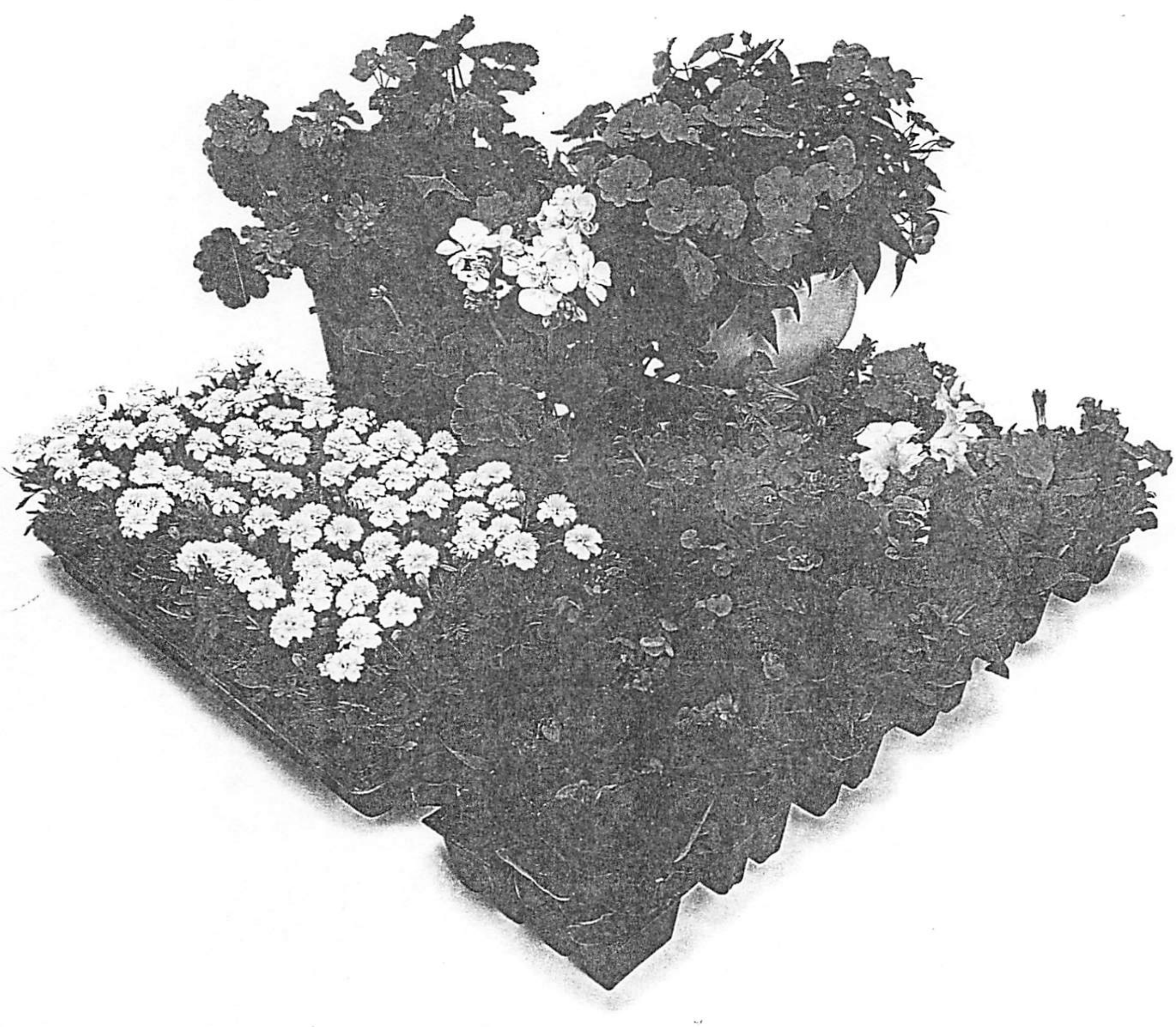
Tips On Growing Bedding Plants

Third Edition



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Section 13

Growth Control Without Chemicals

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Control of excess stem elongation is essential for successful bedding-plant production, especially to the grower who must ship product to market. Many bedding plants are shipped on racks with shelves that are eight inches apart. With a 2.5-inch-deep flat, maximum plant height is 5.5 inches. Keeping many plants shorter than that is a challenge.

Stem elongation can be controlled by several different methods, including applying chemical growth regulators, selecting cultivars, limiting medium volume, spacing plants, applying mechanical stress, limiting nutrient availability, manipulating seedling maturity at transplant, stressing with water, and manipulating day and night temperature. Discussion throughout this section will be limited to nonchemical methods of height control.

Factors Associated With Tall Plants

Growing a tall plant requires selecting a genetically tall species and cultivar. Once a seed germinates, maximum plant height is achieved with an optimal environment, which means water and nutrients are freely available and the root system is not restricted by a small container. Height is further promoted when plants are spaced closely and day temperature is warmer than night temperature.

Selecting Cultivars

When producing bedding plants, the grower normally does not have the option of selecting only short species and cultivars. The market dictates that some tall ones be produced. Therefore, height control must be achieved through methods other than genetic selection.

Limiting Growing Medium Volume

The fact that a small container limits root development and dwarfs plants is well documented. You need only look at old bonsai plants to observe the effects of container size on plant height. A more relevant example is the restriction of growth achieved in plug seedling production even when adequate water and nutrients are provided. It is obvious a 300-foot redwood will not develop in a 512-size plug cell.

The bedding-plant grower normally has a limited selection of container sizes. While the containers (cells) most bedding plants grow in will limit final plant size, the volume of growing medium available to roots is usually large enough that plants can still grow too tall. Therefore, cell size is not a strategy for height control of bedding plants. However, it is important to realize the potential for plant growth and expansion is greater as the growing-medium mass increases; e.g., a four-inch pot versus a cell in a 72-cell tray.

Spacing Of Plants

Most bedding plants are classified as "sun" plants, which are sensitive to crowding. As a survival mechanism, plants growing in a crowded canopy elongate so upper leaves are exposed to direct sunlight. A plant that does not elongate in response to high plant density would be shaded by adjacent plants and be unable to harvest light efficiently for flowering and seed production.

Plants detect density by sensing changes in light quality or color, specifically the red to far red light wavelength ratio. Red light is absorbed by leaves more efficiently than far red light; most far red light is either reflected from or transmitted through a leaf. As plant density increases, the proportion of far red light increases relative to red light within the canopy. Most plants respond to this change in red to far red light by increased stem elongation.

One feature of bedding-plant production is high plant density. Therefore, the natural response of plants in bedding-plant flats is to elongate.

Light Quantity

Elongation of all plants is suppressed by light. In general, elongation of plants increases as light intensity decreases. Light intensity in all greenhouses is lower than that outside because of shading from the glazing material and the greenhouse structure. Most growers are quite aware of the increased plant height that occurs under gutters or near dark side walls.

The presence of overhead hanging baskets (Figure 13-1) decreases light intensity and alters light quality (more far red light). Both changes cause stems to elongate in comparison to those of plants in greenhouses without hanging baskets.

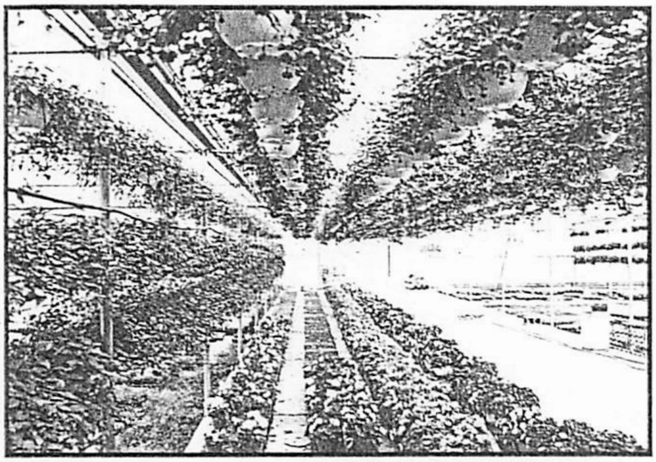


Figure 13-1. Example of a thick canopy of hanging baskets over other plants. Hanging baskets reduce light intensity and change light quality, both of which promote stem elongation in most plants.

Mechanical Conditioning

A plant growing outside a greenhouse is normally shorter than the same kind of plant growing inside. Similarly, plants growing on the edge of a field or stand of plants are shorter than those in the middle. Part of the reason for this height difference is the mechanical stress placed on plants by the wind.

Mechanical stress or conditioning induced by wind or physical contact such as brushing reduces stem elongation. The magnitude of response depends on both duration and frequency. For the conditioning to be useful, plants must be treated for a minimum of 1 to 2 minutes at least once or twice a day.

The biggest challenge in using mechanical conditioning of greenhouse crops is delivery of the stimulus to the plant. For years, the Japanese have used manual brushing of seedlings with a small broom; however, their transplant production units are generally small. Systems such as dusting brushes, suspended aluminum bars, steel bars suspended in a cloth sling, wooden poles, water sprays, and wind from fans have also been tested. All are difficult to implement when bedding plants are grown at different ages and heights in a single greenhouse. Also, materials such as polyvinyl chloride or painted pipes can cause mechanical damage to the leaves that adhere to them.

Mechanical conditioning can be an effective method of controlling plant height, but the lack of good delivery systems continues to limit its commercial usefulness.

Nutrition Manipulation

Plant growth requires energy from photosynthesis and mineral nutrients. While each of the 16 essential nutrients is truly vital, the nutrient that has the greatest impact on plant size is nitrogen, which is required in greater quantities than any other mineral nutrient. Although similar percentages of nitrogen and potassium are often in plants, they actually require about three times more nitrogen than potassium because of differences in the weight of their ions.

Nitrogen, then, is one of the major tools available for height control of bedding plants (Figure 13-2). Growth will be restricted regardless of cultivar, cell size, light, and water availability if nitrogen is limiting. While this statement is also true for other essential nutrients, nitrogen management is normally easiest.

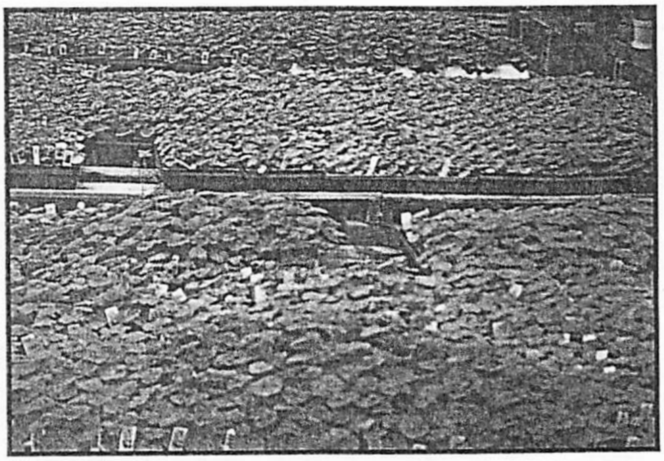


Figure 13-2. Example of differences in geranium seedling growth because of nitrogen fertilization. Taller plants received a fertilizer application, while shorter ones did not.

Media formulations often include a base fertilizer charge; for example, one pound each of calcium nitrate and potassium nitrate per cubic yard. There is sufficient nitrogen in this charge to supply 40 to 60 percent of all the nitrogen necessary to produce bedding plants from plug seedlings during a five-week period. If the growing medium contains a base fertilizer charge, and growth control is desired, plants should not be fertilized again until they begin to exhibit slowed growth associated with nitrogen deficiency. The plants should not require more than two 200 ppm (each) nitrogen and potassium applications between this time and harvest. Higher concentrations of nitrogen or more frequent applications will provide more than sufficient nutrients (nitrogen) for most plants to outgrow the space allotted in flat culture.

If no charge of nitrogen and potassium is added to the growing mix, fertilization with 200 ppm each of nitrogen and potassium will be necessary within the first few days after transplanting. However, no more than five applications of 200 ppm (each) nitrogen and potassium should be needed to finish the crop. Fertilizer should be applied no more than once per week under ordinary production conditions, and only if growth is not satisfactory.

If these strategies of growing slightly nutrient-deficient plants are used during most of the production phase to control plant size and height, the plants may look somewhat chlorotic near market date. An application of 200 to 300 ppm nitrogen and potassium a few days prior to marketing will quickly green up the plants. Shipping delays because of poor weather rapidly result in overgrown plants.

The optimal base charge in a bedding-plant growing medium depends, in part, on the maturity of the plug seedling transplanted into it. A "good" base charge (one pound each of potassium and calcium nitrate) is very desirable if the plug seedling is "mature" and flower buds have been initiated (visible flower buds on impatiens). In this situation, the goal is to obtain sufficient plant growth so the flat is saleable when the plant flowers. However, when the plug seedling is immature and is transplanted into a growing mix with a "good" base charge, vegetative growth may be difficult to control prior to flowering. In this case, a growing medium with little or no base charge is preferable, so there is little vegetative growth while flower initiation and development occur.

Manipulating Plug Maturity At Transplant

There are two advantages to having mature plug seedlings with initiated flower buds. First, production of short plants in a bedding-plant flat is much easier because the plant can be rapidly grown to fill in around the flower buds. If the plug seedling is not mature when transplanted, growth regulators and/or the methods discussed in this section often must be used to restrict size until the plant flowers. A second advantage is less time is required to flower from transplant. A shorter time to flower is very valuable during peak shipment weeks in the spring. Sometimes the difference of only a few days in flowering means the difference between shipping or not shipping a flat to market.

Water Stress

Growth of any plant is associated with increased cell number and size. Enlargement of an immature cell is similar to inflation of a balloon. Immature cells have elastic walls. High water pressure (turgor pressure) in the cell promotes stretching and increased size. The latter results in larger leaves when leaf cells expand, and taller plants when stem cells elongate. The amount of turgor pressure in the cell is determined by many factors, but the most important is the availability of water to the plant.

Water, therefore, is one of the most powerful nonchemical tools a grower has to manage height of bedding plants. Water stress limits cell expansion and plant growth. Plants can be water-stressed by limiting the quantity or availability of water.

Two techniques can be used when growing "dry" (restricted irrigations). The first is irrigating the growing mix thoroughly and then allowing it to dry to the point of plants wilting before irrigating thoroughly again. Growth is restricted during the period when the growing medium is very dry, but once the medium is irrigated and stress relieved, plants rapidly resume elongation with a minimal effect on plant size. The second method of growing "dry" is to limit the quantity of water available to the plant continuously by means of frequent, light irrigations. The growing medium is irrigated lightly only after plants exhibit some signs of water stress, such as wilting. Only the plant shoot and the top half-inch or so of the growing medium is wetted during irrigation. This technique is very effective under climatic conditions that foster slow drying. The system requires intensive grower management to avoid excess soluble salts, but is very effective in regulating growth. It is not possible to use this technique with a subirrigation system because the growing medium cannot be partially wetted.

The duration plants can wilt without sustaining permanent damage, such as leaf burn or death, depends on climatic conditions. Plants may be stressed for one or more days prior to irrigation under cloudy, humid conditions. In contrast, plants exposed to high light intensity and windy, dry air may require irrigation within minutes once they exhibit water stress to avoid severe stress injury.

Uniform plant growth requires uniform irrigation when using water stress for height control. Anything that results in nonuniform water delivery will result in nonuniform plant development.

Hanging baskets over flats can also cause problems when water stress is used for height management. Irrigating hanging baskets without having any dripping is very difficult. Some water is invariably going to splash on flats below when baskets are manually irrigated, and some dripping is likely when the growing mix is irrigated with an automated dripper system. Plants that receive this extra water (and often nutrients) grow significantly larger than surrounding ones (Figure 13-3).

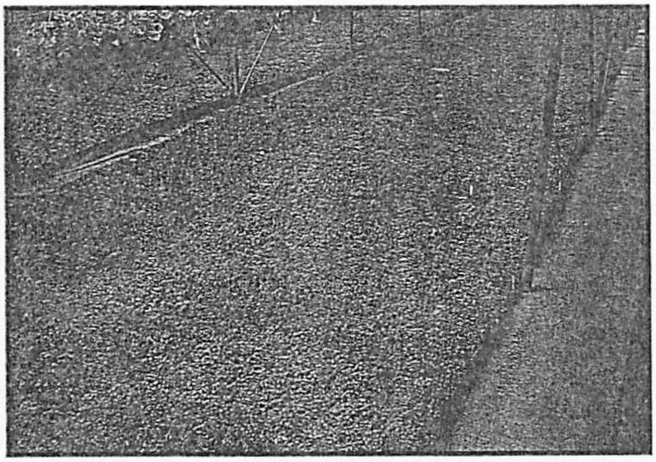


Figure 13-3. Example of difference in bedding plants' growth because of hose watering and dripping of water from overhead baskets.

Temperature Manipulation

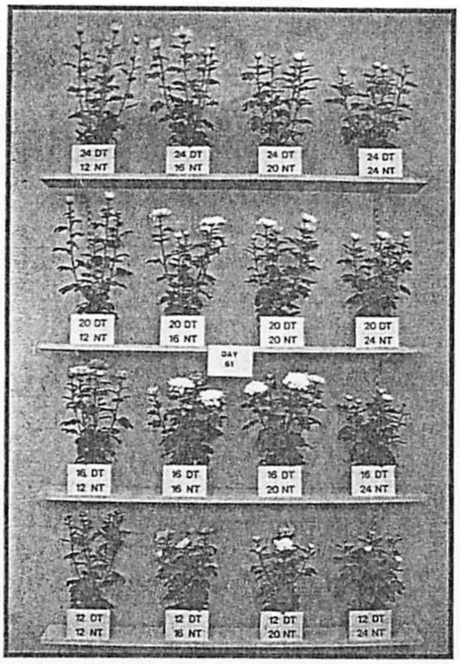
Plant height can be managed by temperature in two different ways: 1) average daily temperature and 2) DIF. This is because plant height is a function of internode number and length. The rate at which a plant matures or forms internodes is largely controlled by the average daily temperature. Internode length, in contrast, is largely controlled by the difference between day and night temperature (DIF).

Assuming there is no photoperiod requirement, the time required for a bedding plant to flower is primarily a function of average temperature. The goal is to have plants in flower just when they are needed for market. If they are in flower earlier than the market date, they continue to grow. So in an indirect manner, average temperature is a mechanism to control plant height.

Plant height is the combined length of each internode formed as a plant grows. Internode length is affected by the way temperature is delivered during a 24-hour period. Internode length and plant height increase as DIF increases (Figures 13-4a and 13-4b). Plants growing with lower day than night temperatures will be shorter than those growing with warmer day than night temperature. Plants respond to DIF whether they are widely or closely spaced (Figures 13-5a and 13-5b).

Plant height response to DIF will depend on the magnitude of the DIF, i.e., how warm or cool the day is compared to the night and how the temperature is changed from night to day. Negative DIF is most effective in controlling stem elongation when the day temperature is lowered in synchrony with the transition from dark to light. Most growers find it most efficient to start lowering the day temperature 30 to 60 minutes prior to sunrise.

The longer cool day temperatures can be maintained during light, the greater the effect of DIF on stem elongation. However, the most important hours for height control during the day are the first 2 to 3 following sunrise. For many species, lowering the temperature during the first 2 to 3 daylight hours will reduce height 50 to 70 percent as much as lowering the temperature throughout the entire day.



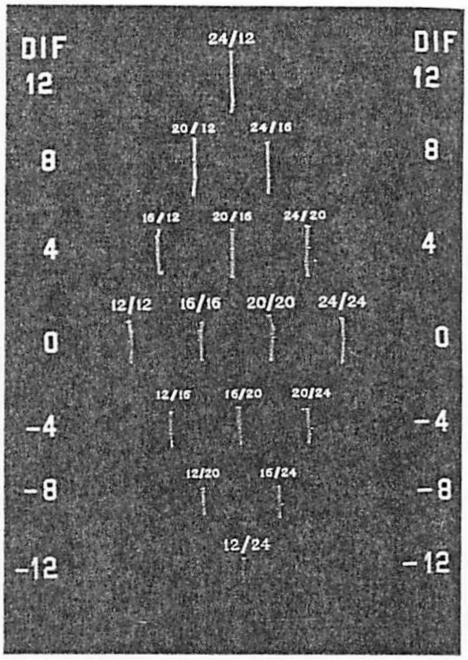
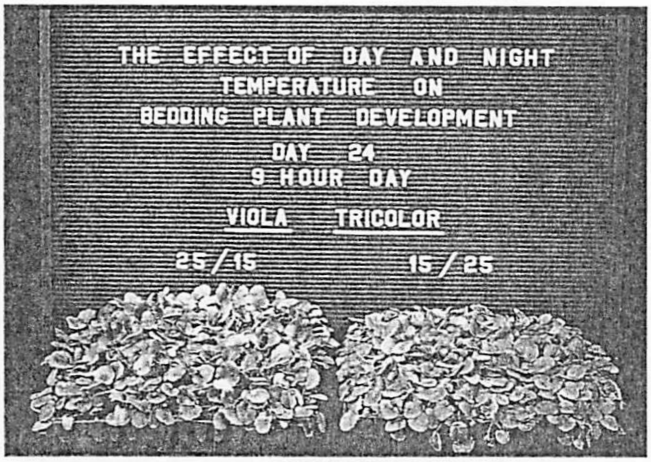


Figure 13-4a. (Right) Chrysanthemum plants grown under 16 combinations of day and night temperature from 12 to 20°C. (12°C=54°F, 15°C=61°F, 20°C=68°F, and 24°C=75°F). Horizontal rows represent common day temperatures, vertical columns represent common night temperatures. Tallest plant in upper left (+12 DIF); shortest plant, lower right (-12 DIF).

Figure 13-4b. (Far right) Internode segments from plants shown in Figure 13-4a arranged by DIF value. Internode length and plant height increase as DIF increases.



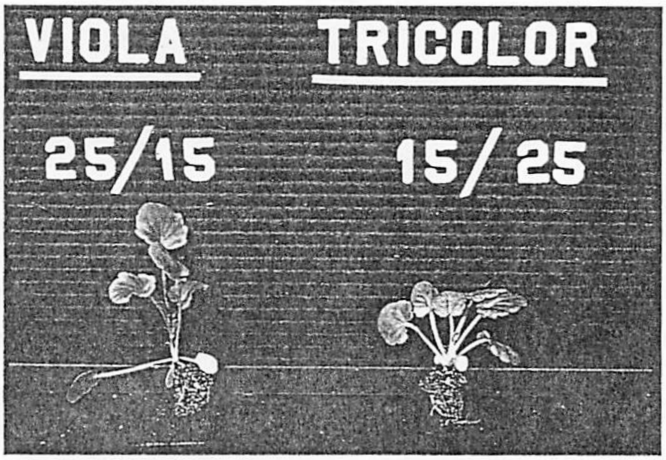


Figure 13-5a, 13-5b. Pansy seedlings from a plug sheet. DIF reduces elongation of bedding plants even under the high plant densities of a plug sheet.

Because temperature often cannot be controlled during late morning and afternoon, abruptly dropping the temperature at sunrise is an effective way to use DIF for height control. A sample DIF regime may be to maintain a constant day temperature of 60°F with a night temperature of 65°F when day temperatures can be controlled. When day temperature cannot be controlled later in the day and rises above the night temperature, a strategy may be to drop the temperature at sunrise to 45 or 50°F.

A secondary response to negative DIF is reduced leaf chlorophyll. As DIF becomes more negative, leaf chlorophyll content decreases and plants appear progressively more chlorotic or yellow. Certain species such as salvia, especially in the plug seedling stage, exhibit severe chlorosis when they are exposed to large negative DIF (Figure 13-6). One of the advantages of temperature dip at sunrise followed by warmer temperatures later in the day is less yellowing compared to that found with low temperatures all day long.

While there are many, many possible temperature strategies, an excellent compromise is to maintain zero DIF (day and night temperature the same) with a 10 to 15°F temperature dip at sunrise for 2 to 3 hours.

An example of using negative DIF is when plants are moved outside of the heated greenhouse in the morning. Plants grown by this practice are usually very short and stocky – a result of high light intensity, mechanical conditioning from the wind, and, of course, negative DIF temperatures.

Be careful that crop maturity is not adversely affected by cooler average daily temperatures when using negative DIF for height control for the first time. Growers traditionally have used warm day temperatures to help maintain an average daily temperature. Average daily temperature is lower and crop development (flowering) slowed if the night temperature is kept the same and the day temperature is lowered. Conversely, raising the night temperature while maintaining a constant day temperature will increase average temperature and hasten flowering (Figure 13-7). Final height at flower will be shorter whether the day temperature is lowered or the night temperature is raised.

The magnitude of plant responses to DIF is influenced by photoperiod. Short days change the response. In other words, DIF will be more effective in February and March than in April and May, even if day temperature is identical, which is unlikely. Plants under supplemental HID lights at night will respond less to DIF, although they may still be short because of the higher light intensity. Conversely, plant response to negative DIF is less under very low light intensity. Control of stem elongation with negative DIF is reduced during periods (5 to 7 days) of continuous overcast weather.

Light from incandescent lamps is rich in far red light and will negate the effects of negative DIF.

Plant response to a change in DIF is rapid and evident on some species within 24 hours. Therefore, DIF is an excellent tool to speed or slow stem elongation as desired. While rapid response to negative DIF is desirable, loss of daytime temperature control, resulting in positive DIF, also means instant loss of stem elongation control. Compact bedding plants being held in check by negative DIF can increase in height significantly if a few days of high day temperatures occur and negative DIF can no longer be maintained.

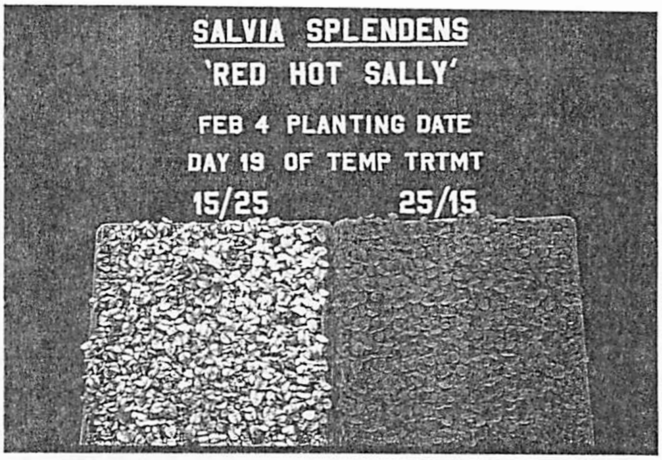


Figure 13-6. Chlorosis of salvia seedlings grown under a -10°C DIF (-18°F) compared with seedlings grown under a +10°C DIF (+18°F).

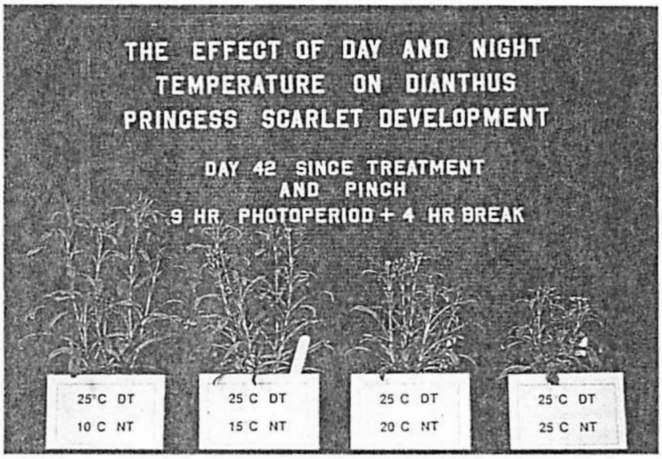


Figure 13-7. Height and development of 'Princess Scarlet' dianthus grown under a day temperature of 25°C (77°F) and night temperatures of 10, 15, 20, and 25°C (50, 59, 68, and 77°F). Notice plants' height decreases and stage of development (flowering) increases as night temperature increases. The more mature plants (right) are shorter than the less mature ones (left).

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