Some Responses of Carnation to Temperature

W. D. Holley

Many experiments have been conducted on the response of carnation to temperature. Work by Kohl (1960) will be cited in this paper along with work and observations made at CSU during the past decade. This is by no means a complete treatise on carnation responses. The paper is presented primarily to generate thought among our growers and to supply some temperature information that may have been missed by our grower clientele.

Kohl, working at UCLA, grew White Sim carnation in containers and moved plants from a growth chamber to a greenhouse, or vice versa, at three stages of flower bud development: 1/8", 1/4", and calyx opening. He compared the plants grown at 2-stage temperatures with others that were grown the entire cycle, either in the refrigerated chamber or in the greenhouse. Greenhouse temperatures were not constant but for the most part were 60 F nights and 70-80 F days, occasionally higher. The refrigerated case was controlled at 50 F nights and 55-60 F days. Table 1 gives a summary of some of the measurements made by Kohl on responses to these temperature treatments.

The most critical temperature on flower quality (weight and diameter) was after the bud had reached the 1/4" stage. Kohl's work indicated that the flower quality factors of weight and size were largely unaffected by the temperature at which the shoot was grown. However, when shoots were grown at 60 F to 1/8" or 1/4" bud stage and then transferred to 50 F, abnormally large flowers with extra growth centers were produced (treatments 6 and 7). These "bullheads" contained an average of 3-1/2 growth centers per flower while those plants grown at 50 N throughout had only 0.7 growth centers. The stage of most rapid bud growth was the stage most susceptible to "bullhead" formation. We can assume from this that a change from 60 to 50 is too much.

Note from Table 1 that a flower developed fastest (122 days) at 60 N with a flower weight of 7.1 grams. This is the weight of a summer flower. If the shoot were grown at 60 N until calyx opening stage (113 days), and then finished at 50 N for 31 days, the flower weighed 9.9 grams and was considerably larger in diameter. While this temperature manipulation is not possible except with single crops in separate houses, it points up the fact that much of the flower size and weight is due to the temperature during the final stage of bud development.

Kohl's work also emphasizes how slowly carnations grow at 50 N and 55-60 D temperatures. Growing carnations at these temperatures is never done except in northern climates where the plants are effectively kept near dormancy due to lack of winter energy. This does help to explain the extremely slow growth we get in mid-winter in Colorado. Not only are the night temperatures low, but net radiation during the day (CFGA Bull. 239) is often very low also.

From Table 1 we see that the longest stems were produced at 60 N throughout or 60 N at least to 1/8" bud stage. When shoots were grown at 50 N for the corresponding

Table 1. Flower and stem quality and days to flower for shoots of White Sim carnation at several temperatures.

Temperature treatment F°	Avg wt flower-grams	Avg flower dia-cm	Avg lgth stem cm	Avg wt top 50 cm stem-g	Average days		Avg days to bloom
					Begin temp	Finish temp	
1. 60 N throughout	7.1	7.0	72.0	11.9	-	-	122
2. 50 N to 1/8" buds 60 N to flower	7.7	7.3	62.5	11.9	141	39	180
3. 50 N to 1/4" buds 60 N to flower	7.7	7.5	60.0	14.2	152	32	184
4. 50 N to calyx open 60 N to flower	12.0	8.2	60.8	18.5	193	16	209
5. 50 N throughout	11.8	8.4	60.2	15.7	-	-	232
6. 60 N to 1/8" buds 50 N to flower	13.6	9.2	70.1	15.3	81	92	173
7. 60 N to 1/4" buds 50 N to flower	13.9	9.1	71.6	14.9	88	73	161
8. 60 N to calyx open 50 N to flower	9.9	8.2	67.3	13.3	113	31	144

period they averaged about 10 cm shorter. The effect of temperature on the weight of the top 50 cm of stem is not quite so easily interpreted. Since almost 70 cm may be marketed in the case of a top grade bloom, total weight of the stem would be a better statistic. Minimal weight for a fancy flower and stem is 25 grams. This would require minimums of 10 grams for the flower and 15 grams for the stem. This minimum stem weight was produced at substantially all treatments except 1 and 2. However, temperature treatments 2, 3, 4, and 5 produced stems too short for the fancy grade. This leaves treatments 6, 7, and 8 which are nearest to commercial practicality. These treatments correspond most closely to producing the shoots in summer and the flowers in fall.

But Colorado traditionally produces its highest quality — longest stems, largest blooms, and heaviest bunches — in April and May. The shoots of these flowers are produced with cool temperatures, short days, minimum water stress, and relatively low energy. The buds and flowers develop under lengthening days, warmer temperatures with increasing energy, and stress.

Temperature is only one of the factors that affects quality and growth rate of carnation. All growers have observed that conditions causing abnormally fast growth are detrimental while slow steady growth leads to quality carnations.

What other factors contribute to stem length besides temperature?

Water — and lots of it; low stresses are due to frequent irrigation with good quality water.

Day length — long photoperiods cause longer internodes and longer stems. But long stems can be produced with cool temperatures and slow growth.

Genetics — among our seedlings we see short, tall, and exceptionally tall individuals. While the Sim varieties are tall, individuals often sport from them that are taller.

Fiberglass coverings — delay flowering of carnations slightly, but the stem length is invariably longer than from similar plants grown under glass. This is probably the "shading effect" that could be accomplished by the correct amount of shading material applied to glass in our climate.

To get weight of stem plus length, flower size, and commercial handling qualities, we must gear our temperature to the energy trapped by our greenhouses. This short wave radiation is required to maintain plant temperature, for the evaporation of water, and finally for photosynthesis. If temperature is limiting, as it is in the winter when net radiation is low, most, if not all, of the incoming energy may be used just to maintain plant temperature. Plants are natural radiators in this case and tend to be cooler than the air surrounding them. There is a certain low base of energy required just to maintain a plant — possibly this is around 60-100 cal/cm^2/day. As energy increases above this base, evaporation of water and finally food manufacture begin increasing. As factors in the environment are altered the optimum temperature for carnation changes.

Table 2 gives suggested growing temperatures for Sim cultivars during fall, winter, and early spring. These recommendations are made from results of numerous experiments over the past decade. They are aspirated temperatures at bud height in houses where minimum horizontal air flow is 10 to 100 ft/min. For accurate temperature control in a greenhouse structure 10 ft/min is necessary when incoming energy is minimum. As energy increases the air velocity should also be increased to the maximum of 100 ft/min.

There will be more on temperature in the next bulletin.

Table 2. Optimum greenhouse air temperatures[a] for carnation during fall, winter, and spring when the energy level is 150-300 cal/cm^2/day.

	Base for soil growing	Add CO_2 at 400 - 1000 ppm	Minimize water stress
Night	50-52 F	52-54	54-56
Day	64-66 F	66-70	70-72

[a]Aspirated temperatures at bud height with horizontal air flow of 10-100 ft per minute.

Literature cited

Kohl, H. C. Jr. 1960. Period during development of a carnation shoot when temperature has greatest effect on flower size. Am. Soc. Hort. Sci. Proc. Vol. 77:540-543.

Turn Page for Schedule

GROWERS' SESSIONS — DENVER, COLORADO — BROWN PALACE HOTEL

Saturday September 25

Onyx Room

8:00-12:00 A.M. Joint Sessions.

8:00 A.M. Employers' Workshop.
Ray Crowley, Presiding. Buzz Session on labor management problems.
"The Agricultural Labor Situation" — Don Kittel, Colo. Farm Bureau.

10:00 A.M. Break. See Trade Fair. Coffee, Cokes (Courtesy Florists Mutual Insur. Co.)

10:30 A.M. "Opportunities in the Mass Market" — Dr. Geo. Kress, Colorado State Univ. Bob Bernacchi, La Porte, Indiana

12:00 A.M. Lunch where you wish/visit Trade Fair

1:30-5:00 P.M. Dual Sessions.

Bedding-Pot Plant Growers, Gold Room.
Other Growers, Onyx Room.

BEDDING—POT PLANT GROWERS

1:30 P.M. "Growing-Selling Plants/Texas Way—Big" Bob Schmidt, Caprock Growers, Inc., Lubbock, Texas

2:30 P.M. "Poinsettias—by Mikkelsen" Jim Mikkelsen, Mikkelsen's Inc., Ashtabula, Ohio

3:30 P.M. Break. See Trade Fair. Coffee, Cokes (Courtesy Florists Mutual Insur. Co.)

3:45 P.M. "What Next for the Colorado Bedding and Pot Plant Program" B & PP Committee

4:15 P.M. "Lily and Poinsettia Program at CSU" Dr. Kenneth Goldsberry

4:45 P.M. "Let's Talk It Over" Panel . . . Questions to the Speakers. Ken Goldsberry, Panel Moderator.

OTHER GROWER'S PROGRAM

1:30 P.M. "The Future of the Carnation" Dr. Gustov Mehlquist, Univ. of Conn.

3:00 P.M. Break. See Trade Fair. Coffee, Cokes (Courtesy Florists Mutual Insur. Co.)

3:30 P.M. "So You Think You Run Good Temperatures" Dr. Joe Hanan, Colorado State Univ. Gordon Koon, Gordon's Greenhouses, Inc.

EVENING PROGRAM

6:30 P.M. Cocktail Party

7:30 P.M. Dinner Dance, Brown Palace Hotel
John Bodette, Detroit, Mich., speaker.

Sunday September 26

8:00-11:30 A.M. DUAL SESSIONS.

BEDDING—POT PLANT PROGRAM

"How to Grow 'Em" — Bedding Plants
Half-day session on Growing Techniques

8:00 A.M. A Look at the Past Bedding Plant Season in Colorado

9:00 A.M. "What It Takes — to Produce Quality Bedding Plants" Bob Bernacchi

10:00 A.M. Break. See Trade Fair. Coffee, Cokes (Courtesy Florists Mutual Insur. Co.)

10:15 A.M. "Some of the Fine Points — of Growing Bedding Plants" Bob Schmidt

11:15 A.M. "Wrap-Up" B & PP Committee

OTHER GROWER'S PROGRAM

8:00 A.M. "Financing for Growers" Federal Land Bank

9:30 A.M. Break. See Trade Fair. Coffee, Cokes (Courtesy Florists Mutual Insur. Co.)

10:00 A.M. "What Makes Your Plants Grow?" Gus Mehlquist

11:30 A.M. Visit Trade Fair, Cash Bar

12:00 A.M. Luncheon.

"America in 1976—Republic or Welfare State?" Mr. Ed Wimmer, Natl. Fed. of Independent Business

2:00 P.M. "Agriculture's Image"

"Government Farm Policies" Dean R. Kittel, Colorado Farm Bureau

"Let's Put Our Best Foot Forward" Dr. Kenneth Brink, Colorado State Univ.

3:30 P.M. Join the Design Pageant and Auction

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