SPLIT NIGHT-TIME GREENHOUSE TEMPERATURES CAN SAVE FUEL

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Traditional procedures for winter greenhouse culture of chrysanthemums requires night temperatures of at least 60^{o}F to ensure proper plant development and timeliness of flowering. Depending upon the weather and greenhouse condition, this is often a costly requirement. Understandably, conservation of energy in greenhouses has caught the attention of many horticulturalists because of the prolonged cold winter and shortages of ever-more-costly fuel. Most are concerned with mechanical solutions to the problem; few have considered integrating our knowledge of plant physiology and plant temperature requirements into the problem of optimizing fuel savings as well as crop yields.

What are the possibilities for reducing night temperatures? A review of the literature offers few if any clues since, traditionally, growers have generally raised night temperatures to optimize growth, especially when daytime carbon dioxide enrichment is utilized. But a few things are known in this regard. In the early 1940's Dr. Fritz Went found that many plant species require a uniformly high temperature only as seedlings. As they matured, they often developed a "thermoperiodicity" whereby a requirement develops for night temperatures that are lower than those of the day. Later work demonstrated that the thermoperiod could differ with varieties of a single species.

The optimum greenhouse thermoperiod may also change markedly with the climate. Early studies showed that following cloudy days lower night temperatures favored optimal growth. For example, while 77°F was the optimum night temperature for the growth of young greenhouse tomatoes following a day of full sunshine, 46°F was optimum following a cloudy day with only 8% sun.

In one of the few studies directly addressing the problem of fuel savings, Dr. Victor Bonaminio of North Carolina State University demonstrated that an equivalent crop of petunia could be produced with lower night temperatures. Counterbalancing his anticipated winter fuel savings, however, was a two to three week delay in flowering.

Is there a way to avoid this delay in flowering and still achieve winter fuel savings? Perhaps the best lead comes from a long time New Haven grower, Bill Loefstedt, who suggested employing split night temperatures, i.e., 60°F for the first few hours after sunset followed by 45°F for the remainder of the night. This idea has a physiological basis, in that most of the required processes for continued growth can be sufficiently completed in the first few hours of darkness at a warm temperature. Direct evidence comes largely from agronomic crops such as soybean, corn, and alfalfa, where many of these processes of metabolism, translocation, and utilization of products formulated during the day are completed in the first few hours after darkness.

Bill Loefstedt, with the cooperation of Bill Buzzard of the Connecticut Agricultural Experiment Station and Landon Winchester of the New Haven Park Department, tested his hypothesis in a New Haven

Figure 1. Bill Loefstedt with chrysanthemums held in split nighttime temperature of 60^{o} until 11 p.m. and 45^{o} from 11 p.m. to 6 a.m. The mums were blooming on schedule when this photo was taken on March 16.

Park Department greenhouse. Night temperature was maintained at 60^{o}F until 11:00 p.m., then it was allowed to drop to 45^{o}F and maintained there until 6:00 a.m. During the day the house was vented at 75^{o}F. No supplemental lighting or CO_2 enrichment were utilized, but plants were watered daily at 6:00 a.m. with warm (70-75^{o}F) water.

In early February, eight varieties of chrysanthemums (minimum of three plants each) and lilies (21 plants of Nellie White) were obtained from two commercial growers. Marigolds and petunias were also cultivated under the split-night temperature regime. In terms of market quality there was no reduction in size, appearance, or stage of development of the plants grown under the split-night temperature in our greenhouse compared with those grown with the traditional, constantly warm night in another greenhouse. The lilies, in fact, appeared to mature faster under the split-night temperature regime. In addition to maintaining plant quality we estimate Bill saved 6% of his normal fuel requirement for this February.

Clearly, additional testing will be needed to verify the first trial and to determine the specific duration and temperature regime for each crop species. The potential for greater fuel savings is apparent by lengthening the temperature setback, decreasing the temperature further, or a combination of both. Bill's results do indicate a practical means for greenhouse operators to save energy without upsetting plant growth schedules.