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Temperature and Duration of Pretreatment Effects on Growth and Development of Geraniums

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Abstract. **Geranium seedlings *(Pelargonium ×hortorum* Bailey 'Smash Hit Red') were given various cold pretreatments (CP) to obtain more rapid adaptation to constant or split-night temperature regimes. The six following CP were used: either 13C or 17/13C for 5, 10, or 15 days. The effect of these CP given at seedling stage was compared with that of control plants held at 17C at night. The CP did not significantly increase the time to first visible flower buds or to anthesis. The number of flowering stems, plant height, shoot dry weight, and leaf area of control plants were not significantly different from plants receiving CP.**

During late fall and throughout the winter months, ≈70% of greenhouse heating costs in northern latitudes occur during the night (Lussier, 1981). Reducing the difference between inside greenhouse temperature and outside temperature is an excellent means of reducing energy consumption and production costs for geraniums and other pot plants.

Recent studies have shown that low night temperature (LNT) used throughout all production stages results in delays in time from sowing to anthesis (Armitage et al., 1981; Quatchak et al., 1986; Tsujita, 1982; White and Warrington, 1988). The split-night temperature (SNT) method, whereby the temperature is lowered during only part of the night, has enabled scientists to resolve this problem with bedding plants (Shedlosky and White, 1987) and flowering pot plants (White and Warrington, 1984). Low-night-temperature treatments applied at the seedling stage [as a cold pretreatment (CP)] might also provide considerable energy saving without prolonging production time. Seedling geraniums are less affected by temperature from this stage to the first visible flower buds than more advanced plants (Armitage, 1985; Hellgren, 1984).

The purpose of this study was to determine the influence of various CP and then duration on the growth and flowering of geranium to adapt these plants to lower production temperature regimes.

Seeds of geranium 'Smash Hit Red' were sown 3 Jan. 1986 in a substrate consisting of 1 peat moss : 1 vermiculite (v/v). Seedlings were transplanted 17 Feb. 1987 into 0.5-liter pots (IO-cm standard pots) containing a Cornell Peat Lite A mix (Boodley and Sheldrake, 1973) and Osmocote (14N-6.7P-11.6K) incorporated at a rate of 3 kg·m^{-3}. During this study, plants were given four supplemental liquid fertilizations (250 ml/pot) using 20N-8.8P-16.6K to provide 200 ppm N. One month before the end of the study, the plants were transplanted into 1.75-liter pots (15-cm standard pots).

Treatments were provided in three identical and connected greenhouse compartments from 19 Feb.-6 Mar. 1987. During CP, day temperature in each greenhouse compartment was 20 ± 2.0C. Control plants were placed in the first compartment, where a high of 17 ± 1.5C was maintained between 1700 and 0800 HR. In the second compartment, plants received a CP consisting of 17 ± 1.5C nights, from 1700 to 0030 HR and then 13 ± 1.5C from 0030 to 0800 HR [split night temperature (SNT)]. One group of plants was given this treatment for 15 days, a second group for 10 days, and a third group for only 5 days. In the third compartment, plants received a CP of 13 ± 1.5C between 1700 and 0800 HR for 5, 10, or 15 days. All plants having received one of the CP during 5 or 10 days were then placed in the first compartment (17C from 1700 to 0800 HR) with control plants before the start of CP. Following the treatments, all plants were distributed in five blocks with two plants of all CP and a control in each, and placed in a double-layer polyethylene-covered greenhouse. Thermocouples placed at canopy height were connected to a Honeywell recorder (Electronick 112 Type T, Honeywell, Minneapolis). The daytime air temperature in the greenhouse was 20 ± 2.0C and at night it was 17 ± 1.5C from 1700 to 0030 HR and then 13 ± 1.5C from 0030 to 0800 HR during the last part of the experiment.

The number of days to first visible flower buds (S-mm diameter) and anthesis were recorded for all plants. The growth and development variables (plant height, shoot dry weight, and leaf area) were recorded for all plants when 50% of the plants in each treatment reached anthesis. The shoots of each plant were cut at the soil level and the root system cleaned in a water bath and dried with an air hose. The shoot and root systems, after being dried for 48 h in a hot-air oven (70C), were each weighed. Leaf area was measured using a leaf area meter (LI-COR 3000; LI-COR, Lincoln, Neb).

A complete-block design with five replications was used. All seven treatments (control and six CP) were placed in each block. Each experimental unit had two plants. Multiple comparisons were done according to Duncan's new multiple range test.

The time to the first visible flower bud stage (57 to 60 days) or to anthesis (85 or 86 days) was similar for all plants, regardless of whether they received a CP treatment. These results are in agreement with the theory proposed by Armitage et al. (1981) for seed-propagated geraniums. According to these authors, the length of time between sowing and first visible flower bud stage is least affected by temperature. However, temperature will greatly affect the length of time from first visible flower buds to anthesis. During this latter stage, all the plants received the same night temperature (NT) regime, 17/13C in our experiment. Tsujita (1982) showed that flowering of geraniums was delayed when they received a lower NT regime throughout all production stages.

Cold pretreatment did not cause a significant variation in the number of flowering stems (2.9 to 3.7) when compared with control plants, although the control had the fewest (Table 1). Our results are in agreement with those of Hellgren (1984). Tsujita (1982) has shown that CP can cause an increase in the number of axillary stems and thus increase the number of flowering stems. Nevertheless, the CP we used were not applied long enough to produce significant differences. Sénécal and Dansereau (1987) also obtained a nonsignificant increase in number of flowers per plant by using a LNT regime to produce *Gerbera jamesonii* H. Bolus ex Hook. in the spring.

Plant height was not significantly affected by the different CP when compared with the control plants (Table 1). This same tendency was observed by White and Warrington

Table 1. Effects of different cold pretreatments (CP) (temperature and duration) on the growth of *Pelargonium ×hortorum* 'Smash Hit Red'.

Treatments		Plant	Shoot
Night temp (°C)	Duration (days)	ht (cm)	dry wt (g)
13 (CP)	5	22.2 b[z]	20.11 ab
13 (CP)	10	22.7 b	19.61 b
13 (CP)	15	22.7 b	20.21 ab
17/13 (CP)	5	22.0 b	19.71 b
17/13 (CP)	10	25.0 a	21.66 a
17/13 (CP)	15	23.7 ab	21.05 ab
17 (control)	15	23.3 ab	20.84 ab

[z]Means separation in column by Duncan's new multiple range test, $P = 0.05$.

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(1984). However, if we compare the means of CP receiving NT of 17/13C during 10 days with those of three CP receiving NT of 13C, the latter were more compact. Tsujita (1982) has shown this same response, also using geraniums.

The CP did not adversely affect shoot dry weight (Table 1); however, Hellgren (1984) obtained contrasting results. These differences might simply be due to the different experimental conditions. This previous work was carried out in a growth chamber where the photosynthetic photon flux of 64 and 140 $\mu mol \cdot m^{-2} \cdot s^{-1}$ was considerably less than natural light intensities in the greenhouse.

Cold pretreatment did not affect the leaf area (range ≈1900–2200 cm^2). White and Warrington (1984) obtained a decrease in leaf area while using LNT. However, these authors used NT regimes instead of CP throughout the entire experiment. If there is a reduction in new structure formation during a CP, as reported by Longuenesse (1978) during LNT regimes, then those plants similarly treated would become more efficient under a SNT regime (Gent et al., 1979).

The results of this study indicate that it is possible to acclimate geraniums propagated by seed to SNT regimes by using pretreatments. Cold pretreatments did not cause a delay in the number of days to first visible flower buds and anthesis. Moreover, marketable quality of plants can also be improved using this method. A LNT regime applied at an early growth stage led to a slight increase in the number of flowering stems as well as more compact plants. The reduction in the plant height, as a result of this method, would mean less need for growth regulators. From a commercial view point, this method would lower energy costs by using CP for 15 days or even longer. For example, the use of 13C instead of 17C as a pretreatment results in a 22% reduction of heating costs during a period when the outside average temperature is -6.5 (Sénécal, 1984).

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