The control of plant height by

by Royal D. Heins, Meriam Karlsson, and John Erwin

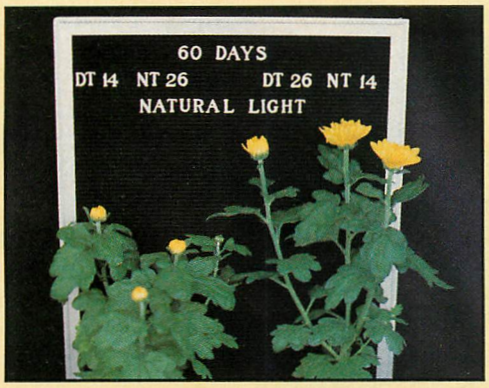

Figure 1. Influence of 14°C (57°F) and 26°C (86°F) at different times of the day on 'Bright Golden Anne' development. The photograph shows the plants at 60 days after start of short days. Plant on the left was forced with cool day (14°C) and warm night (26°C). Plant on the right was forced with warm day (26°C) and cool night (14°C). Plants were exposed to the indicated temperatures from start of short days until flowering.

Tradition says that the day temperatures should be warmer in the greenhouse than the night temperatures. And that is what normally happens in a greenhouse due to solar heating during the daylight hours. While day temperatures are normally warmer than night temperatures, recent research at Michigan State University has shown that day temperatures cooler than the night temperatures may be useful in controlling plant height of certain greenhouse crops.

Background

We have been conducting modeling research on chrysanthemums for about four years. When we first started the modeling research, one objective was to identify how day and night temperatures between 50° and 85° F influenced plant development. In these experiments, plants were grown with day temperatures both warmer and cooler than the night temperatures. One of the most significant observations we saw was the large difference in height of plants at flowering when plants were grown under different temperature regimes (Figure 1). Irrespective of night temperatures, plants grown with cooler day temperatures than night temperatures were shorter than plants grown with warmer day temperatures than night temperatures.

Results of many temperature treatment combinations are shown in Figure 2. This figure shows the effects of day and night temperatures on final plant height of chrysanthemums. As day temperatures increased from 50° to 85° F, plant height increased linearly. As night temperatures increased from 50° to 85° F, plant height first decreased, then increased. The increase in height with night temperatures above 70° F was due to an increase in leaf number. These plants experienced a delay in flower initiation.

With these observations on chrysanthemums in mind, we conducted studies on the effects of day and night temperature on Easter lilies.

The lilies responded similarly. During the 1986 lily forcing season, we forced lilies under combinations of day and night temperatures of 57°, 65°, 72°, 79°, and 86° F (25 temperature combinations). Plants were placed at these temperatures on January 20, after flower initiation. Data were collected during development and at flowering. Key observations are described below.

Time to flower

Time to flower was a function of average temperature. It did not make any difference when during the day a plant was exposed to warmer temperatures. Warm temperatures at night had the same effect on rate of development as warm temperatures during the day.

Plant height

Final plant height was influenced by both day and night temperatures. As day temperatures increased, plant height increased (Figure 3). As night temperatures increased, plant height decreased (Figure 4). The responses were additive, that is, the tallest plants occurred when the nights were cool and the days warm. The shortest plants occurred when the nights were warm and the days cool (Figure 5).

Neck length

The neck, or last internode on the stem just below the flower, often elongates excessively. We have observed necks 4" in length on commercial lilies. This long neck adds excessively to final plant height. In this experiment, the neck responded to temperature exactly as the stem. Long necks were present on plants grown with

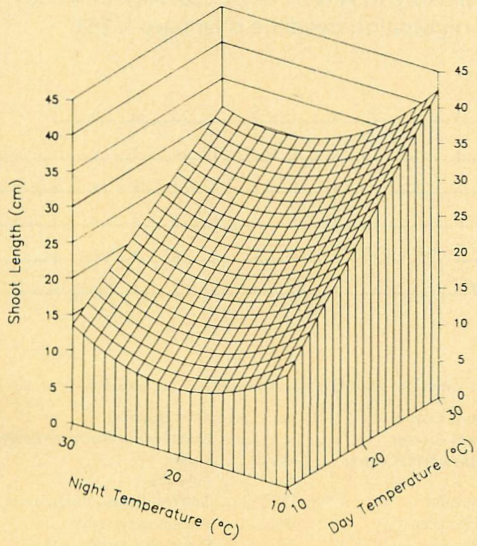

Figure 2. Surface plot of chrysanthemum shoot length versus day and night temperature. Day and night temperatures are shown from 10°C (50°F) to 30°C (86°F).

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innovative temperature control

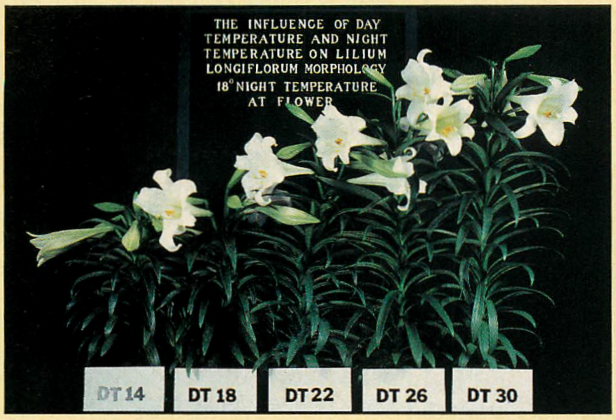

Figure 3. Influence of day temperature on appearance of 'Nellie White' Easter lily plants at flowering. All plants were grown with a night temperature of 18°C (65°F). Day temperatures were 14°C, 18°C, 22°C, 26°C, or 30°C (57°F, 65°F, 72°F, 79°F, or 86°F). Plants with warmer day temperatures flowered first and were put in a cooler until plants in cooler treatments flowered.

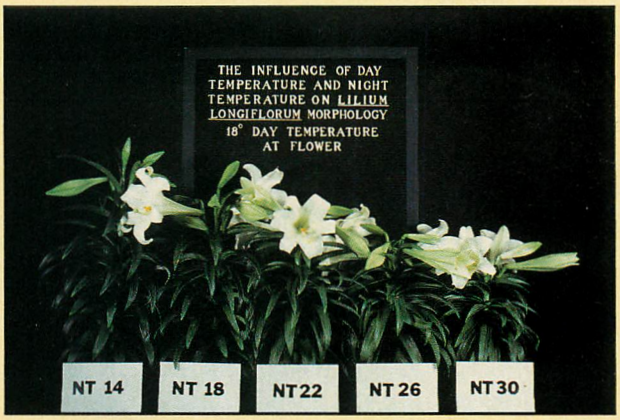

Figure 4. Influence of night temperature on appearance of 'Nellie White' Easter lily plants at flowering. All plants were grown with a day temperature of 18°C (65°F). Day temperatures were 14°C, 18°C, 22°C, 26°C, or 30°C (57°F, 65°F, 72°F, 79°F, or 86°F). Plants with warmer day temperatures flowered first and were put in a cooler until plants in cooler treatments flowered.

warm days and cool nights, while short necks were present on plants with cool days and warm nights.

Leaf size and orientation

Leaf length and width changed with day and night temperatures. Leaves were long and narrow when forced with warm days and cool nights but were shorter and wider when forced with cool days and warm nights. The cultivar Ace typically has longer and narrower leaves than the cultivar Nellie White. Nellie White plants grown with warm days and cool nights looked very similar to Ace plants in this experiment.

The orientation of the leaves also changed as day and night temperatures changed. Leaves were very upright on plants grown with warm days and cool nights. When the day and night temperatures were similar, leaf orientation became more horizontal. As day temperatures became cooler than the night temperatures, leaves tended to curl downward.

Flower number

No significant differences in initial flower number existed between plants in the different treatments as flower initiation had occurred prior to plants being moved into the temperature treatments. However, the number of flowers at flowering decreased as both day and night temperatures increased above 75° F due to flower bud abortion.

Conclusions

The relationship between the day and night temperatures had a major impact on the development of both chrysanthemums and Easter lilies. It is possible to use temperatures as a growth regulator. When day temperatures can be maintained

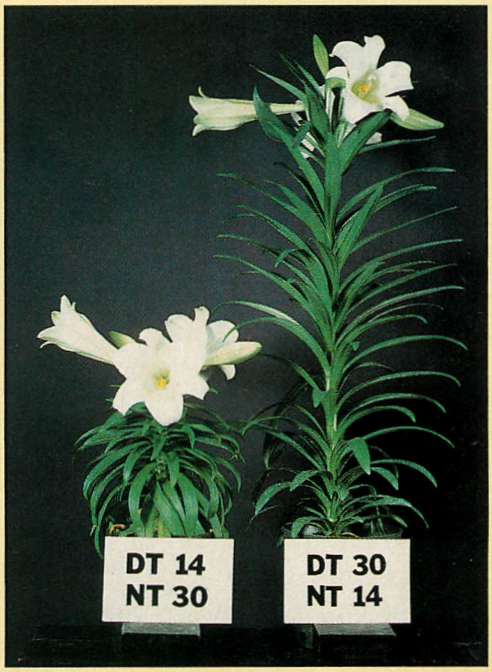

Figure 5. Influence of 14°C (57°F) and 30°C (86°F) temperatures given at different times of the day on 'Nellie White' Easter lily development. The photograph shows the appearance of the plants at flowering. Plant on the left was forced with a cool day (14°C) and warm night (30°C). Plant on the right was forced with a warm day (30°C) and cool night (14°C). Plants were exposed to the indicated temperatures from January 20 until flowering. Flower initiation had occurred by January 20.

lower than the night temperatures, plant height will be reduced. Likewise, when day temperatures are warmer than the night temperatures (which is common), plant height will be increased. Growers who attempt to trap some heat in the afternoon and save energy by reducing night temperatures will either have taller plants or will have to apply additional growth retardants to control height.

Several growers experimented successfully with cool days and warm nights in growing chrysanthemums and lilies last year. A couple of warnings are in order, however. Night temperatures should never exceed 70° F on lilies until flower initiation is complete (as observed by looking at the meristem). Temperatures above 70° F on lilies prior to flower initiation can result in devernalization. Devernalization will result in very high leaf numbers and delayed flowering (probably after Easter!).

In chrysanthemums, night temperatures above 70° F should be avoided as flower initiation can be delayed after the start of short days. Likewise, night temperatures above 70° F can delay flower development after visible bud.

Energy considerations

One concern about warm nights and cool days is the possibility of increased energy costs. This concern is valid for growers without thermal blankets. Increasing night temperatures will likely increase energy costs. However, growers with thermal blankets already know that it is cheaper to heat at night with the blanket closed than during the day with it open during cloudy weather. Our computer simulations of energy requirements have also shown the energy consumption with cool days and warm nights to be no greater than with warm days and cool nights when the weather is cloudy and a thermal blanket is used at night.

Properly utilized, we believe that day and night temperature manipulations can be used by the grower to help control plant height with little or no increase in energy costs. While we typically think of reducing plant height by lowering day temperatures, the opposite is also true. Excessively short plants can be induced to grow taller by using warm days and cool nights. This information should be especially useful to chrysanthemum growers who have over-applied growth retardants. ❞

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