COLORADO FLOWER GROWERS ASSOCIATION

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EFFECT OF SOIL TEMPERATURE ON CARNATION GROWTH

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The importance of energy conservation in greenhouses led us to re-investigate the benefits of increasing soil temperatures for carnations. If possible, warming the soil would be a means of reducing heat requirements of carnation ranges. Our results showed that, in raised benches, soil temperatures between 45 and 78°F, or 45 and 65°F in gravel, had no statistically significant effect on yield and quality of carnations. What differences did occur were due to plot position. As stated several years ago by Holley (CFGA Bul. 61), there is no improvement in carnation growth when soil temperatures are raised during the winter months. In general, raised benches will approach air temperatures of the greenhouse, and under usual watering procedures, 43°F water did not significantly effect soil temperature. Within 60 minutes after irrigation, plot temperatures were within two degrees of the starting temperature.

Methods

Two raised, wooden benches, in an east-west house, were divided into 21 plots (Fig. 1), 12 plots filled with soil, 9 with gravel. There were seven treatments with 3 plots per treatment (Table 1). Temperatures in heated or cooled plots were controlled by thermostats with either chilled water circulated through copper lines buried in the substrate, or by electrical heating tapes. Galvanized hardware cloth was placed on top of the tapes or water lines to aid in heat distribution. Temperatures at a representative point in each plot were recorded four times daily.

'CSU White' carnations were direct benched May 27, 1977, and single pinched June 11, 1977. Planting density was 3.8 per sq. ft., 30 plants per plot, standard cultural procedures were followed with automatic fertilizer injection through Chapin, double wall tubing. Night temperatures were set at 52 F, heating to 65 during the day with ventilation starting at 68°F.

Flowers were cut below the sixth node, with data including stem length, stem weight, internode length, grade and yield.

Results

During the first 4½ months, plot temperatures were difficult to control. In general, all plots reached temperatures in the 70°F range, regardless of cooling. Once the soil surfaces were completely covered by the foliage, temperatures stabilized as noted in Table 1, and were maintained throughout the remainder of the experiment. A temperature profile was determined for the plots, showing

Table 1. Soil treatment temperatures

Treatments	Code	Temperature °F
Gravel Cool	GC	45 - 50
Gravel Variable	GV	47 - 62
Gravel Warm	GW	60 - 65
Soil Cool	SC	45 - 50
Soil Variable	SV	50 - 62
Soil Warm 1	SW1	60 - 65
Soil Warm 2	SW2	73 - 78

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no significant differences in temperature regime either vertically or horizontally. Temperature regimes given in Table 1 were valid for the main treatments.

Two experiments were conducted to determine the effect of watering gravel and soil plots with 43 degree water. One plot from each treatment was watered to leaching. Five random temperature measurements at 3 and 6 inch depths, at intervals up to 60 minutes after watering, showed that such watering had little effect on temperature. In all cases, the plots were within 2 degrees of the starting temperature 60 minutes after watering ceased.

The yield from each treatment was divided into three periods, so that peak production could be analyzed separately for each peak crop (Figures 2 and 3). Although differences were not mathematically significant, the plants growing in gravel without temperature control had higher peak production than plants growing in gravel maintained at high or low temperatures. During the third peak in April, carnations in the uncontrolled temperature, gravel plots peaked one to two weeks ahead of the cool or warm treatments (Fig. 2). Carnations growing in soil, maintained at low temperatures, peaked ahead of the other treatments during January and again in April (Fig. 3). There were no significant differences noted for flower quality, stem length or weight. Plants in cool soil plots produced the most flowers, but this could just as easily be attributed to the fact that these particular treatments, during randomization, were placed in such positions as to receive maximum light through the winter and spring periods.

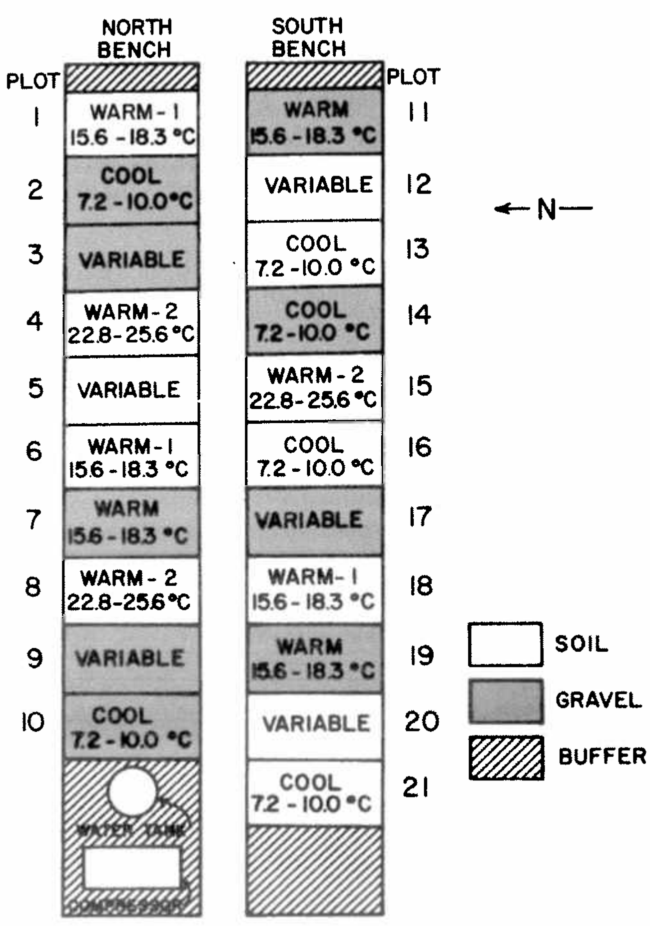

Fig. 1: Arrangement and location of soil temperature treatments. See Table 1 for conversion to degrees Fahrenheit.

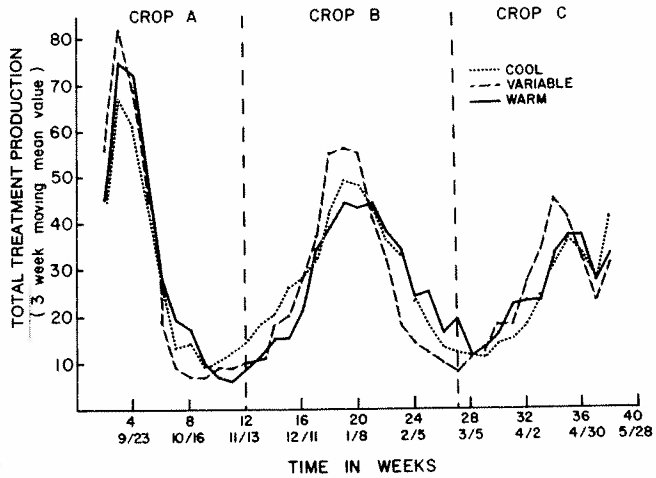

Fig. 2: Smoothed, total weekly production of carnations grown in gravel in raised benches.

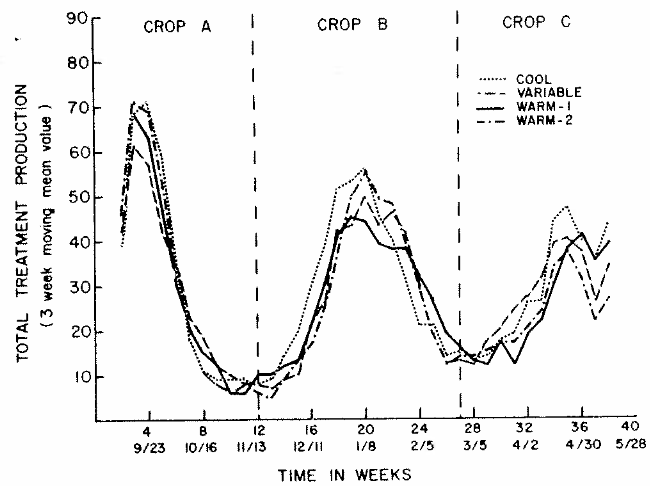

Fig. 3: Smoothed total weekly production of carnations grown in soil in raised benches.

Discussion

The results show that there will be no cost benefits through improved carnation growth by raising soil temperatures. There still remains the possibility that heating the soil with reduced air temperatures might be a valid energy conservation measure. Our data also show that root substrates have very high heat capacity, and thus are highly resistant to temperature changes. Normal irrigation with unheated water will not make much change in soil temperature. Similarly, it will be very difficult to raise soil temperature significantly through the use of heated water. Observation under practical conditions show that severe humidity conditions are likely to be encountered if the temperature of water applied through gates systems exceeds 70°F. During the last winter water temperature was monitored, and, during January and February was often 36°F. However, this temperature had no observable effect on soil temperatures when the water was applied through a trickle irrigation system.

The results were not unexpected. Raised carnation beds will approach equilibrium with the surrounding air temperature of the greenhouse, unless the plants are small and do not completely cover the soil surface. It appears to be a reasonable assumption that if the soil is cold, it will remain cold. This may be particularly applicable to ground beds, especially in beds adjacent to greenhouse walls, and where heat can be removed by conduction to the outside.