SPLIT-NIGHT TEMPERATURES: CHRYSANTHEMUM

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More than 10 crops have been studied under split-night temperature (SNT) regimes at the Univ. of Conn. Floriculture Greenhouses. Of these, the chrysanthemum is one of the most appropriate crops for adaption of this technology. In this report, only data from a 10^{0}F drop (60^{0} to 50^{0}F) for a six hour period (2300 to 0500 hours) will be considered.

The concept proposed by Loefstedt (1977) assumed that a nine hour summer night was long enough for the plant to accomplish whatever it did in the dark. Therefore, during the 15 hour winter nights it should be beneficial for plants to reduce the temperature for part of the night, slowing their respiration and conserving their energy.

Experiments were designed to determine the response of chrysanthemums* to SNT. Maturity was delayed; they did grow more slowly during the six hours in which the temperature was lowered 10^{0}. They also gained weight and height which might be explained as conservation of photosynthate or not expending their energy needlessly during a long night.

Since mums can be programmed rather precisely by manipulation of night length, beginning long night treatment sooner should conveniently compensate for the SNT delay. Several crops were grown with long nights commencing 7 days earlier. This was too much. A series of crops was then grown with a 0, 2, 4 and 6 day advance in the onset of long nights. From this data the following recommendations for long night advance (LNA) evolved based upon the date of harvest.

Month of Flower	Begin Long Nights
Nov. and May	1-2 days earlier
Dec. and April	2-3 days earlier
Jan. and March	3-4 days earlier
February	4-6 days earlier

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*Chrysanthemum rooted cuttings were supplied by Yoder Bros., Barberton, Ohio and Stafford Conservatories, Stafford Springs, CT.

Under the best of conditions, the date of harvest can vary a few days. The above recommendations should provide a harvest date which, on the average, will be the same as for those grown without a long night advance and grown at 60°F all night. This is, of course, with about 1000 ppm CO_2 and no venting until the temperature reaches 80 - 85°F on sunny days.

Several benefits are derived. With the above LNA it was found that 4 cultivars of mums increased 13% in weight in January and 3% in March when cut to 30" stems with one third of the leaves removed (total plant weight increased by 19% and 12%). They were taller by 7% in January and 10% in March. A portion of the extra length may be attributed to elongation of the peduncles (the stalks supporting the blossoms). This is of great value in pompons that tend to become "clubby" during midwinter, providing a more open and attractive flower cluster without chemical treatment (McDaniel, 1984). Pompon growth at lower night temperatures may result in a reduction in the number of flowers produced (Cathey, 1954) but the peduncles are longer and the flowers

TABLE 1

The effect of split night temperature and long night advance (LNA) on the mean fresh weight at 76 cm with one third leaves removed of four cultivars of chrysanthemums harvested in January 1982.

		Cultivars			
Temperature	LNA	Charisma	Polaris	Florida Marble	Indianapolis White #4
(degrees F)	(days)	(grams)			
60	0	30.9a[z]	37.9d	31.3ab	40.5b
60/50	0	30.0a	46.4bc	33.4a	46.0ab
60/50	2	28.2a	54.7a	33.4a	49.0a
60/50	4	28.0a	52.3ab	32.2ab	41.7b
60/50	6	30.5a	49.0abc	30.4ab	45.6ab
60	6	30.0a	43.0cd	27.4b	41.2b

z Mean separation within columns by Duncan's Multiple Range Test, 5% level.

are larger; those produced in January were 12% larger while those in March were 8% larger (Watson, 1982). Tables 1, 2, 3 and 4 are representative of the dozens of tables from the research by Schneider (1980) and Watson (1982). The above results were calculated from these tables.

The obvious advantage is a reduction in heating cost. Gent et al. (1979) calculates this to be about 20% for an eight hour reduction of 10°F during the night. A saving of about 15% for a six hour period has been calculated in a number of ways. If 1/3 of the heat requirement is assigned to the 2300-0500 hours of the night (extrapolated from Gent et al. 1979), the heating requirements given in the Conn. Greenhouse Newsletter #106 give a figure of 17% heat saving. If maintaining a 60° F night temperature in a well insulated greenhouse costs $1.50/sq. ft./year, the saving would be 25¢/sq. ft./year, or $750.00 in a 30 x 100' greenhouse. Since production is not decreased and quality is improved, SNT becomes an attractive cultural procedure.

TABLE 2

The effect of split night temperature and long night advance (LNA) on the mean fresh weight at 76 cm with one third leaves removed of four cultivars of chrysanthemums harvested in March 1982.

		Cultivars			
Temperature	LNA	Charisma	Polaris	Florida Marble	Dignity
(degrees F)	(days)	(grams)			
60	0	29.5bc[z]	57.3b	49.4ab	49.1a
60/50	0	36.2a	71.7a	40.2bc	51.1a
60/50	2	33.3ab	67.8ab	39.7bc	50.0a
60/50	4	29.6c	67.0ab	42.7bc	50.9a
60/50	6	25.9c	71.6a	37.3c	47.9ab
60	6	32.4ab	74.4a	53.8a	43.8b

[z] Mean separation within columns by Duncan's Multiple Range Test, 5% level.

Additional Notes

1. A six hour reduction in night temperature of 10^0 F is not proposed as the optimum. It would seem that a modulated temperature wherein the greenhouse is gradually cooled from day to night temperatures beginning at sundown, then, after a period of time, gradually cooled to SNT with the reverse in the morning might be more conducive to optimum growth. This would also reduce the great demand for heat in early morning, which might tax central heating systems. This type of temperature management is feasible only in greenhouses with computer controlled environment.

2. Pot mums responded in similar fashion (Schneider, 1980) with a 0 to 5 day delay for a February crop under SNT. Plant height and flower size showed a small but insignificant increase.

3. A drop in SNT to 40^0 was excessive. Severe flowering delays (from 13 to 30 days) were experienced with pot mums (19 to 35 days with pompons); some 'Royal Trophy' did not set

TABLE 3
The effect of split night temperature and long night advance (LNA) on the mean height of four cultivars of chrysanthemums harvested in January 1982.

Temperature	LNA	Cultivars: Charisma	Polaris	Florida Marble	Indianapolis White #4
(degrees F)	(days)	(cm)			
60	0	87.2c[z]	100.2c	92.3a	86.0b
60/50	0	90.8b	106.8b	92.8a	85.3b
60/50	2	91.9b	114.2a	93.2a	92.5a
60/50	4	95.9a	113.5a	88.5b	90.7a
60/50	6	87.1c	97.9c	86.9b	82.0c
60	6	83.2d	92.7d	80.0c	78.5d

[z] Mean separation within columns by Duncan's Multiple Range Test, 5% level.

bud. It should be noted that it was necessary to leave a ventilator cracked and activate an exhaust fan in order to obtain this low temperature.

4. There are other temperature patterns that are in use for mum production. In England some growers drop the temperature one night each week, hopefully choosing the coldest night in order to maximize fuel savings (Butters, 1977). A delay of 2-3 days may be experienced.

Another concept is temperature averaging. Cockshull (1980) reports that higher day temperatures may be balanced with lower night temperatures without sacrificing growing time or quality. Wilkins (1984) finds that except for the 3 weeks after long night treatments commence you can do almost anything with the temperature as long as the daily average is the same. His results should be published soon. Since we recommend 80-85^{o} F days (heat to 65^{o}) with 1000 ppm CO_2, it does seem that the maximum should not be increased but heating beyond 65^{o} during daylight hours may be cost effective if it is less expensive to raise temperatures during the day than at night.

TABLE 4
The effect of split night temperature and long night advance (LNA) on the mean height of four cultivars of chrysanthemums harvested in March 1982.

Temperature	LNA	Cultivars: Charisma	Polaris	Florida Marble	Dignity
(degrees F)	(days)	- - - - - - - - -	(cm)	- - - - - - - - -	- - -
60	0	88.2d[z]	99.2c	94.0c	98.1c
60/50	0	101.6a	113.8b	101.2a	103.8b
60/50	2	100.9a	116.2a	103.1a	106.1a
60/50	4	97.0b	117.9a	98.3b	97.3cd
60/50	6	94.1c	114.3b	98.4b	95.4c
60	6	82.7e	93.6d	90.7d	82.2e

[z] Mean separation within columns by Duncan's Multiple Range Test, 5% level.

A third concept might be called temperature inversion. In northern Europe many days are dark and dreary. Photosynthesis is not as temperature sensitive as other growth processes so lower day temperatures do not proportionately lower photosynthate production. Greenhouses equipped with efficient heat blankets are more easily heated at night than during the day when the heat blankets are open. Therefore, some growers keep their crops warmer at night than during the day except when the sun warms the houses.

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