COLORADO FLOWER GROWERS ASSOCIATION

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Selection for Tolerance of Carnations to Low Temperatures

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The recent fuel crisis and increased fuel costs has emphasized the need for fuel conservation in greenhouses. One method is to grow at lower temperatures. However, our carnation cultivars have been selected for maximum production at night temperatures of 52 to 54°F and cooling temperatures of 66 to 70°F with CO_2 (CFGA Bull. 254). For the grower to arbitrarily reduce temperatures can result in reduced yield and poorer quality. In CFGA Bulletins 123 and 175, W. D. Holley pointed out that the variability to be found in a supposedly genetically uniform, asexually produced carnation is sufficient to permit selection of plants responsive to a wide range of environmental conditions. It was the objective of this study to see if this could be done. As a result, we have been able to select several promising clones from nine carnation cultivars. These will be tested next year to see if they will maintain their productivity.

Methods

The study was carried out in the CSU Temperature House, with the compartments set up to provide four temperature regimes. Nine carnation cultivars were planted as shown in Fig. 1 on June 7, 1976. All north beds were soil, all south beds were inert media. Spacing was 6 x 8-inches, with automatic fertilizer injection at each watering through Chapin, double-wall drip tubes. The greenhouse was covered with FRP, Tedlar® coated fiberglass. CO_2 was injected.

Each selection contained 96 plants, divided into 8 plots, each containing 12 plants. The selections, as noted in Fig. 1, were planted in rows half the width of the bed, excluding the last two rows on the east end of each bed. Position was selected randomly. The temperatures were selected to give an eight degree variation from night to day and still cover the recommended temperatures as well as a low range.

Records on yield and quality were kept on individual plants. Colored tags were used to denote grade, following SAF standards, and hung on the supporting wires as each flower was cut. Tags were also used to indicate off-color and split or bullhead flowers. Beginning September, 1975, and ending March, 1976, the tags were collected the end of each month. Keeping life quality was tested on single plants. Fancy, standard and short flowers were placed in 200 ppm 8-HQC immediately after cutting, and placed in a keeping room maintained at 70°F, with 50 to 100 ft-c intensity.

Results

The average yield per plant, mean grade and keeping life of each cultivar, regardless of temperature treatment is presented in Table 1. CSU Red and White Pikes Peak had the lowest average yields of any of the nine cultivars, and White Pikes Peak had the lowest average flower quality. There were no significant differences in keeping life for any of the cultivars except the two reds, Scania and CSU Red (Table 1).

Low temperature ranges reduced quality when all plants were averaged (Table 2). However, the effect was largely on plants grown in soil. There was little effect of temperature regime on flowers produced in gravel. But, the fact that all gravel beds were located on the south had an observable effect on results, so that the differences could be attributed to location.

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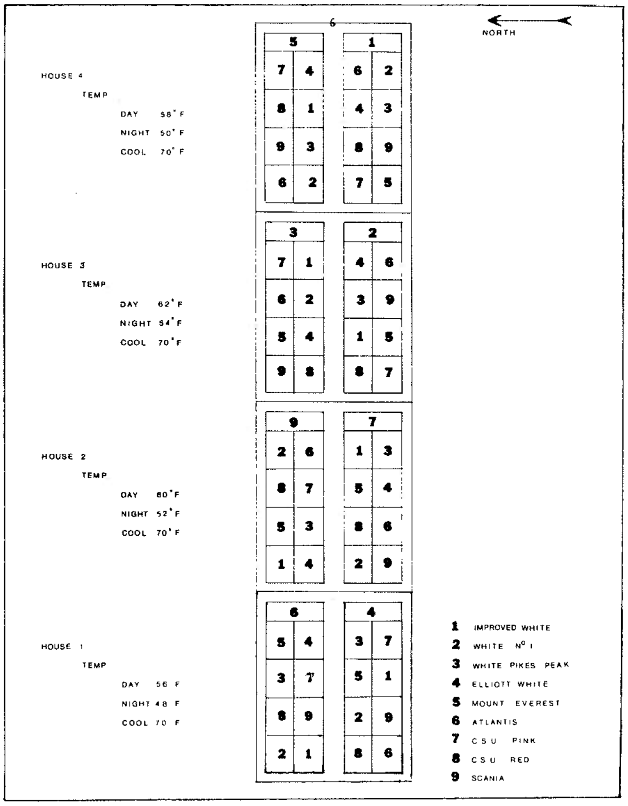

Fig. 1: Experimental plan in the CSU Temperature House for testing the response of individual plants to varying temperatures.

Table 1: Average yield, quality and keeping life of nine carnation cultivars grown in four temperature regimes.

Cultivar	Yield per plant	Mean grade	Keeping life (Days)
Elliott White	13.1	3.36	8.9
Atlantis	13.0	3.33	8.9
Improved White	12.5	3.25	8.6
White No. 1	12.3	3.53	8.5
Scania	12.1	3.35	7.8
CSU Pink	12.0	3.48	8.5
Mount Everest	11.4	3.49	8.9
CSU Red	10.9	3.47	7.8
White Pikes Peak	10.9	3.09	8.6
Minimum difference required for significance	1.7	0.20	0.5

Cut flowers from plants grown in gravel generally had slightly better keeping life, but again, this could be attributed to position in the greenhouse. Higher temperature regimes reduced keeping life by as much as one-half day, with best keeping life in the 48-56°F regime. The effect was largely on the cultivars Elliott White, Mount Everest, Atlantis and Improved White. There was little or no effect of temperature regime on keeping life of CSU Pink, CSU Red and Scania. The variability in keeping life due to treatment was much smaller than the variability in time. Thus, it can be seen in Fig. 2 that flower keeping life varied from more than 12 days to less than 7 days, depending upon the time of season when cut. This problem was noted by Lancaster (CFGA Bull. 292).

Table 2: Average yield, mean grade and keeping life of nine carnation cultivars grown in four temperature regimes, September, 1975 through March, 1976.

Temperature regime: Night	Day	Yield per plant	Mean grade	Keeping life (Days)
50	58	12.4	3.34	8.7
54	62	12.3	3.40	8.1
52	60	11.9	3.45	8.3
48	56	11.4	3.32	8.9
Difference required for significance		0.9	0.08	0.2

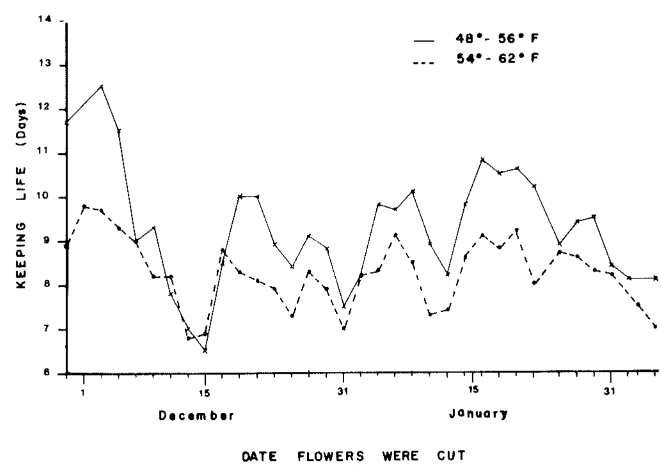

Fig. 2: Variation in keeping life of carnation cut flowers between the period of October 30, 1975, and February 6, 1976; and grown at two different temperatures of 48 and 54°F nights, heating to 54 and 64°F days with cooling starting at 70°F for both treatments.

Of particular interest was the behavior of individual cultivars shown in Figures 3 through 5. On an individual treatment basis, the differences shown in Fig. 3 for yield were not statistically significant. But, flower quality and keeping life variations (Figures 4 and 5) were statistically significant. Thus, mean grade of White No. 1, White Pikes Peak, Atlantis, CSU Pink and CSU Red were not much affected by the temperature treatment. But quality varied markedly as the result of temperature for Mount Everest flowers produced from plants grown in soil (Fig. 4).

We have been able to obtain some good data on variability of the carnation (see also CFGA Bull. 242). An example is provided in Table 3 for the nine cultivars grown in the 48°F night, 56°F day regime. Although low temperatures reduced average yield for the cultivars (all plants combined), individual plants could be selected which had good production. For example, plants in Improved White had an average yield of 12.3 flowers. But this could vary for individual plants from 3.6 flowers to 22.0 (12.3 ± 9.7). Quality could vary from 2.28 (almost all designs) to 4.20 (almost all fancy). Table 3 states the variation that can be expected in the normal production bed.

Summary

We would like to point up that this temperature study does not correspond with previous work. In this case, we varied both night and day temperatures simultaneously, whereas in some previous work (CFGA Bulletins 93 and 106) either the night temperature was varied and the day temperatures held constant, or vice versa. The effect of the combination was expected to be different. The results do suggest that we could look at means to reduce the variability in carnations in our selection process. We might take a lower average yield per plant, if the differences between individual plants could be reduced. Or, perhaps we should look at methods to fix yield — such as in single cropping, and select carnation clones with single cropping in mind. The results emphasize the need for good, continuing, reselection programs for the carnation, particularly if new cultural procedures are to be used effectively.

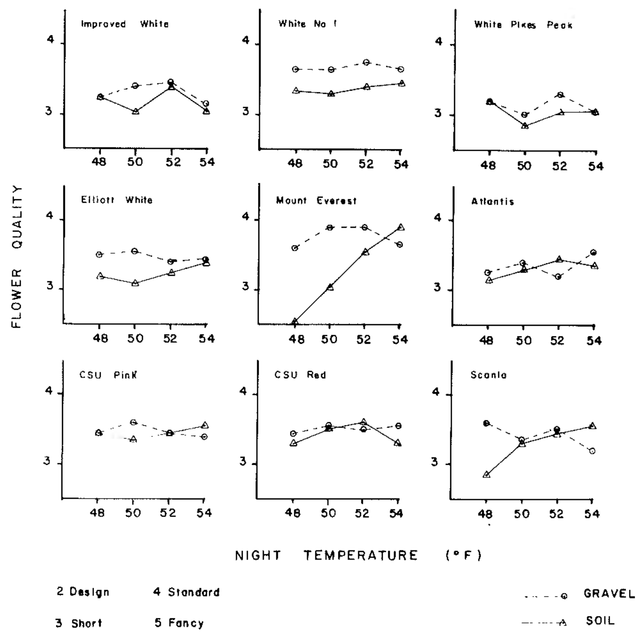

Fig. 4: Average quality of flowers cut from nine carnation cultivars (12 plants per treatment) subjected to four temperature regimes. Day temperatures were 56, 58, 60 and 62°F minimum with cooling starting at 70°F in all treatments; lowest possible grade 2.0, highest possible grade 5.0. Minimum difference required for significance was 0.5, each point an average of flowers cut from 12 plants.

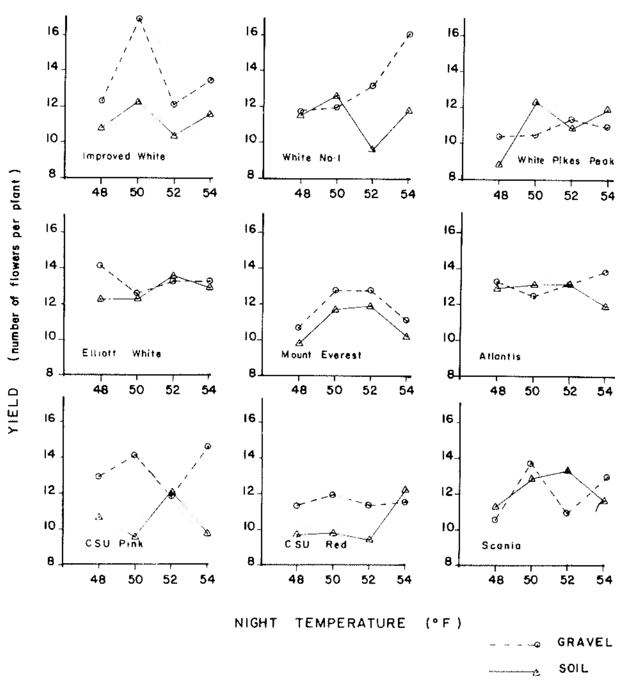

Fig. 3: Yield of nine carnation cultivars (12 plants per treatment) between September, 1975, through March, 1976, planted June 7, 1975, and grown at four different temperature regimes. Minimum day temperatures were 56, 58, 60 and 62°F, with cooling in all treatments beginning at 70°F. The interaction of root medium, temperature and cultivar was not significant. There were statistically significant differences between the main effects of medium, temperature and cultivar.

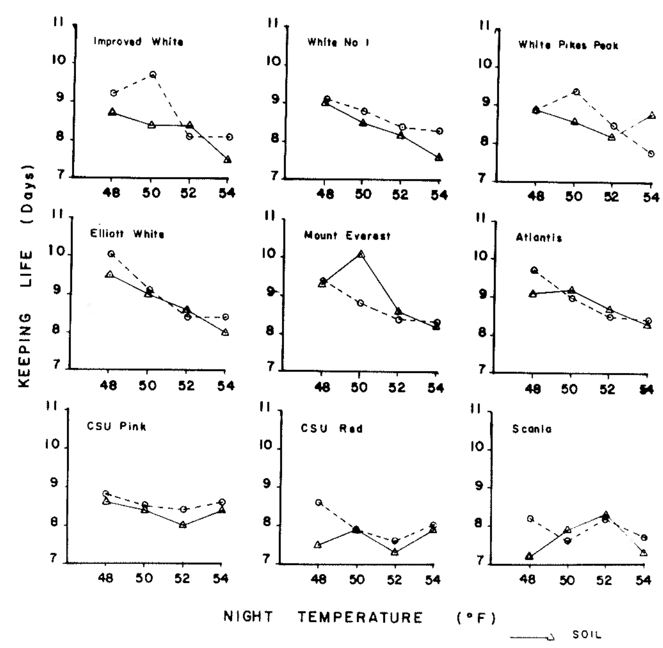

Fig. 5: Average keeping life of cut flowers produced by nine carnation cultivars (12 plants per treatment) grown in four temperature regimes. Flowers cut between September, 1975, through March, 1976, from plants benched on June 7, 1975. The day temperatures were 48, 50, 60 and 62°F minimum with cooling starting at 70°F for all treatments. Minimum difference required for significance was 1.1 days.

Table 3: Variability* of single plants in carnation cultivars. Examples selected from plants grown at 48°F nights, heated to 56°F days, with cooling starting at 70°F. (Average of flowers cut from 24 plants in each cultivar).

	Yield		Mean Grade	
Cultivar	Average	Variability	Average	Variability
Improved White	± 12.3	9.7	3.24	± 0.96
White No. 1	± 11.8	7.7	3.64	± 0.72
White Pikes Peak	± 10.4	5.7	3.22	± 0.78
Elliott White	± 14.1	4.5	3.51	± 0.74
Mount Everest	± 10.7	7.3	3.59	± 0.34
Atlantis	± 13.3	7.5	3.25	± 0.76
CSU Pink	± 13.0	7.3	3.46	± 0.40
CSU Red	± 12.1	7.0	3.18	± 0.84
Scania	± 10.6	6.6	3.58	± 0.66

**Variability was calculated by multiplying the standard deviation of the average by two. There is a 95% chance that, under similar circumstances, a single plant's production taken at random will fall between the limits expressed by the variability.*

Anon: 1975. Dutch pay one-third less than us in fuel oil costs. *The Grower* 84(8):321. (British)

British are paying at best possible terms for large users of heavy oil 29.9¢ per gallon (British Imperial). CO_2 costs $920 per acre for liquid. If we burn 45,000 gallons, the costs are $71,000 plus $920. The Dutch pay 22.1¢ per gallon, so for the same amount of fuel, their cost is $12,400, and they get their CO_2 free. The Dutch advantage on heavy fuel is 30%. If we are buring light oil, our costs would be $18,600, and propane instead of liquid at $1,150, or a 37% advantage.

Sims, T. 1976. Once-over harvesting is now reality with chrysanthemums. *The Grower* 85(13:679-680). (British)

It now seems established that mums can be harvested successfully in the bud stage and marketed in the normal manner after a few days in opening solution. Mums are more delicate than carnations and their handling needs more controlled conditions than those reported earlier for carnations. Ideal conditions for mums are 60-64°F, 60-80% RH and low light, no direct sunlight. To date, the best home mixed solution for bud opening is: 3% Sugar, 250 ppm tartaric acid, 40 ppm ACL (Monsanto). Rate per gallon (Imperial) are 135 grams sugar, 1.2 grams tartaric acid and 0.2 grams ACL 60. The rate of acid applies to Efford water which has a pH of 7.8 to 8.0. This mixture costs approximately 7¢ per gallon, at the rate of 25 stems per gallon.

Varieties react differently to this treatment. Hurricane is sensitive to sugar damage, and levels should be reduced in the summer. Yellow Snowdon is slow to open. Vase life of mums is similar to conventionally opened flowers. If a week is saved in the growing house by once-over harvesting, this, on a slow AYR program, would be worth approximately $1,800 per acre per year. The ingredients for one AYR crop would cost about $500 per acre. Added to this would be the cost of extra handling and opening room facilities. In winter, when a quality bonus is assured, there is real potential.

With once-over harvest it should be possible to crop more of the floor space and increase output. Buds pack easily, can be cool stored, and speed of opening is controlled.

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