'Photoperiod Manipulation' A Valuable Tool For Carnation Flower Control*

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Although the commercial greenhouse carnation plant had been reported to be a long day photoperiodic plant prior to 1960, no real interest was taken by researchers and commercial growers until after that date wherein commercial adaptation was thought and since found possible.

Daylength Control Begins to Pin-point Single Pinch Cropping

As far back as 1962, we at Yoder Bros. began giving thought to and growing single pinch, one flush carnation crops with the intention of demonstrating that it was possible to produce only a one flush crop for the Christmas sales period which would be considered "economically practical". Since good reds are in greatest demand during the December-January sales season, planting dates, spacing, and variety tests got under way. A year or so later the idea was greatly enhanced by the introduction of carbon dioxide as a basic ingredient to improve winter growth and quality. In fact, prior to this time it was generally accepted by mid western carnation growers that it was a waste of time to make any new carnation plantings from rooted cuttings between August 1 and January 1.

Commencing in early 1965 we started a rather intensive and continuous study on the effects of daylength control on several representative commercial carnation varieties. Plantings have been made almost monthly since that date in a continuous effort to upgrade techniques and growing methods so that some degree of reliability could be built into formulas and schedules.

Some of the highlights of our practical studies have now been published for the first time and can be currently found in the Yoder October 1968 Grower Circle News issue #67.

To date, single pinch one flush crops have been used as the experimental method that most accurately reflects the true effects of photoperiod response and control. In addition, the one flush cropping method does also offer advantages in many commercial situations for improving the efficiency and flexibility of valuable greenhouse space.

(continued on page 3)

Photoperiod Manipulation

(continued from page 1)

The conventional 15 to 24 month continuous flowering carnation crop is no longer profitable or well suited to numerous small and mixed crop greenhouses. The major carnation producing areas of Denver, California and New England, as well as some larger local producers, keep the U. S. markets well supplied for practically all periods of the year except for peak holiday demands. The single cropping technique should then be considered as a useful as well as profitable method to incorporate in crop rotations for supplementing demand periods when maximum price returns can be had.

Economic Basis For One Flush Crops.

The program that is now being offered to the commercial growers has been geared to produce a minimum of 16 saleable blooms per square foot of greenhouse bench space within an approximate 21–25 week growing period. If grown continuously each square foot of bench space would produce no less than two individual crops a year or 32 saleable flowers. The total yearly production is slightly more than one continuous crop would produce in a 52 week period in this part of the country, but each crop can be pinpointed to a specific season and cut-out time for any one crop has been reduced to a six week cut-out duration. In most situations a net return of 12¢ for saleable bloom should cover all material and production costs and may commence to yield a small profit. Holiday carnation costs generally are well beyond the 12¢ level.

Carnation Crop Lighting Requirements

There are still future chapters to be written on this subject, but a basis for lighting a carnation crop has now been established.

1. *Source and Quality of Lights*

In an attempt to remain practical, the conventional incandescent light bulb has been our primary source of light energy used to regulate the photoperiod on the carnation plant. Our work has been based on a minimum of 15 foot candles obtained by using 40-watt bulbs with reflector pans strung 18"–20" apart and 3 feet above soil level. This is essentially double minimum chrysanthemum lighting requirements.

A preliminary comparison last winter between the use of incandescent versus cool daylight fluorescent light sources demonstrated the superior results with the lower intensity incandescant bulbs. It bears out a similar report by G. P. Harris from the University of Reading in England who claimed there to be a synergistic effect between the *red* and *far red* light qualities emitted from incandescant bulbs.

2. *When to Light*

The stage of growth that we have found to be most receptive to lights is when the new axillary shoots are 1 to 2 inches long or when 3–5 pair of leaves are visible. According to the recent Yoder carnation cropping schedule now published, it will be noted that there is no direct correlation between pinch date and start of light on crops. The recommended time to start lighting is from the pinch date in August and from two weeks later in October and through March.

This variation reflects the difference in expected growth from rooted cuttings harvested in the different seasons. Summer planted cuttings have generally set a terminal flower bud at plant time, and later breaks develop before the top is pinched out. Late season plants which reflect a short day cutting and less reproductive traits, start to develop their breaks only after pinching. Subsequently, the new breaks have to develop some before lighting is necessary for flowering control.

3. *Time of Night*

Tests made in Barberton, Ohio within the past two years were consistent in establishing that lighting in the middle of the night was more effective than lighting at either end for a given number of hours. But for all practical purposes as long as the minimum duration and light intensity requirements are met, reasonably good results would be had by lighting at any period of the night.

4. *Flowering Period When Supplementary Lighting Useful*

Extending the daylength for flowering control is most useful for crops flowering from *December through mid June* in the northern latitudes of the United States. There is no added benefit from artificial lighting for crops scheduled to flower from late June through November. The naturally long days coupled with higher growing temperatures exert a greater hastening influence on the crop than is actually desired. Without adequate temperature controls the crop is forced to flower too rapidly and substandard flowers with low petallage result.

5. *Duration of Light*

A 17-18 hour day of natural daylight plus artificial light has resulted in consistent hastening of flower development in all trials at Yoders. Longer durations do speed flowering more, but over-lighting can be very disadvantageous in reducing quality of crop, small flowers, weak stems, etc.

Success From Photoperiod Control is Dependent on Other Environmental Factors as Well

1. *Temperature*

Late fall, winter and early spring direct plantings benefit markedly from bottom bench heat for a rapid and uniform take-off.

Having grown winter crops at various temperature levels, our results have indicated that carnation bud initiation takes place most rapidly when temperatures are in the mid 50's. Subsequent development is hastened by temperatures above 55°F though the exact increase used would be governed by available light intensity of a region.

There is a significant interaction between temperature and daylength. These factors combine to effect both bud initiation and development. The results of our work do support the findings of previous English investigations that flower bud initiation occurs most rapidly and uniformly under long day photoperiods coupled with temperatures below 60°F. Sixty degrees F or above will actually delay the initiation process.

Once a bud has been initiated in a shoot terminal, rais-

(continued on page 4)

Photoperiod Manipulation

(continued from page 3)

ing the temperature will accelerate the rate of flower development. Thereby there is an optimum temperature which supports bud initiation, but the flower bud developing temperature should be adjusted to the light which a grower would have available in his environment. Thus, optimum temperature curves for carnation initiation and development vary with season.

A December or January flowering crop is started from a long day reproductive cutting taken from the stock plant in May or June and planted as a rooted cutting in late July. At the time of pinch lateral breaks are already well developed and budded. Under those circumstances, the developing temperature for a mid winter flowering crop requires a gradual reduction in finishing temperatures.

A May flowering crop is planted in late November and pinched in mid December. These plants were taken from short day conditioned plants and much more vegetative than the June cuttings. These plants will not produce axillary breaks until pinched. This winter planting will perform best if started in a 60°F minimum N. T. house up to pinch date. Thereafter the N. T. should gradually be dropped down to the 54-55° F range and carried at that temperature through the lighting period. The combination of lower temperatures plus increasing long days is most conducive to initiating buds uniformly on all breaks. After the lighting period, both day and night temperatures must be gradually raised going into the longer and warmer days of March and April. The prevailing natural long days together with normally higher finishing temperatures makes the spring flowering crop the most uniform of the year with a very short cut-out period.

2. *Carbon Dioxide Supplement*

The seasonal cropping timetable published in the Yoder Grower Circle News is based upon the use of approximately 1200–1500 ppm CO_2 applied to the crop between 7:30 am and 3:00 pm every day from mid October to April 1.

Culture Pointers That Will Add Greater Emphasis To the Success of Daylength Controlled One-Flush Crops

1. *Start With Graded and Standard Quality Cuttings*

2. *Spacing*

Our work to date indicated that a 4 x 6 spacing works well. Wider spacing has a tendency to increase more shoots per plant and thereby lengthen crop crop-out time.

3. *Pinching*

Allow adequate establishment time before pinch. Usually requires about 3 weeks. When using a Yoder cutting the recommended practice is to leave four sets of leaves on all plants after the pinches are removed.

4. *Pruning*

Using 6"x 4" spacing with the objective of cutting a minimum of 16 saleable flowers per sq. ft., allow no more than 4 breaks to remain on each plant. Prune the others off at the earliest possible date.

Variety Selection

Variety selection is a vitally important factor in successful lighted crops. The more vegetative varieties and

selections such as "Alaska" or "Mars" require a greater light stimulus to achieve desirable results, than is needed for reproductive varieties such as "Scania" or "Apollo". Thus it is more economical to program those with the greater reproductive tendency which in turn will respond more effectively to the lower light stimulus to control flowering.

In that the Sim family of sports and selections continue to dominate the world wide carnation programs, it is not surprising to note that the more suitable choice found for the current cropping programs were selected from the same family. The following varieties were chosen for their (1) responsiveness to light (2) low splitting tendencies, (3) strong stemmed traits for mid-winter flowering.

Red	Pink	White	Variegated
Ohio Red Sim	Ohio Lt. Pink	Ohio Wh. Sim	Sparkle
Red Gayety	Imp. New Pk. Sim	Imp. Wh. Sim	
C.S.U. Scania	Apollo		
Scania			
Scania 3-C			

Future Development of Single Crop Programs Will Be Dependent Upon The Plant Breeder

The Sim varieties have fit the needs so well for the continuous cropping carnation programs in that they have the growth traits of being able to support all stages of vegetative growth simultaneously with flower development. The Breeder has also produced varieties that seem to support only one stage of growth at a time. "Apollo" and some of the miniature varieties are good examples of this type usually referred to as "cropping" varieties. Heretofore this habit was considered undesirable and as a result few of those introductions have survived in the trade. Now there is a place and need for such growth habits wherein all the energy from each shoot can be channeled to the terminal bud for maximum flower development rather than wasting energy in lateral shoot growth. "*Let this be a challenge to carnation Breeders.*"