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THE "IDEAL" TEMPERATURES FOR ALSTROEMERIA PRODUCTION IN COLORADO

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A summarization of local research evaluating alstroemeria response to air temperature in combination with two substrate temperature treatments.

Introduction

Colorado has definite climatic advantages compared to other places where alstroemeria are grown. For example, Fort Collins receives 20% more total radiant energy than Ontario, Canada, during an average year (3), and the semi-arid atmosphere allows for a greater evaporative cooling capacity. These advantages can be turned into profit. This study was designed to determine the most beneficial temperature conditions which will maximize production of Colorado-grown alstroemeria.

The two cultivars studied, 'Atlas' and 'Monika,' were classified as "Carmen-type" and "Butterfly-type" alstroemerias, respectively (2). Plants in these categories yield far fewer flowering stems than the highest producing commercial "Orchid-types." As a result, the quality and number of flowers harvested in this study could have been greatly enhanced if the supplier had permitted the use of the two "Orchid-type" cultivars which were originally requested.

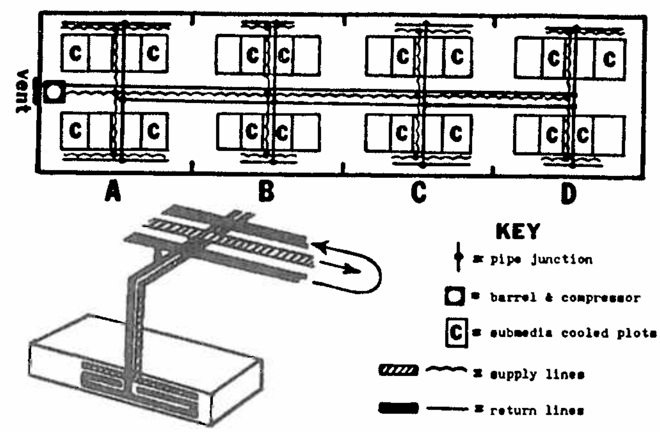

Fig. 1. Schematic of the randomized plot design and the cooling system used to determine the flowering responses of 'Atlas' and 'Monika' compared to non-cooled plots.

Materials and Methods

The two cultivars were grown in the "temperature house" facility at the W.D. Holley Plant Environmental Research Center. Interior walls and doors separated the facility into four 16 × 17 ft compartments which were designated "A" to "D" from west to east (Fig. 1). Each compartment contained two raised benches which were subdivided into four plots with a buffer zone at either end. Four plots in each compartment were randomly assigned to be cooled with a chilled water system, while the remaining four plots received no cooling. The cooled plots contained seven loops of 1/4-inch o.d. Biotherm© tubing laid on a 2-inch foundation of pea gravel.

A one ton capacity compressor was used to chill a 50 gallon water tank to 40°F, and the water was circulated through the Biotherm© tubing. Thermostatic control valves allowed cold water to the benches when the substrate temperature rose above 52°F.

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All compartments were heated to 50 to 52°F at night, and the following daytime temperature regimes were established:

COMPARTMENT	HEAT TO	COOL AT
A	58°F	68°F
B	68°F	78°F
C	73°F	83°F
D	63°F	73°F

Ninety-six divisions of each cultivar were planted in the benches on November 18, 1985. Every plot contained six plants, three 'Atlas' and three 'Monika' (density of 1.4 square feet per plant). Plant data were collected every other day and summarized weekly during a 52 week period beginning February 10, 1986. Flowering stems were harvested by pulling them when a minimum of one anther began to dehisce pollen. For the first few months of the trial, 'Monika' stems had to be cut to prevent uprooting, and the stubs were removed later to promote lateral rhizome branching. Each harvested stem was measured from the base of the stem to the base of the cyme whorl, and the stems were then graded according to these criteria:

GRADE CATEGORY	CRITERIA
1	36+ inch stem with five or more cymes
2	24+ inch stem with three to four cymes
3	12+ inch stem with two cymes
4	<12 inch stem with one cyme

Both the length and cyme number requirements had to be fulfilled for a stem to be considered in a specific grade category. If only one of the two criteria were met, the stem was downgraded. Lower grades were also assigned to stems with poor foliage.

Beginning January 1, 1986, carbon dioxide was injected into each compartment during daylight hours to maintain 1000 ppm on clear days. Plants were automatically watered four times daily with the standard Colorado State University nutrient solution (1). During the trial, three incandescent 40 watt lamps were strung over each bench to supply a night break when local daylengths were less than 12 hours (December 4, 1985, to April 1, 1986, and September 15, 1986, to the end of the experiment). Plants were thinned on a monthly basis, with no greater than 25% of the stems removed at one time.

Air temperature and radiation data were collected from the fifth to the 52nd week of the trial using a Hewlett-Packard (HP) computer system. Substrate temperature data were collected during weeks 9, 13, 16, 23, 28, 31, 34, and 39 (4). Copper/constantan thermocouples were placed in copper sheaths and inserted into the gravel (6 inches deep) at the center of a plot. Only two soil probes were available per compartment; therefore, the probes were randomly moved to a different pair of plots every other day during a soil-data-collection week. Daily radiation was measured with a silicon cell pyranometer placed in each compartment.

Results and Discussion

Total radiation received in the two easterly compartments (C and D) was approximately 20% less than that recorded in the westerly compartments (A and B) during the 48 week period. Relative humidity varied less than 15% between compartments when periodic measurements were taken. The lower humidities in the cooler compartments (A and D) were attributed to the continual ventilation required to maintain lower air temperatures. Average CO_2 concentrations in all compartments were more than 900 ppm when 20 random observations were made.

The average substrate temperatures in the cooled plots of each compartment ranged from 2 to 6°F lower than the non-cooled plots (Table 1). Even though specific heating and cooling temperatures were established, the weekly daytime air temperatures of the four compartments fluctuated considerably throughout the 48 weeks when environmental data were recorded (Fig. 2).

During weeks five to 33 (March 10 to September 28) the average air temperatures in compartments A and D could not be kept low enough to make them differ from each other. After week 33, the air temperature differences became more evident. Although the pre-set temperatures were not achieved for compartments A and D, the conclusions drawn regarding plant responses are valid since temperature differences still existed between the remaining compartments. Furthermore, the observed loss of summer temperature control is a common occurrence in commercial greenhouses. Thus, the results of this study may be more practical from a grower's view point because the temperature regimes actually maintained are feasible commercially. The average night air temperatures were A 57, D 55, B 55, and C 57°F.

The total production of 'Atlas' (10,018 stems) in all compartments was 1.6 times as great as 'Monika' (6,376

Table 1: Average day/night air temperatures and cooled or non-cooled medium temperatures recorded from March 10, 1986, to February 8, 1987, in four greenhouse compartments.

	Avg air temp (°F)		Avg medium temp (°F)	
Compt	Day	Night	Cooled	Non-cooled
A	68	57	57	61
D	68	55	54	61
B	72	55	61	63
C	75	57	59	64

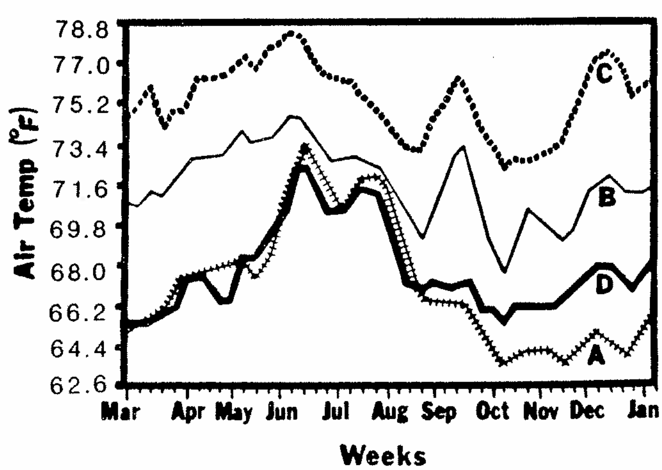

Fig. 2. Smoothed weekly averages of daytime air temperature in four greenhouse compartments (designated A to D from west to east) used for alstroemeria production experiments. (vertical scale was converted from °C to °F)

stems). 'Atlas' plants in compartment D produced the greatest number of stems when production in all compartments was compared during the 52 week period. The 'Atlas' cultivar reached its highest production peak from approximately June 23 to July 6, 1986 (Fig. 3). After July 6, production declined steadily in all compartments. In the 18 week period from September 1 through January 11, both cultivars grown in compartments B and C virtually ceased to produce, despite substrate treatment. Furthermore, it was noted the 'Regina' and 'Red Sunset' cultivars in the buffers (no medium cooling) did not produce flowers from September through January, regardless of air temperature. During that same period, the coolest compartments yielded: 303 stems from the cooled substrate versus 25 from the non-cooled substrate in compartment A; and 430 cooled versus 64 non-cooled in compartment D. Consequently, the cooled substrate treatment coupled with cooler air temperatures allowed production to continue virtually year-round.

'Monika' production peaked at approximately the same time as 'Atlas,' however, the yield of harvestable stems was much less than 'Atlas' (Fig. 4). Compartment C produced the greatest yield of 'Monika' during the peak period, and the decline in production thereafter was similar to that seen in 'Atlas.' From September through January, the production trend by compartment was similar to 'Atlas': 111 stems from the cooled versus 10 from the non-cooled substrate in compartment A; and 192 cooled versus 26 non-cooled in compartment D.

Cultivar flower production differed significantly between compartments. 'Atlas' plants grown in compartments A and D (68°F) produced the greatest number of harvestable stems, but average daytime temperatures ranging from 72 to 75°F (compartments B and C) reduced production. There were no differences in the production of 'Monika' due to daytime air temperature. 'Atlas' dramatically outproduced 'Monika' under all air temperatures.

Medium temperature had no effect on the quality of stems produced in this study. However, quality was influenced by the compartment air temperature, and the cultivars had different average grades. 'Atlas' plants produced higher quality flowers than 'Monika' in all air temperature regimes

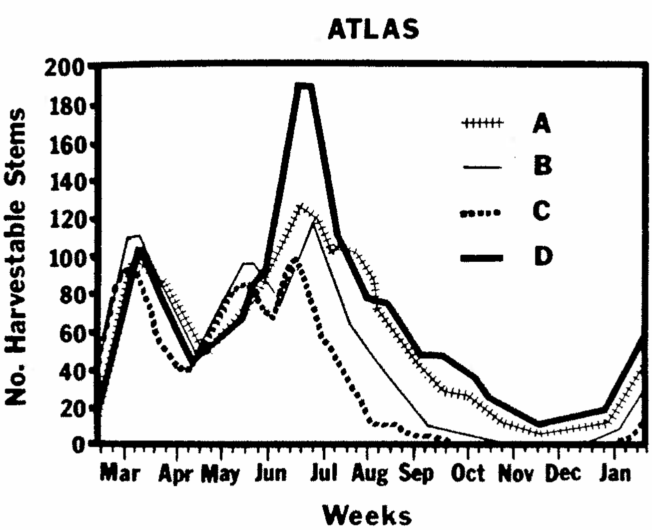

Fig. 3. Smoothed weekly yield of alstroemeria 'Atlas' stems from four compartments with different average day/night (D/N) air temperatures.

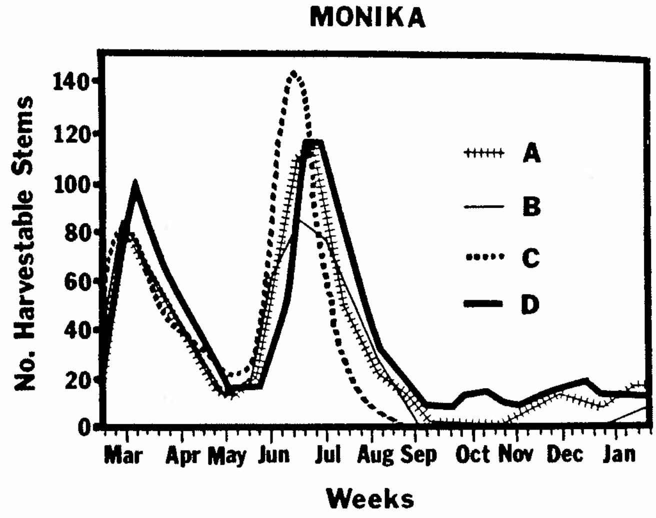

Fig. 4. Smoothed weekly yield of alstroemeria 'Monika' stems from four compartments with different average day/night (D/N) air temperatures.

(Table 2). Flower quality of both cultivars increased with increasing air temperature. This phenomenon was due to the use of stem length as one of the criteria for grading. The shorter stems from the cooler compartments (A and D) were often downgraded because they fell below the length limitation for a particular grade category. Considering the lower plant production in the warmer compartments, the quality advantage possessed by plants grown in warmer temperatures would be outweighed by a grower's desire for greater yields.

Substrate temperature did not affect stem length. Air temperature was the most significant factor influencing stem lengths of both cultivars. Longer stems of both cultivars were produced in the warmest average air temperature treatment (75 day and 57°F night). The stem lengths of 'Atlas' were comparable in the other three temperature treatments, but were more than 2.4 inches shorter than the cut flowers in the warmest treatment. The average length of all harvested 'Monika' stems was 19% less than that of 'Atlas,' which reduced the quality of 'Monika' stems.

Conclusions

The highest production of alstroemeria cultivars 'Atlas' and 'Monika' can be obtained with substrate temperatures of 53 to 57°F and an average air temperature of 68°F. Day-

Table 2: Quality grade for stems of alstroemeria cultivars 'Atlas' and 'Monika' harvested during the period February 10, 1986, to February 8, 1987. "Grade 1" = 36+ inch stem with 5+ cymes, "Grade 2" = 24+ inch stem with 3 to 4 cymes, "Grade 3" = 12+ inch stem with 2 cymes, and "Grade 4" = <12 inch stem with 1 cyme.

	Atlas		Monika	
Category	Number	Percent	Number	Percent
"Grade 1"	245	3	38	0.6
"Grade 2"	5543	55	2452	38.4
"Grade 3"	4004	40	3698	58.0
"Grade 4"	226	2	188	3.0

time temperatures above this level resulted in markedly lower yields. However, warmer temperatures contributed to a slight advantage in flower quality. Stem length increased linearly as air temperature increased. Under all conditions, 'Atlas' outperformed 'Monika' in terms of yield, flower quality, and stem length.

'Monika,' due to the poor yield and flower quality, is not recommended for Colorado alstroemeria growers. 'Atlas' had more acceptable yields and flower quality; however, the maximum number of cymes observed for 'Atlas' (five) was less than the eight cymes per stem commonly obtained from "Orchid-types."

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