SUPPLEMENT

Bulletin 392
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CUTTING AND TIMING CARNATIONS — A REVIEW

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The most important cultural procedure in carnation growing is cutting. Similarly, cutting is tied to timing so the two cannot be separated in any discussion of proper cutting. There have been over 35 CFGA and CGGA Bulletin articles dealing with cutting, timing and lighting standard carnations (Table 1), and one might think this sufficient to tie down cutting and timing to a recipe formula. Far from it. The best data available, which is reproduced in this article, is nearly 20 years old. Much of the original work by Holley, Wagner and others was prior to fan-and-pad cooling, introduced in the middle 1950's, followed by CO_2 injection in the 60's and lighting in the early 70's. In recent years, some growers seem to obtain consistent high production and quality with cutting practices that differ from those who

Table 1: Colorado Association Bulletins dealing with carnation timing and cutting.

Bulletin	Date	Title
12	1950	Progress report on carnation timing.
20	1951	Carnation timing.
29	1952	Carnation cropping systems — A report of progress.
30	1952	The role of the second pinch in carnation production timing.
38	1952	Carnation timing from a single pinch.
40	1953	Carnation timing from second pinches.
44	1953	Carnation cutting methods and two-year culture.
48	1953	Two-year culture of carnations.
53	1954	Timing carnations from a pinch and a half.
Special Bulletin	1954	Precision growing of carnations.
59	1954	A comparison of three cutting heights of carnations.
65	1955	Growing carnations more than one year.
75	1956	The effects of thinning on production and grade.
77	1956	Carnation timing with air cooling.
86	1957	Some factors which influence soft growth.
89	1957	Some effects of greenhouse cooling on carnation timing.
94	1957	Some effects of timing and cooling on carnation quality.
108	1958	Continuous culture of carnations.
110	1959	Crop control on carnations.
136	1961	Effect of size of winter crop on yield and grade of carnations.
137	1961	Planting date, type of plant and pinching on yield and grade of carnations.
160	1963	Carnation crop forecasting.
181	1965	June pinching to reduce July-August yield of carnations.
209	1967	Effects of photoperiod on carnation.
209	1967	Effects of photoperiod and CO_2 enrichment on carnation.
215	1968	Carnation timing is affected by inert media.
224	1969	Lighting of carnations.
234	1969	Effect of watering frequency and inert media on carnations.
257	1971	Lighting carnations for crop control.
265	1972	Cyclic lighting of carnations.
283	1973	Effects of summer pruning on carnation.
284	1974	Timing carnations in Colorado with lights (Revised Nov. 23, 1973).
287	1974	The flowering of return carnation crops from multiple breaks left below a cut.
302	1975	Effect of plant density on two years of carnation production.
320	1977	Producing side breaks on carnations.
386	1982	Carnation Pinching Revised.

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may attempt to save every possible break. The variability among greenhouse operations is enough to cause despair in arriving at a general consensus as to what constitutes good carnation cutting.

Basics

The best place to start is with certain basics that never change. Larry Taylor, in Bulletin 44, stated 5 factors a grower should consider when deciding cutting levels on carnations: 1) Growing conditions, or how well, the plants are grown, 2) The size of the plant. 3) What are the future market prospects and demands? 4) When will the breaks that are on the stem flower? And 5), what are the future plans for the plants? Regardless of improved procedures we may be using 25 years later, those same 5 questions must still be asked when a grower sets cutting methods.

Plant Vigor

Starting with Taylor's first main point, we should emphasize that cutting and timing methods will vary with how *well* carnations are grown. In Bulletin 320, Hanan and Hartley reviewed those factors that determine break production in carnations. Severe drying, or lack of water, can delay peak flowering four weeks by slowing formation and elongation of laterals (CFGA Bul. 234). It is common observation to find breaks high on a main stem (Fig. 1), indicating that at some time in the growth cycle the plant was subjected to poor growing conditions such as low light, dry growing, high salinity, low nutrition, high temperatures, etc. which prevented break formation and elongation. When better conditions are introduced, such as lower temperatures in the fall, or better light in the spring, breaks begin to grow again. In 15 years of observation, growers producing the most vigorous plants with the best available technology, generally obtain the most flowers with highest quality and least problem in establishing cutting and timing procedures.

The use of chemical growth promoters to enhance breaking, especially on old plant stems is a chancy procedure. Work by Koon, Holley and others several years ago showed that high dosages of Accel would produce additional side breaks. Unfortunately, if there is not enough energy (winter), the breaks tend to sit still until conditions improve. Often, the new breaks tend to be parasitic, and reduce the quality of those stems producing a flower. The situation is worse if growing conditions are less than optimum for the time of year (hunger, high salts, dry soils, high or low temperatures, no CO_2).

Effects of new procedures

The effect of cooling, for example, was pointed out by Holley (Bulletins 77, 89, 94) as causing a gain of 2 weeks between planting and pinching, and a gain of 4 to 5 weeks between first and second crops from a single pinch. Since

Figure 1: What happens to carnation breaks when the plant is subjected to unfavorable growing conditions, followed by an improvement in environment. For example, drought followed by more water, high salinity followed by a correction such as leaching, excessive summer temperatures followed by better conditions in the fall, or insufficient solar energy in the winter followed by higher light in the spring.

those articles, specifications for greenhouse cooling have been nearly doubled, and there has been no work on the signficance of enhanced cooling. There is no specific information on timing as influenced by CO_2, although we know that CO_2 improves yield and quality. CO_2 injection came after Koon and Holley (Bulletins 108 and 110) worked out timing procedures that are reproduced in Tables 2 though 6. Holley (Bul. 215) indicated that, in inert media, late June and July planting of single pinched plants returned too early for Christmas, and suggested that carnations in inert media be planted in late May with additional pinching to delay and

Table 2: Carnation timing from breaks and blind cuts (CFGA Bul. 108). Cooling with plants in ground beds, without lights.

	To flower in —											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Leave 3 to 5-inch breaks in —	Sept Oct	Oct Nov	Oct Nov	Nov Dec	Dec Jan	Jan Feb	Mar Apr	Apr May	May June	June July	July	Aug
Cut to blind in —	May June	June July	July Aug	Aug Sept	Sept Oct	Oct Nov	Dec Jan	Feb Mar	Mar Apr	Mar Apr	Apr May	May June

build the crop. Observation at CSU, between plants in ground beds versus raised soil beds, suggests at least one to two weeks difference in timing, with raised beds ahead of carnations planted directly in the ground. Miniature timing may not be as drastically affected as standards, but stem length of miniatures in raised beds can be nearly twice those grown in the ground.

The point to be made in all this discussion is that cutting and timing procedures will vary between raised and ground beds, soil type, use of CO_2 and ability to control at optimum temperatures. Secondly, almost all data specifically dealing with timing and cutting without lights is 20 years old.

Table 3: Carnation timing, depending upon length of break (CFGA Bul. 108). Cooling, plants in ground beds, without lights.

Length of breaks (in)	When left —	To flower in —
4 to 5	May 15	Aug-Sept
1 to 3	May 15	Aug-Sept
3 to 4	Aug 23	Jan-Feb
2 to 3	Aug 23	Jan-Feb
3 to 4	Sept 5	Jan-Feb
1 to 2	Sept 5	Jan-Feb
6 to 7	Oct 10	Dec-Jan
4 to 5	Oct 10	Jan-Feb
3 to 4	Oct 10	Mar
5 to 6	Nov 8	Feb
4 to 5	Nov 8	Mar
2 to 3	Nov 8	Apr-May
1	Nov 8	May-June
7	Dec 3	Mar
4 to 6	Dec 3	Apr
2 to 3	Dec 3	Apr-May
5	Jan 23	May-June

Lighting

Lighting dusk-to-dawn with low intensity incandescent is now common procedure. Both Holley (Bulletins 224, 257) and Koon (Bul. 284) have shown that a 6 week cycle of 3 weeks on and 3 weeks off is sufficient to place continuous flowering carnations into well-defined cycles, and that the grower can time flowering to peak during desirable marketing periods. An attempt to outline the best available information on timing with lights is presented in Table 7, largely using Gordon Koon's information. Some additional work at CSU indicates that the time between lighting to peak flowering varies from 7 to 8 weeks in fall and spring, to 12 to 14 weeks in the winter. The actual time required for breaks to flower under lighting — such as worked out by Koon (Tables 2, 3) — has not been well defined. Koon suggests 4 to 6 pairs of leaves should be visible for greatest effect of lighting, although Holley and Rudolph (Bul. 224) indicate that 7 pairs is the most sensitive stage to lighting (3 to 4 pairs visible). For maximum effect it is desirable to have as many breaks as possible each between 4 to 7 pairs of leaves when lighting begins. However, lighting will reduce lateral production, particularly on single pinched plants lighted for the first crop. Information we have indicates that, on plants that are in more-or-less continuous production, and growing vigorously, there will always be sufficient breaks present to provide a response to lighting.

Under ideal growing conditions, Homan and Holley (Bul. 287) found that they could cut above the 7th node below the flower, secure a fancy flower, and still leave breaks. They state that cutting above or below the 7th node had little effect on timing, with the time required for a break to flower varying from 5 months when cut in May to 6.5 months when cut in January. In general, they felt that 3 breaks was about the maximum number that should be left on a stem. Homan did not include lighting in this work. However, Metzger (Bul. 265) found that a 33% "on" period for cyclic lighting produced nearly double the number of breaks per stem on each of the varieties studied. The loca-

Table 4: Recommended procedures for cutting carnations in continuous culture (CFGA Bul. 108). Cooling with plants in ground beds without lights.

Month	Procedure	Explanation
January	Leave extra large breaks, make blind cuts, undercut, fancy	Breaks flower after Mother's Day, or mid-summer.
February	Blind cut, undercut, fancy	Breaks flowering mid-summer.
March	Blind cuts, undercut, fancy	Breaks flower in mid-summer.
April	Blind cut, may raise cutting level one-half wire, good wood.	Breaks flower in August, blind flower in Oct-Nov.
May	Blind cut, cut to new level, fancy if possible.	Breaks flower in Aug-Sept, blinds source of Christmas flowers.
June	Blind cut, cut to origin or undercut.	Breaks flower in Sept-Oct. Blind flowers in Jan-Feb, will reduce quality.
July	Leave medium and small breaks, set new blind cut ½ wire above Apr level.	Breaks left flower in Nov-Dec. Blinds come Feb-Mar.
August	Leave large and medium breaks Blind cut at new level.	Breaks flower in Nov-Dec. Blinds produce Easter crop.
September	Blind cut at level set in Jul	Breaks flower in Jan, reduces quality. Blind cuts flower for Mother's Day.
October	Leave medium and small breaks Blind cuts to origin or undercut	Breaks flower early spring, blind cuts produce after Mother's Day.
November	Leave all breaks. Blind cuts to origin or undercut.	Breaks produce Easter and Mother's Day. Undercutting reduces June production.
December	Leave large and medium breaks	Breaks produce for Mother's Day. Undercut to reduce July production.

Table 5: Timing carnations from a single pinch (CFGA Bul. 110). With cooling, in soil, raised benches. (See also Bul. 89) without lights.

Bench	Pinch	First crop flowers	Second crop flowers	Total weeks for 2 crops
Jan 15	Feb 25	July	Sept-Oct	42
Feb 15	Mar 20	Jul-Aug	Oct-Nov	42
Mar 15	Apr 15	Aug	Nov-Dec	41
Apr 15	May 10	Aug-Sept	Dec-Jan	40
May 15	June 5	Sept	Dec-Jan	38
May 25	June 15	Sept-Oct	Jan-Feb	40
June 5	June 25	Oct-Nov	Feb-Mar	43
June 15	Jul 5	Nov-Dec	Mar-Apr	45
June 25	Jul 15	Nov-Dec	Mar-Apr	46
Jul 5	Jul 30	Dec-Jan	Apr-May	47
Jul 15	Aug 10	Dec-Jan	Apr-May	46
Aug 15	Sept 15	Jan-Feb	May-June	45
Sept 15	Oct 15	Mar-Apr	July	45
Oct 15	Nov 20	Apr-May	Jul-Aug	45
Dec 15	Jan 25	June	Aug-Sept	43

Table 6: Timing carnations from one-and-a-half pinches (CFGA Bul. 110). With cooling, in soil, raised benches, without lights.

Bench	First pinch[1]	Second pinch[2]	Start flowering	Weeks to flower
Jan 15	Feb 25	Apr 10	July	22
Feb 15	Mar 20	May 15	Aug	22
Mar 15	Apr 15	May 25	Sept	22
Apr 15	May 10	June 20	Oct	22
May 15	June 5	Jul 10	Nov	22
June 5	June 25	Aug 1	Dec	23
June 25	Jul 15	Aug 25	Jan	25
Jul 15	Aug 10	Sept 20	Feb	26
Aug 15	Sept 15	Nov 1	Mar	26
Sept 15	Oct 15	Dec 5	Apr	26
Oct 15	Nov 20	Jan 10	May	26
Nov 15	Dec 25	Feb 15	June	26

[1]1st pinch above 5 or 6 pairs of leaves.
[2]2nd pinch on 2 or 3 original breaks.

tion of breaks occurred at lower positions as the percent of light per cycle increased, with cycle lengths of less than 30 minutes required for favorable results (Table 8). Unfortunately, cyclic lighting requires an increase in intensity which reduces economic benefits over continuous dusk-to-dawn. This information suggests we can do much more to not only control peak flowering, but the number and location of laterals on standard carnations.

Reducing Production

There are certain periods during the year when it is desirable to reduce production on carnations, such as in July and August. The best information for doing this on a continuous flowering crop is Koon's given in Table 4. In recent years, it appears that some growers are able to establish a fairly constant cutting level to provide breaks as needed, and then to cut down to remove those breaks that would flower in the summer. This acts both to remove unwanted production and to control height. Undercutting, where the crop is healthy and vigorous, may actually open up the canopy for better light distribution, increasing break formation. However, the requirement is a healthy, vigorously growing plant. The attempt to save all possible breaks, or to increase breaking, even for good markets in January and February is usually considered a poor practice. Inevitably, as light decreases, the ability to sustain and grow a break to a high quality flower decreases. Excessive breaks flowering in January and February will drastically reduce grade. Furthermore, many breaks in excess of three per stem may fail to flower — at least until light increases in the spring. If, for some reason breaking occurs high on the stem (Fig. 1), then height control is lost, and quality is decreased as shorts must be cut to save breaks. Again we come back to the fact that a vigorous crop is in itself an aid in cutting and timing.

Table 8 is an attempt to summarize such timing and cutting information that has been published since 1960. At present, Davis' work (CFGA Bul. 315) indicated that on an average for every 1 centimeter decrease in break length, an additional 0.3 weeks was required for flowering. A portion of her work dealing with break length on weeks to flower is presented in Table 9. The variability between maximum and minimum weeks for a particular break to flower is obviously a function of where the lateral is on the stem and location of that stem in the bench — further modified by time of year and the particular growing conditions. Davis' work further showed that it took less sunlight to flower a break when grown under fiberglass as compared to a break grown to flower under glass. It was not unusual to require three times as long to return to flower from a stem which had no breaks, as compared to a stem which had a visible lateral.

Table 7: Timing carnations with lights (CFGA Bul. 284 and discussion with Gordon Koon). Cooling with plants in ground beds, all single pinch.

Bench	Year	Light	Flower	Remarks
Apr 15	First	When breaks show	Aug, take one break no higher than 3rd wire	Will reduce breaks for 2nd crop.
		Sept 1	Christmas	
		Jan 10	May-June	
	Second	Jul 1 or	Sept	
		Jul 15	Oct	Reduces Christmas crop and lowers quality.
		Oct 13, adjust for Easter	Feb, Valentine	May be too late for Mother's Day
		Jan 10	Mother's Day	
May 15	First	When breaks show	Oct	May reduce breaks for 2nd crop. Heavy crops for Jan-Feb may reduce quality.
		Oct 13	Feb	
		Jan 10	Mother's Day	
		Feb 21	Late May-June	
	Second	See above for Apr 15 or:		
		Sept 1	Christmas	
		Oct 13	Valentines	
		Dec 5	Easter	
		Jan 10	Mother's Day	
June 1	First	—	Nov	Lights will severely delay 2nd crop.
		Dec 5	Mar, Easter	
		Feb 21	May-June	
	Second	See above for Apr 15 or May 15.		
June 25	First	—	Christmas	Lights will severely delay 2nd crop.
		Jan 10	Mother's Day	
		Feb 21	Late May-June	
	Second	See above for Apr 15 or May 15.		

Note: minimum dusk-to-dawn for 3 weeks, breaks lighted at 4-7 pairs of leaves.

Table 8: Information summary from CFGA Bulletins, cooling, CO_2, raised benches, in soil.

Bul. No.	Planting or continuous	Treatment	Lighting[1]	Flowering	Remarks
181	Continuous	No pinch	None	Heavy Jun-Aug	High pinching level established by breaks on stem.
		Pinched high 6/15	None	Sept-Dec	
		Pinched 6" lower 6/15	None	Nov, Jan-Feb	
		Cut above breaks	None	50% 9/13-10/3	
		Pinched same height no breaks	None	50% 9/20-10/17	
		Cut 6" lower	None	50% 11/15-12/12	
		Pinched 6" lower	None	50% 11/8-12/5	
209	Jul 19	Single pinch	None	Dec, Apr-May	Delayed 2 wks compared to lighted with CO_2. Lighted crop had no laterals with no CO_2. Lighting with CO_2 gave higher yield.
			9/13-2/1	Dec, Jun (No CO_2)	
		Continuous	None	Mar, peaked Apr	
			9/13-2/1	Nov-Feb	
224	Jul	Single pinch	None	Nov-Dec, Apr, Jul	Very low yield Apr. Do not light in Dec on young plants. Results difficult to follow.
			12/1-12/30	Nov-Dec, Feb-Mar	
			1/1-1/30	Nov-Dec, Feb-Mar, Apr-May, Jun-Jul	
			2/1-2/28	Nov-Dec, Feb, May, Jul	
			3/1-4/30	Nov-Dec, Feb, May-Jun	
			4/1-5/15	Nov-Dec, Feb, May-Jun	

Table 8: Information summary from CFGA Bulletins, cooling, CO_2, raised benches, in soil. (continued)

Bul. No.	Planting or continuous	Treatment	Lighting[1]	Flowering	Remarks
	Continuous		None	Steady production, increasing in Jun-Jul	
			12/1-12/30	Feb-Mar, Jun-Jul	Reduced Easter-Mother's Day yield
			1/1-1/30	Mar, Jun-Jul	
			2/1-2/28	Feb-Mar, May, Jun-Jul	Too late for Mother's Day
			3/1-4/30	Feb, Apr-Jun	Very heavy Apr-Jun
			4/1-5/15	Apr-Jun	Probably interaction between treatments.
257	Jul 7	Single pinch	None	Dec, Apr, Jun	Very high in Jun, late for Christmas.
			8/20-2/25	Nov-Dec	Low continuous to Jun.
			3 on-3 off from 8/20	Nov, May-Jun	As good as 3-4 and 3-5 on and off.
	May	Double pinch	None	Nov-Feb, Jun	Very high in Jun.
			8/20-2/25	Nov-Feb, Jun	Slight delay both crops.
			3 on-3 off 8/20	Nov-Feb, May-Jun	Very low in Jan, lighting reduced grade. 3-4 and 3-5 on-off same.
			None	Continuous, increasing, in Apr-May	
			8/20-2/25	Nov-Jan, Jun	Low yield in Apr-May
			3 on-3 off 8/20	Nov-Dec, Jan, Mar, Apr, May-Jun	Length of "off" period extended time between crops.
265	Aug 7	Single pinch	Start 9/20		
			Continuous	95 dys to peak	30 min. cycles
			50% cyclic, 1 min	95 dys to peak	lost control, must use 1 min. cycles.
			33% cyclic 1 min	95 dys to peak	Cyclic lighting increased number
			50% cyclic 1 min low intensity	105 dys to peak	of breaks and reduced distance between flower
			None	125 dys to peak	and top break.
283	Continuous gravel	Continuous cut	None	1.4 sq. ft. through summer, Jan, May-Jun	
		pinched all long shoots 6/15	None	No production to Aug 7, peaked Nov-Dec, May.	
		Hedge trimmed to leave ¼ of breaks	None	No production to Aug, peaked Nov-Dec, May.	
		Hedge trimmed to leave ¼ of breaks	9/1-8/15	No production to Aug, Nov-Dec, April.	
386	Jun 3	Single	None	1st peak Sept, 2nd peak Feb, 46.5 flowers/sq. ft., 11 months	
		¼	None	1st peak Sept, 2nd peak Feb, 45.3 flowers/sq. ft.	
		1½	None	1st peak Sept, continuous flowering Nov, 46 flowers/sq. ft.	
		1 ¾	None	Small peak Sept, continuous production Nov, 44 flowers/sq. ft.	
		2	None	1st peak Nov, declining production to lowest Easter, 44 flowers/sq. ft.	
	Jul 3	Single	None	1st peak Oct-Nov, 2nd peak Feb-Mar, 41.8 flowers/sq. ft., 10 months	
		1¼	None	Small peak Oct-Nov, 2nd peak Feb, 39.5 flowers/sq. ft.	

Table 8: Information summary from CFGA Bulletins, cooling, CO_2, raised benches, in soil. (continued)

Bul. No.	Planting or continuous	Treatment	Lighting[1]	Flowering	Remarks
		1½	None	Start production Oct, peak Valentines, 37.4 flowers/sq. ft.	
		1¾	None	Start production Oct, peak Jan-Feb, 37.6 flowers/sq. ft.	
		2	None	Start production Nov, peak Jan-Feb, 34.1 flowers/sq. ft.	

[1]Continuous dusk-to-dawn, low intensity incandescent.

Table 9: Length of time required for a carnation break to flower, cooling, both glass and fiberglass, raised benches, soil (CFGA Bul. 315).

Length (in)	Minimum time required (wks)	Average time required (wks)	Maximum time required (wks)
2	12	22	31
4	11	20	30
6	9	18	28
8	8	17	26
10	6	15	25
12	4	13	23
14	2	12	21
16	—	10	19

Another point to be made has recently been emphasized in Bulletin 392. It is extremely important to properly set temperature controls during the day to make maximum use of Colorado sunlight in the winter. Suggestions are, for standard carnations, to set the minimum heating level to 62°F, and allow the temperature to rise to a maximum of 70°F before the first stage of cooling begins. This allows the sun to act as a semi-automatic temperature control system. The more sunlight, the higher the temperature. This procedure must be employed with CO_2 injection. Raising the ventilation temperature, especially on first year plants, allows maximum use of CO_2, and can hasten peak production by more than two weeks as compared to no CO_2 and a low ventilation temperature (i.e. 65°F).

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