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Bulletin 285

February 1974

## Summer Cooling of Carnations

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Carnation grade holds high through the spring months in Colorado as a result of increasing day lengths and higher light intensities. However, as summer progresses flower quality begins declining. This loss of quality is brought about by rapid growth in longer days, higher light intensities and higher temperatures. Under standard cultural practices the summer cooling temperature is usually set near 65F. Once this temperature is reached in the evening the cooling system shuts off or cycles a while then the greenhouse temperature slowly drifts to night temperature. During the summer excessive residual heat in the greenhouse may cause the drift period to extend many hours into the night. These high temperatures cause rapid respiration of the plant's food reserves. The result is a loss in flower size and stem strength. Split calyxes from rapidly expanding petals may occur. This past summer we investigated the possibilities for improving carnation grade by reducing night temperatures.

### Materials and Methods

Rooted cuttings of cv Atlantis were planted in the south benches of all 4 compartments of the CSU Temperature House on February 8, 1973. Each bench contained 17 rows of 7 plants with rows 8 inches apart. The plants were grown in gravel with automatic watering and feeding. The cuttings were double pinched to bring plants into a sustained period of flower production throughout the summer.

Cooling, heating and ventilation temperatures were the same in the 4 compartments until June 15. At that time the following cooling temperatures were established:

Compartment A — cooling temperature set at 60F  
Compartment B — cooling temperature set at 65F  
Compartment C — cooling temperature set at 56F  
Compartment D — cooling temperature set at 58F

This cooling scheme was maintained until October 6, when all compartments were set to cool at 65 and to heat to 60F. Clocks were wired to fan circuits to record daily fan operation time. Temperatures were monitored by thermocouples connected to a Bristol 24-point recorder.

All flowers were cut with long stems so that stem length would not limit grade. No attempt was made to leave lateral breaks for a return crop.

### Results and Discussion

A summary of the data by treatments is shown in Table 1. The design grade is broken down into subcategories as to cause of downgrading. The highest mean grade of flowers was produced when plants were cooled to 60F. For the entire record period, Compartments B, C and D produced mean grades of 4.05, 3.96 and 4.01 respectively, compared to 4.15 for A (60F). While these differences appear small, two things are indicated. Cooling to 60F improved grade when compared to 65F. Cooling can be overdone as was indicated in Compartments D and C where cooling was to 58 and 56F.

Figure 1 shows mean grade by weeks for each temperature treatment from early summer to early fall. A decrease in grade for all temperatures occurred from early July to early September. Beginning August 5, the 60F cooling regime showed a significant grade

Table 1. Yield and grade of carnations produced by four summer cooling temperatures — July 8 to October 20, 1973.

Cooling temp.	Grade					Total yield	Designs	
	Fancy	Standard	Short	Design	Mean		Weak stems	Malformed
65 (B)	331	262	100	94	4.05	787	37	55
60 (A)	335	251	84	87	4.15	749	47	38
58 (D) <sup>a</sup>	396	260	93	147	4.01	896	52	95
56 (C)	296	278	117	107	3.96	798	71	36

<sup>a</sup>Compartment D received somewhat more energy as it was on the east end.

Table 2. Yield and grade of carnations produced by 4 summer cooling temperatures from September 3 to October 20, 1973.

Cooling temp.	Grade				Total	Mean grade
	Fancy	Standard	Short	Design		
65	105	51	19	30	205	4.13
60	69	40	20	20	149	4.06
58	102	71	25	55	253	3.87
56	69	55	32	43	199	3.75

improvement over 65F. This improved grade from 60F cooling continued to early September when the 65F cooling recovered and was equal or better the rest of the record period.

Cooling to 58F equalled 65F in grade until mid-September then decreased through early October. Cooling to 56F caused a serious decrease in grade from early September to the end of the records.

All treatments were decreasing sharply in production through September and the first half of October. A slight increase in design grade flowers during this period caused a much larger decrease in mean grade. Table 2 was prepared to show the effects of summer cooling temperatures (June 15 to October 6) on the grade of flowers from September 3 to October 20. The lower the cooling temperature the lower was the mean grade. The lower mean grades were caused by an increase in production of design and short grades of flowers due to weaker stems at the lower cooling temperatures.

Table 3 breaks down the design grade flowers into several categories. As cooling temperature decreased below 60F the number of weak stems increased (Table 3, 58 and 56F treatments). The total malformed flowers produced showed no distinct trend but was greatest at 58F and least at 60 and 56 (Tables 1 and 3). Total design grade flowers was least at 60 and 65F and most when plants were cooled to 56 or 58F (Table 1).

Table 4 presents the average fan operation time per day from June through September. There was an appreciable difference in fan time between Com-

partments A and B (60 and 65F). Differences between fan time to maintain 60, 58 or 56F were small. It is worth noting in Figure 1 that during the time from August 5 to September 2 60F cooling maintained a higher mean grade than 65F. At no other time was grade better at 60F. In light of this, the use of fans for 4 to 6 more hours daily to cool the additional five degrees is a questionable practice.

Table 3. Reasons for downgrading the design flowers produced by 4 summer cooling temperatures, Sept. 3 to Oct. 20, 1973.

Cooling temperature	Design grade	Weak stems	Malformed flowers	Other
65	30	13	17	0
60	20	14	5	1
58	55	24	31	0
56	43	34	9	0

Table 4. Average fan operation time in hours required per day to cool to four temperatures.

Cooling temperature	June	July	August	September
65F	13.9	12.9	12.9	7.0
60	17.6	15.5	18.6	11.2
58 <sup>a</sup>	19.2	20.4	20.2	12.8
56	19.0	20.2	20.1	13.5

<sup>a</sup>Compartment D received more early morning sun since it was on the east end of the line of compartments.

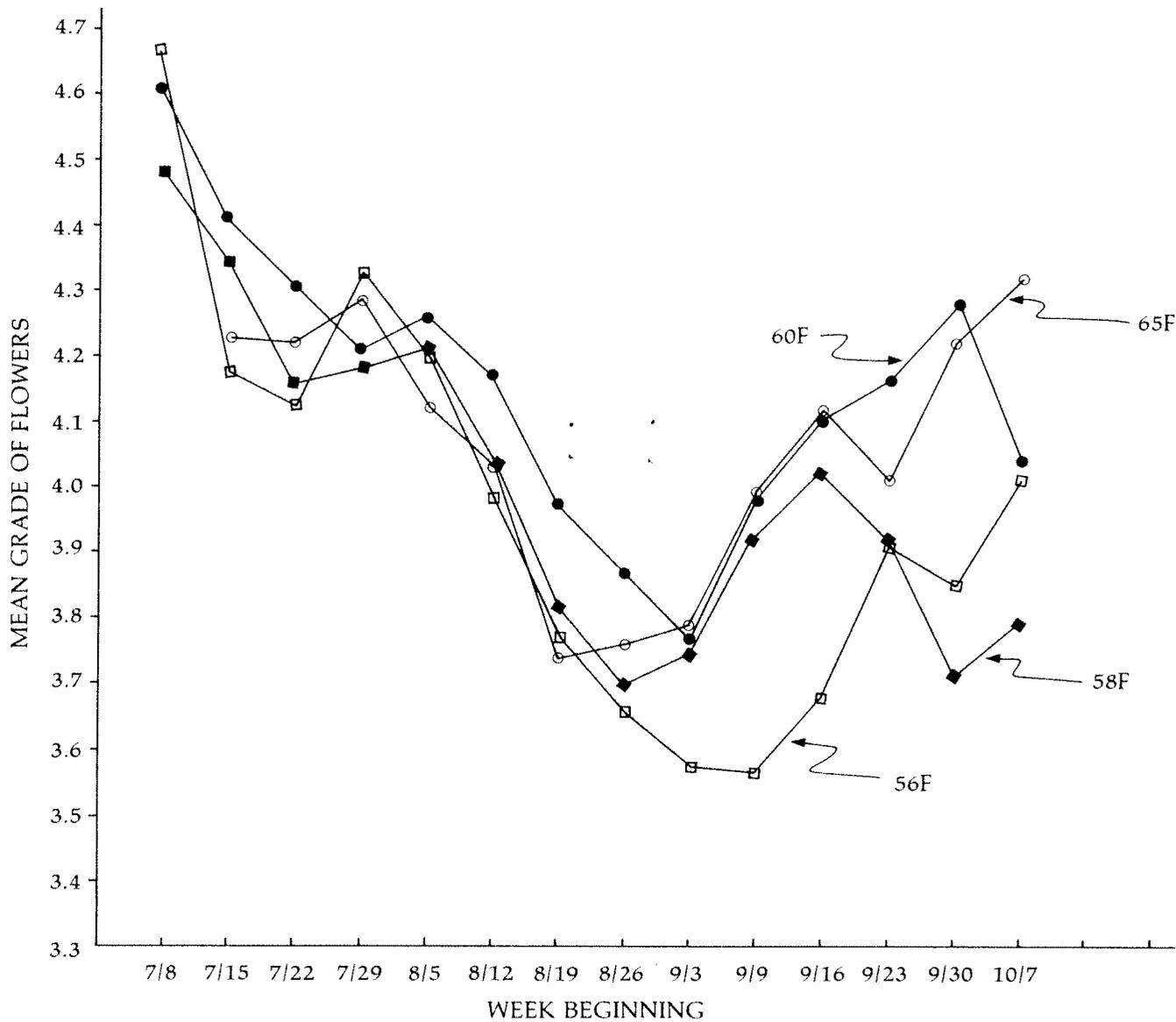


Figure 1. Mean grade of flowers by weeks produced by four cooling temperatures.