS

Varities	Average	Night temperatures °F.		
		60°	50°	40°
Victory Red (5 plants)	Cut	42.6	41.3	49.3
	% Split	9.6	6.6	9.0
Ida (5 plants)	Cut	37.0	30.6	47.0
	% Split	0.6	0.0	0.3
White Briry (9 plants)	Cut	95.3	88.0	111.0
	% Split	2.3	2.0	1.0
Puritan (30 plants)	Cut	317.0	268.3	296.0
	% Split	36.6	37.3	53.3
	Total flowers cut	1393.0	1283.0	1519.0
	Average percent split	10.0	10.8	12.5

grown at 50° F. N. T. The peduncles were noticeably thinner and were the main cause of low quality grades of flowers produced at the higher temperatures. With the variety Victory Red during the period from February 6 to April 17, 73 percent of the flowers cut from plants grown at 60° F. N. T. were grades 1 and 2 while for those grown at 50° F. N. T. only 50 percent were in these two grades.

This information merely served as a guide for the second experiment.

Discussion of Table 2

Sample Record Sheet - 1949-1950

The sheet is divided into four main columns, one for each variety grown. These are further divided into N (number of flowers) and G (grade) for the normal and split flowers. On each date there is one entry for each grade cut. Other separate records were kept for each plot in each temperature. In addition to the grades listed in the CSW system is the grade 0 to represent flowers below grade #2, because of either stem strength or stem length.

TABLE 2

SAMPLE RECORD SHEET - 1949-1950

Plot I	House 1		60° F. Temperature													
	Victory Red (5 plants)				Ida (5 plants)				White Briry (9 plants)				Puritan (30 plants)			
Date	Normal		Split		Normal		Split		Normal		Split		Normal		Split	
	N	G#	N	G#	N	G#	N	G#	N	G#	N	G#	N	G#	N	G#
Nov. 29	1	0	3	0	1	2			1	2						
Dec. 6			1	2					2	2						
16	4	2	1	2	1	2			3 2 3	1 2 0			5	0		
22	2	0			1	1			1	2			2 5	2 0	3	0
29	1	1			4	0			4 2 5	1 2 0	1 1	1 0	10	0	1	1
Jan. 3			1	0	3	0			4 8	2 1			3	0	1	0
6			1	0	2	2			2 4 1 3 9 7 2	1 2 0 0 2 1 E			9	0	3	0
18			1	2	1 1	0 2							7	0	3	0

TABLE 2 CONTINUED

Date	Victory Red (5 plants)				Ida (5 plants)				White Briry (9 plants)				Puritan (30 plants)			
	Normal		Split		Normal		Split		Normal		Split		Normal		Split	
	N	G#	N	G#	N	G#	N	G#	N	G#	N	G#	N	G#	N	G#
Jan. 27	3	0	2	0	2	0			7	0			13	0	8	0
									1	1						
Feb. 6	2	0	1	0	1	0			6	0			46	0	5	0
					1	0			2	1						

Grade #0 - stem too weak to support flower

RESULTS FOR SECOND EXPERIMENT

1950-1951

During the second experiment the temperature was controlled much more accurately; other environmental conditions were similar to those in commercial greenhouse operation.

Table 3 and Figure IV illustrate that the total production of flowers was increased with the increase in temperature. Table 3 and Figure V illustrate that the percentage of split calyces decreased on plants grown at the higher temperature. Plants grown at 50° F. N. T. produced almost twice the number of flowers that were produced on plants grown in the "fluctuating" 50° F. N. T.

All three varieties reacted similarly to the temperature treatments in both production and in percentage of "splits". The production of Millers' Yellow was greatly decreased by the low temperature, more so than the other two varieties and the percentage of "splits" in Millers' Yellow was considerably greater than in the other two varieties when grown at 40° F. N. T.

These results are in agreement with Connors (1917), Szendel (1938), and Post (1942), but seem to disagree with Bailey (1941) where he states that "flowers are fewer with higher than normal temperatures". Bailey may infer temper-

TABLE 3

INFLUENCE OF TEMPERATURE ON FLOWER PRODUCTION AND PERCENT OF CALYX SPLITTING OF CARNATIONS

Varieties	Average	Night temperatures °F.			
		60°	50°	50°*	40°
Wm. Sims (20 plants)	Cut	107.3	76.0	48.3	22.3
	% Split	1.99	2.05	4.21	13.6
Northland (15 plants)	Cut	64.3	32.3	26.3	10.0
	% Split	0.46	1.04	2.49	13.4
Millers' Yellow (15 plants)	Cut	50.7	36.0	14.6	3.6
	% Split	2.45	3.97	7.4	53.9
Total flowers cut		657.0	443.0	266.0	108.0
Average percent split		1.65	2.48	4.1	15.7

*Temperature was lowered to 35° F. on December 9 and January 9, and to 40° F. on February 14 to study the effect of fluctuating temperature.

atures above the 60° F. N. T. used in the present investigation.

Szendel (1938) found a 60 percent increase in production of the variety Sophelia by raising the temperature from 50 to 60° F. N. T. In the present investigation, however, the increase in production for the variety Northland is slightly under 50 percent and less for the other two varieties and tends to show that there is varietal

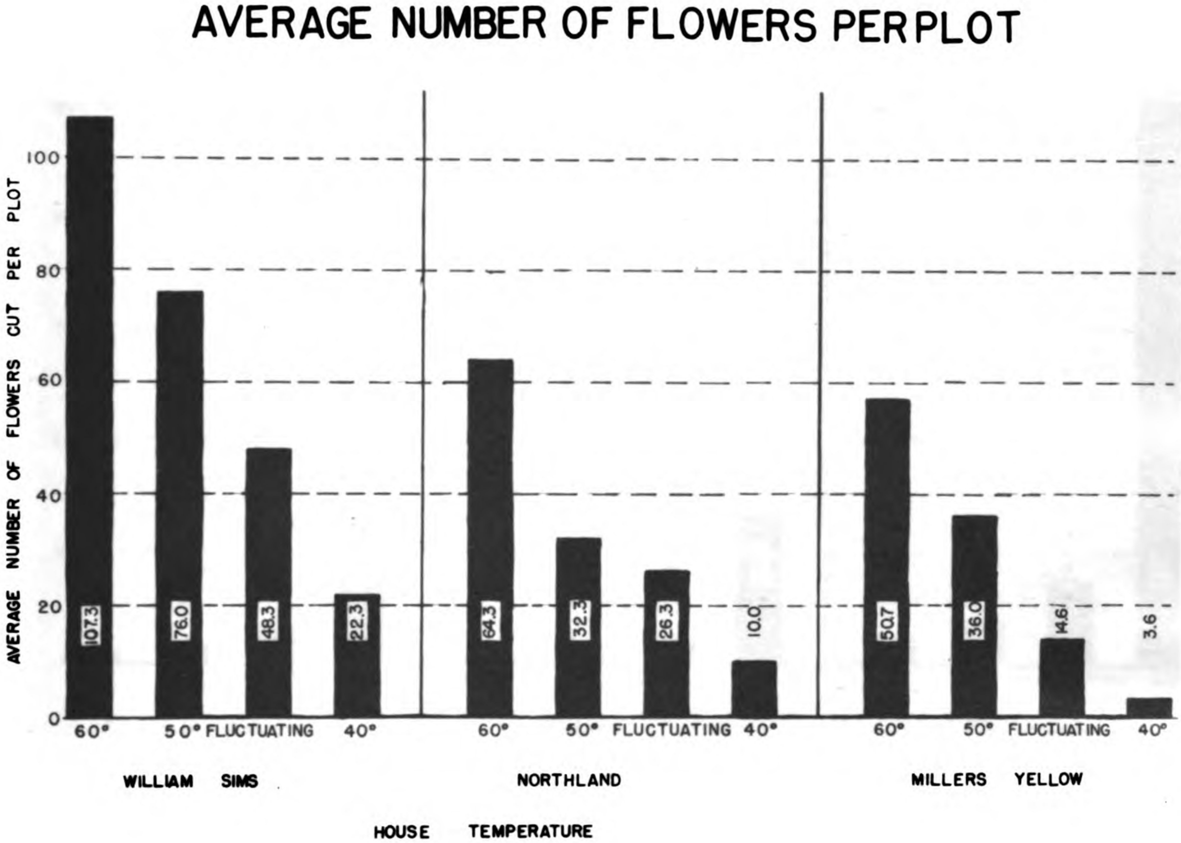


Figure IV.

difference in response to temperature.

Both Bauer (1947) and Allwood (1931) link splitting with changes in temperature. The larger (approximately 40 percent) increase in incidence of splitting in the 50° F. fluctuating night temperature over that in the 50° F. constant night temperature house substantiates these statements. No attempt was made to determine the effect of an occasional high night temperature. Because splitting was less with the higher night temperature, it is not believed that an occasional high night temperature would increase the percentage of "splits". It is probable that

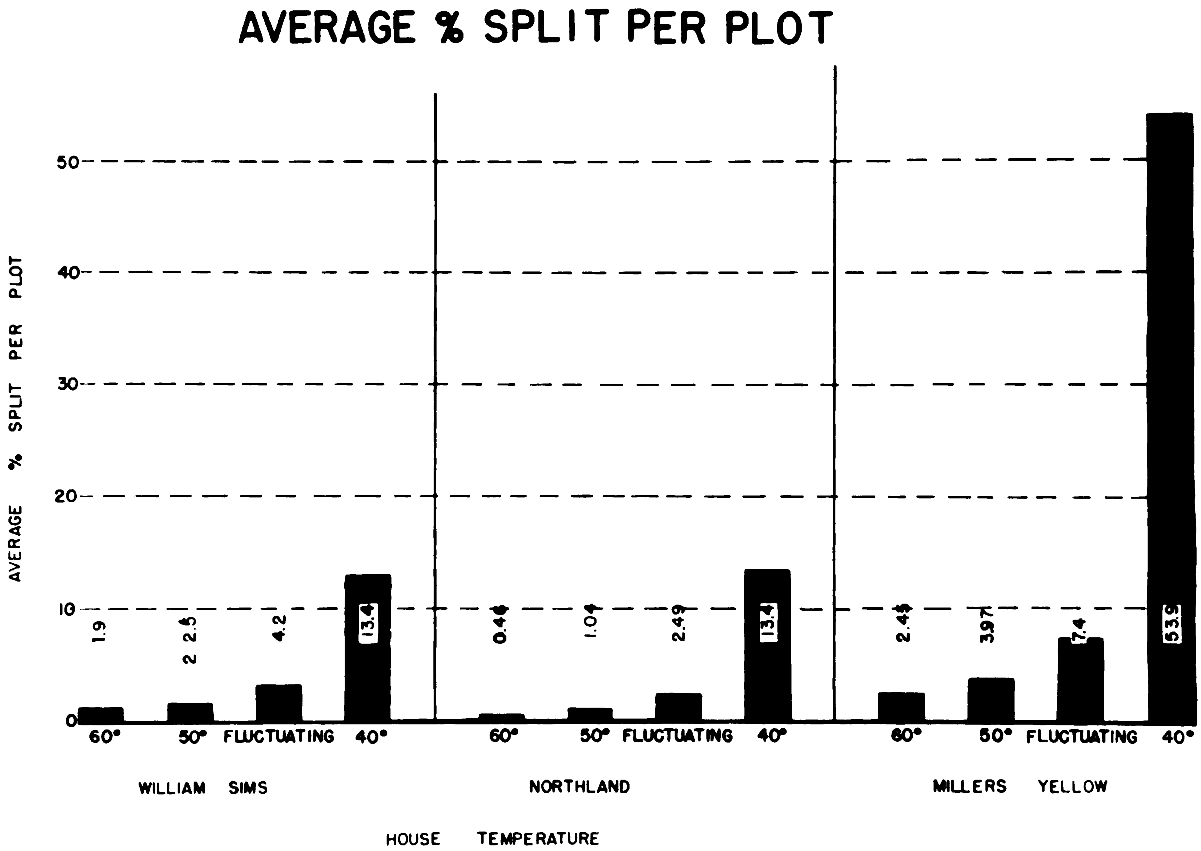


Figure V.

a fluctuating temperature will increase the percentage of "splits" only if the fluctuation is lower than the normal temperature.

The large increase in production in the 60° F. house naturally must be sufficient to offset the lower quality and higher costs of production if it is to be of practical value to commercial growers of flowers. Table 4 was compiled to demonstrate this comparison. The following plan was adopted in the construction of this table: the number of flowers of each grade was multiplied by a figure that was an approximation of the average price for each grade. These prices were: Seconds x $0.05, Firsts x $0.07,

TABLE 4

QUALITY PRICE

(per square foot)

Variety	Night temperature ° F.			
	60°	50°	50°*	40°
Wm. Sims	$2.99	$2.21	$1.41	$0.64
Northland	2.09	1.34	1.05	0.35
Millers' Yellow	1.50	1.49	0.53	0.09

*See Table 3

Extras x $0.09, Fancys x $0.12, and Specials x $0.15.

The figures of A. Washburn and Sons, Bloomington, Illinois, for costs of greenhouse production for 1950 were used to determine the differences in cost for each of the three temperatures used. Using the 40° F. N. T. as a standard, it costs 10¢ more per square foot to produce flowers in the 50° F. N. T. and 30¢ more in the 60° F. N. T.

Growing these plants until March 15 (as in the present investigation) the profit from plants in the 60° F. N. T. would be considerably greater for Wm. Sims and Northland than from plants grown in the 50° F. N. T. even with the 20¢ increase in cost per square foot. The decrease in quality of Millers' Yellow was so great with the higher temperature that a greater profit was indicated on plants grown in the 50° F. N. T.

The increase in gross income by an increase in temperature from 40 to 50° F. N. T. was great enough with all three varieties to more than offset the added costs of the higher temperature. It can easily be seen that unless the production from March 15 to June 15 increased phenomenally, there would be no profit from carnations grown at 40° F. N. T.

The constant temperature increased gross income over the fluctuating temperature enough to warrant automatic devices or added labor to control temperature. With the fluctuating temperature a profit would be realized on the plots with Wm. Sims, it would be doubtful for Northland, and practically impossible for Millers' Yellow with only $0.53 gross income from plants grown through March 15.

These data would indicate that a greater profit is obtained by growing carnations at 60 than at 50° F. N. T. in spite of the lower grade of the product produced at the higher temperature.

Table 4 also suggests that there is probably an optimum temperature for each variety of carnations.

Discussion of Table 5

Sample Record Sheet - 1950-1951

At the top of the sheet "Rows 1 to 4" and letters "A,B,C,D,E" correspond to the plants' locations in the planting diagram (Figure III). The numbers 1 to 4, representing the vertical rows in the planting diagram, are for the four horizontal spaces divided by the double lines; the letters, in like manner, representing the horizontal rows. On the left-hand edge the "2,1,E,F,S" represent the five grades of the CSW grading system. The numbers entered on the sheet each represent one flower cut; the number itself being a code for the date the flower was cut. For example: 1 = Nov. 28, 2 = Nov. 30, 3 = Dec. 6, etc. A parenthesis around the number indicates that the flower had a split calyx. The space, therefore, between two double horizontal lines under one of the letters A, B, C, D, or E shows the record of one single plant.

TABLE 5

SAMPLE RECORD SHEET - 1950-1951

House #I 60° F. N. T.			Rows 1 to 4		Wm. Sims
Grade	A	B	C	D	E
2			3	9	8,8,8
1	4,12,14	4,7,14,14	18	9,14	4,8,9
E	1,6,6	5,5,6	6		1
F					
S					
2	13	4,13	14		14
1		5,9	1	3,4,10	4,9,9
E	16	6	(5)	12	5,10
F		6			
S					
2		1,4,10			8,9,13
1	12,13,13	9,12	(4),(4),9	(4)	8
E	10	6		3	(5),5,6
F					
S					
2	8,9				4
1	10,12,17	3,9,12,13	4,9,9,12, 12,14	9	17
E		1,6,6,9, 19	3,5,16	5	2,16,16
F					
S					

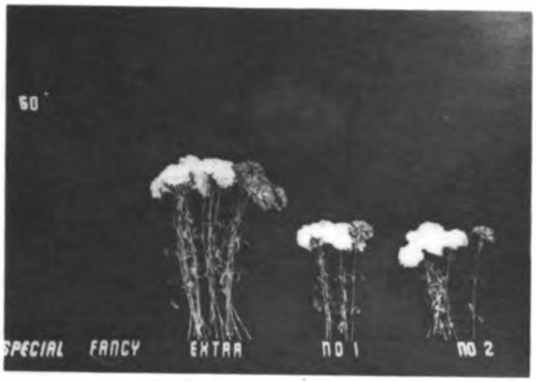


Figure VI.

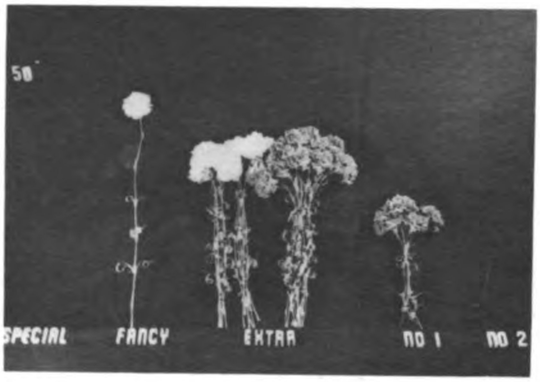


Figure VII.

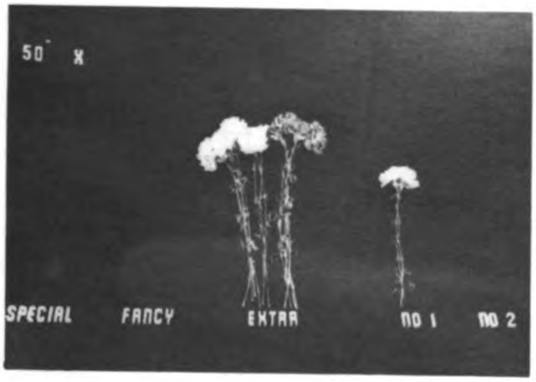


Figure VIII.

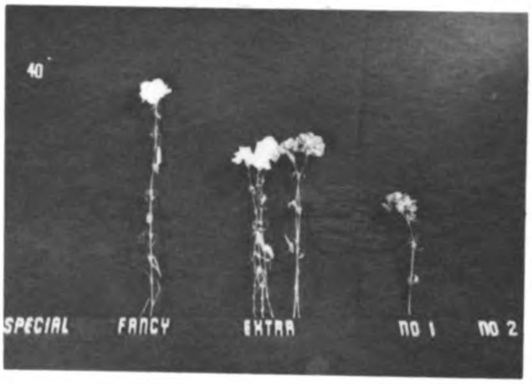


Figure IX.

Figures VI - IX. Quality of Crop

Figures VI through IX represent typical yield of flowers from the four temperature treatments on February 18, 1951. There is a large quantity of low quality flowers from the 60° F. N. T. planting (Fig. VI). This was the only planting from which any No. 2 grade carnations were cut. The flower heads were small, the stems weak, and the leaves thin and undersize. The 50° F. N. T. produced the largest number of flowers with the grade of Extra (Fig. VII). These flowers have strong, fairly straight stems, heavy leaves, and good sized flower heads. There was much lower production in the fluctuating 50° temperature (50°x) than in the 50° F. N. T. where the temperature was constant (Fig. VIII). There is no noticeable difference in the size of flower heads from these two temperature treatments. The stems and leaves appear slightly thinner when grown under the fluctuating temperature. The poor production at 40° F. N. T. is very evident from Figure IX. The flower heads are poorly formed, and a split calyx is present.

ANATOMICAL RESULTS

A count was made of the petals in all flowers where the calyx was split and of a typical flower of the same variety taken at random in the same plot for comparison. Petal count is presented in Table 6. There is a 16-18 percent increase in the average number of petals in the "splits" over the normal flowers. In all of the pairs counted there was only one pair in which the petals in the normal flower exceeded the petals in the flower with the split calyx. If more splitting of calyces is found at low temperatures and more petals in the split flowers, it is possible that there may be some relationship between temperature at which the plants are grown and the number of petals. Table 7 shows the relationship between number of petals and temperature. The number of petals per flower is greater at a higher temperature. For each variety the highest number of petals was found in flowers grown at the 60° F. N. T. This is not in agreement with Szendel's (1939) work. He found a decrease in the number of petals per flower from flowers grown at a higher temperature. Szendel's average petal count per flower varied from 71.5 petals at 40° to 68.6 petals at 60° F. No definite conclusions may be made from these results since they were secondary findings.

TABLE 6

AVERAGE PETAL COUNT

(45 Flowers)

Variety	Split	Normal
Wm. Sims	63.2	52.9
Northland	67.3	57.0
Millers' Yellow	68.0	55.4

TABLE 7

AVERAGE NUMBER OF PETALS FROM FLOWERS GROWN AT FOUR DIFFERENT TEMPERATURES

Variety		F. N. T.			
		60°	50°	50°x	40°
Wm. Sims	Split	67.0	62.7	63.5	60.0
	Normal	57.6	47.7	54.6	52.0
Northland	Split	0	70.3	0	63.5
	Normal	0	57.5	0	54.0
Millers' Yellow	Split	85.5	71.3	58.0	64.6
	Normal	55.0	51.0	49.0	49.6

In about one-half of the "split" Millers' Yellow flowers there were from two to eight growing points which greatly increased the number of petals. These extra growing points were also found in a few "split" Wm. Sims. Figure X shows the petals from two Wm. Sims flowers cut on February 18, 1951. The flower with the "split" calyx has 66 petals compared to the "non-split" of 48. In the "non-split" flower most of the petals are uniform, the lower part of each petal is straight and narrow. The petals from the "split" flower are often immature, malformed, and some petals are fused to others from the proximal tip for half the length of the petal. In almost all "split" flowers examined, there were some abnormal petals.

Many microscopic preparations were made of the naturally split area in calyx cups of those split by hand and of normal calyces from the variety Millers' Yellow. No difference in structure was observed between the naturally and the artificially split calyces. The area of splitting was similar in all flowers examined and is illustrated by drawings A and B of Figure XI. Drawing A is a typical transverse section at the origin of the split. The splitting begins on the inner surface of the sepal at the tip and proceeds down a line of parenchyma between two vascular bundles. The rupture did not cross through the vascular bundle in any of the split calyces examined.

Drawing B (Fig. XI) is of a transverse section of a calyx, approximately one-eighth inch above the origin of

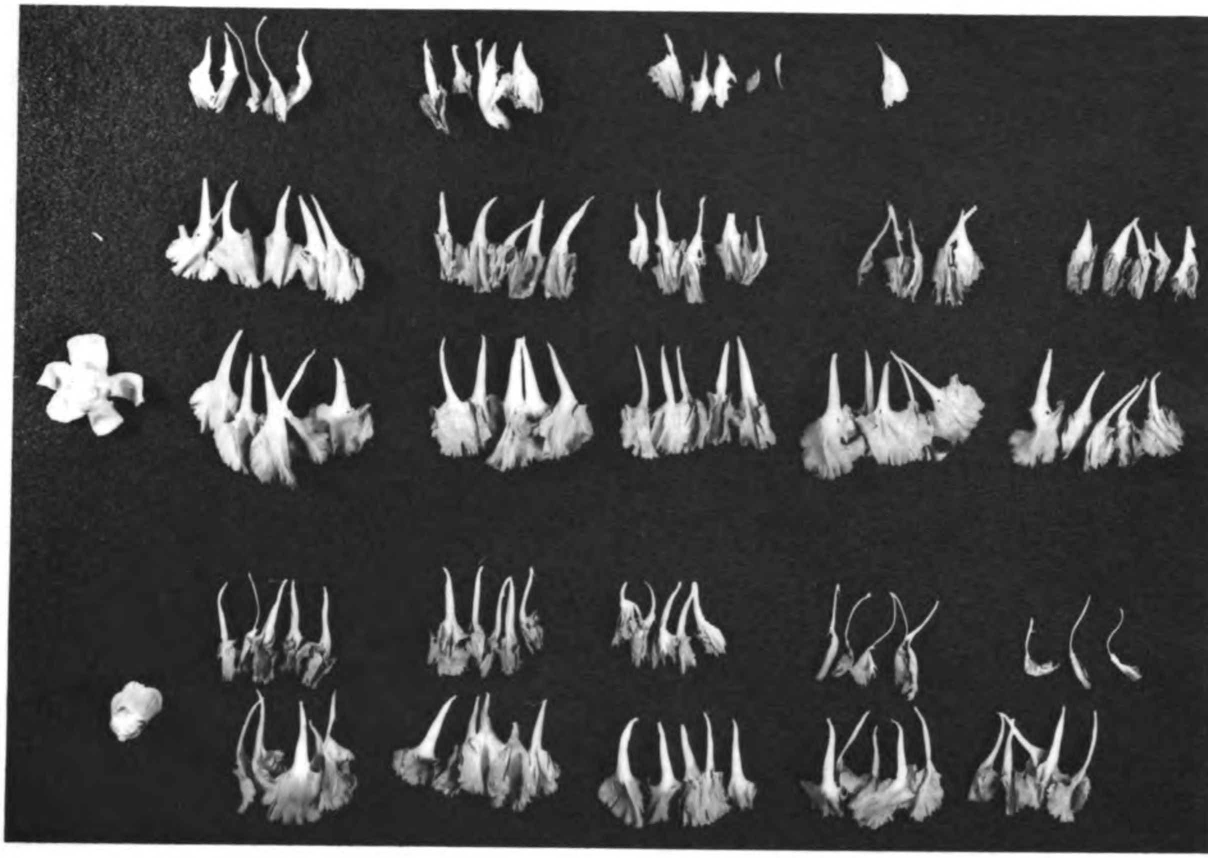
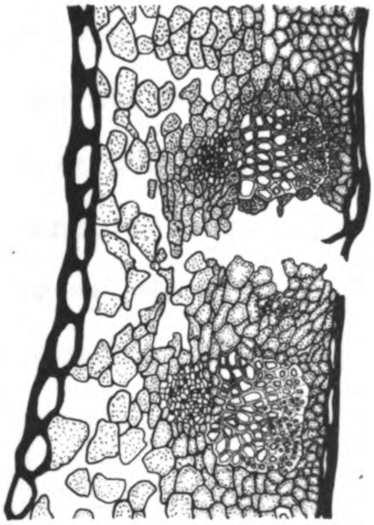


Figure X. Petal Count of a "Split" and a "Non-split" Flower (Wm. Sims Variety)

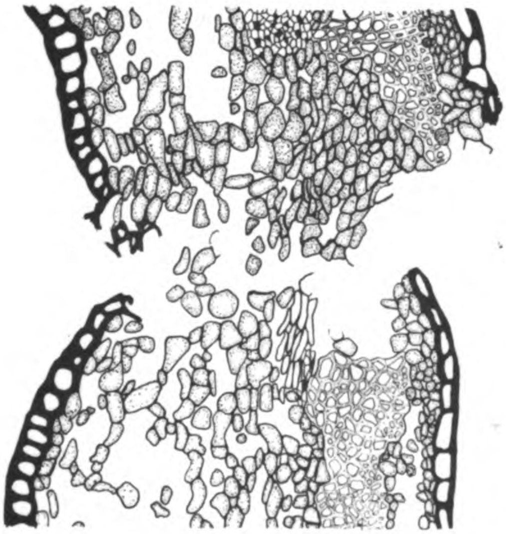
the split. These two cross sections are similar except for the dehydration and browning of the exposed cells and distortion of the epidermal layer.

Since the rupture is apparently of a mechanical nature it is possible that mechanical pressure from the inside is the main cause of the rupture.

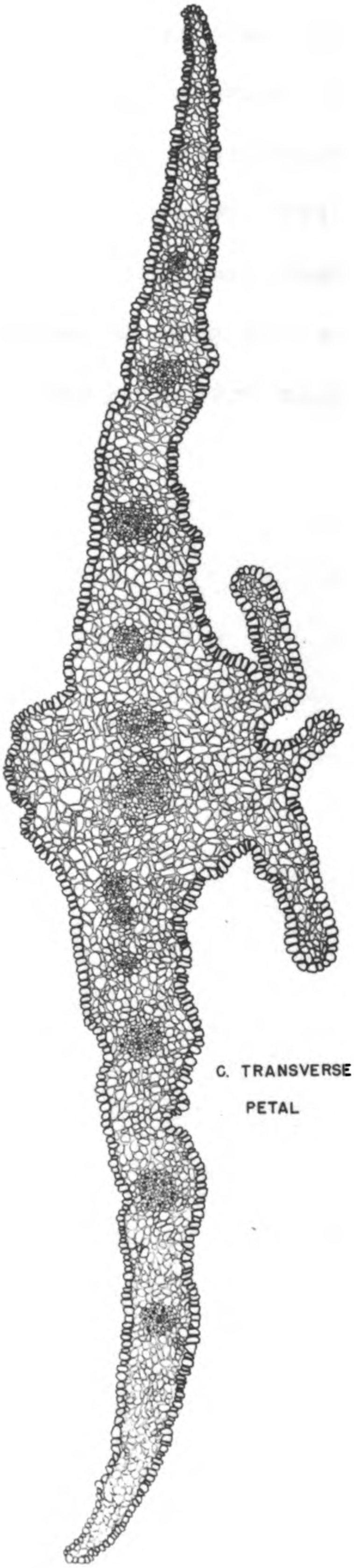
The corolla constitutes the greatest bulk of the flower. It is the most logical part of the flower to cause most of the pressure on the calyx. An examination was made of the structure of the lower part of the petal. Drawing C (Fig. XI) is a transverse section through the narrow basal portion of a petal from the variety Millers' Yellow. At



A. TRANSVERSE SECTION OF CALYX TUBE THROUGH ORIGIN OF SPLIT
X 125



B. TRANSVERSE SECTION THROUGH SPLIT IN CALYX TUBE
X 125



C. TRANSVERSE SECTION OF PETAL

Figure XI.

this stage of development, the only well organized tissue in the petal is vascular. The epidermis is evident but the intervening tissue is loosely connected, disorganized and parenchymatôus in nature. With this type of tissue constituting the bulk of the petal it is possible that growing conditions might greatly influence both the size and number of cells in this tissue. This in turn might regulate pressure on the calyx cup.

CONCLUSIONS

1. Temperature has a considerable effect upon growth and splitting of the calyx of carnation flowers.
2. A night temperature of 60° F. resulted in greater production and less splitting of calyces but poorer quality than the 50° F. night temperature.
3. At 40° F. night temperature production was greatly decreased but calyx splitting was increased.
4. There is a marked difference in varietal response to temperature.
5. It is possible that with some varieties the increased production from the 60° F. night temperature would be enough to offset the increased operating expenses and lower quality flowers.
6. If once a month the temperature is lowered 10 to 15° F. below the night temperature usually used, production will greatly decrease and splitting increase.
7. The number of petals in a flower with a "split" calyx is usually greater than in a normal flower of the same variety from the same plot.
8. Splitting of the calyx cup appears to be caused by mechanical pressure inside the calyx. It may be because of an increased number of petals, an increase in the size of the basal portion of the petal, reduced growth

of the calyx itself, or failure of elongation of petals as the flower develops.

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