# Height Control of Greenhouse Crops

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Many of the floricultural crops grown in greenhouses tend to grow taller than desired and require height control to prevent excessive internodal elongation. This bulletin is designed to introduce growers to the alternatives available for height control and suggest appropriate methods for different situations.

There are three categories of control available to producers--biological, physical, and chemical control-- and each should be evaluated equally by producers experiencing undesirably tall crops. When deciding on the best control method, account for cost of the method (including equipment, labor, and other encountered expenses such as fuel), how the method will affect crop timing, and how the method will affect the quality of the crop at sale.

**Biological Control** is the ultimate method. Through genetics and plant breeding, a plant cultivar is developed that grows to the perfect height. Try to select dwarf or short cultivars to obviate excess height. For example, chrysanthemum cultivars are classified as short, medium, or tall. Select cultivars that best match your production system and market demands. Unfortunately, we don't have the perfect-height-cultivars for all of our greenhouse crops and must rely on other control mechanisms other than biological control of height.

**Physical Control** of plant height is based on how your growing environment and cultural practices affect plant growth habits. Physical methods of control may include:

- **pot depth**--Not all 6"-diameter pots are the same height; we have "azalea" pots, that have only 3/4 the height of "standards". Using azalea pots is one method of reducing the total height the plant-plus-pot will attain; it will not affect the soil-to-flower height.
- **water stress**--Allowing plants to wilt slightly between watering leads to shorter plants, but quality may be greatly reduced. In some instances such as with impatiens seedlings, it can be used quite effectively without long-term damage to the plants. Care should be taken not to subject plants to a wilt so severe that they cannot recover.
- **nutrient stress**--Withholding or reducing fertilizer tends to slow overall growth, stem elongation included. Reducing nitrogen fertilization to plants is effective in height control, but remember that you are also slowing the growth and development of your plants along with stem elongation.
- **wind, vibrations or touching**--Plants reduce their elongation when exposed to wind, vibrations, or routine touching. These "seismomorphogenic" (vibrational/wind) and "thigmomorphogenic" (touching) responses can be used for height, but are not economical in most cases. An exception would be with tomato and other vegetable transplants where we have no chemical height controls available. For example, brushing tomato transplants for about 40 strokes back and forth with a cardboard tube suspended from an irrigation boom twice daily for 18 days can result in as much as a 30% reduction in stem elongation. This technique also works for Easter lilies, but again, the economics and labor requirements may be prohibitive and should be evaluated prior to implementation.
- **light intensity**--Higher light intensity or irradiance tends to reduce plant elongation, and your plants will be shorter at maturity. The key wording is "shorter at maturity". Higher irradiance increases plant growth rate, and plants will grow faster; perhaps taller at first than plants in lower irradiance. However, at maturity or flowering, the plants produced in higher light will be shorter; given very poor light, plants tend to stretch, become leggy, and develop more slowly.

- **photoperiod**--In general, short days of winter will result in both less growth and less stretching than long days of summer. The reduced growth is due to less light being received per day by the plants while the reduced elongation is a direct photoperiod response related to the daylength, not associated with lower irradiance levels. However, photoperiod is not a factor we usually regulate strictly for height control since other effects such as flowering can also be affected by photoperiod.
- **temperature**--Temperature is a big word, and there are many aspects of temperature that can affect plant growth and height. The average (average of day plus night) temperature affects plant growth; higher averages usually result in more rapid growth and development. The difference between the day and night temperature (**DIF**) affects stem elongation and plant height. The DIF is calculated as: day temperature (°F) – night temperature (°F) and can be positive (day higher than night), zero (day = night), or negative (day less than night). Negative DIF's reduce stem elongation and can be used to control plant height. A common program would be to use a 66°F night temperature and a 60°F day temperature setting. Lowering the temperature for a 2 hour period starting at dawn is almost as effective as keeping a lower temperature throughout the entire day. This is fortunate for North Carolina growers, since temperatures during most of the year prohibit maintaining a 60°F day temperature for the entire day. DIF is effective on many crops including many bedding plants, poinsettias, mums, and Easter lilies. Be aware that night temperatures above 68°F can cause delay in floral initiation of some crops; these night temperatures are best avoided. Also account for a delay in flowering if your average daily temperature (average of day + night temperature) is reduced below ~62°F; lower daily averages slow growth and development rates.

**Chemical Control** involves the use of chemical growth retardants. Most of the available growth retardants are anti-gibberellins, they inhibit gibberellin (GA) synthesis within the plant (Table 1). GA's are responsible for cellular elongation, so without it, cells do not elongate as much, and plants do not grow as tall. Ethephon and dikegulac sodium are not anti-gibberellins; ethephon releases ethylene, which reduces elongation in some bulb crops and dikegulac sodium slows the growth of terminal buds by removing apical dominance.

As the chemicals we use become more effective and the cost increases, it becomes increasingly important to apply growth retardants in the most efficient manner possible. When considering chemical growth retardants, ask yourself:

- **When should they first be applied?**

**i.** For most plants, apply after the plant has developed sufficient foliage (photosynthetic area, leaf area) to prevent stunting of the plant's development.

**ii.** Apply just prior to rapid shoot elongation; e.g. after pinching and newly developing shoots are visible, but have not elongated yet.

**iii.** Make your final application before the stage when floral size will be reduced. If growth retardants are applied too late, the size of the flowers can be reduced and floral development can be slowed. A good example would bract size reduction in poinsettia due to too late of an application of Cycocel or Bonzi.

**iv.** Remember, "when" in this instance is based on a physiological stage of plant development such as number of leaves, length of shoots, or plant diameter <u>not</u> chronological age such as 3 weeks after pinching. Recommendations given in terms of chronological age are merely guidelines that have been correlated to physiological stages and should only be used as rough estimates as to when to apply growth retardants.

- **Where should they be applied?**

**i.** The target tissue or plant part to receive the chemical depends on the chemical used and the plant species being grown.

Table 1. Growth regulators labeled for height control of greenhouse florists crops.

| Trade name | Common name | Greenhouse florist crops and application methods labeled for each chemical.* |
|---|---|---|
| A-Rest | Ancymidol | Azalea (S), bedding plants (S)**, bleeding heart (D), chrysanthemum (S,D), clerodendrum (D), dahlia (D), foliage plants (S)**, gardenia (S), gerbera daisy (S), Easter lily (S), lily (D), poinsettia (S,D), tulip (D) |
| Atrimmec | Dikegulac sodium | Fuchsia (S), kalanchoe (S) |
| B-Nine SP | Daminozide | Bedding plants (S)**, chrysanthemum (S,PD), foliage plants (S)**, gardenia (S), hydrangea (S), poinsettia (S) |
| Bonzi | Paclobutrazol | Bedding plants (S)**, chrysanthemum (S,D), freesia, potted (CS), geranium (S), poinsettia (S) |
| Cycocel | Chlormequat-chloride | Azalea (S), geranium (S,D), hibiscus (S), poinsettia, red (S,D) |
| Florel | Ethephon | Daffodil (S), hyacinth (S) |

*This list only includes labeling for height control purposes and none other. Application methods are: CS = corm soak, D = media drench, PD = preplant foliar dip, S = foliar spray.

**See label for complete listing of plants labeled.

**ii.** Apply to the foliage. Chemicals can be sprayed on, or foliage can be dipped into the solution at time of transplanting. If dipping foliage into a solution, use a consistent soaking time, say 10 seconds. For sprays, remember that we do not spray plants, we spray an area. This is the only way to assure even coverage and consistent results. If we "spray to run-off" or "spray to glistening", every sprayer will apply a different amount, and there is no way of predicting the results.

**ii.** Apply to the substrate (growth media or soil). This is the same as a soil drench; drenches use larger volumes of solution per plant/ pot, but usually at lower concentrations than a spray or dip. Drenches can take more time to apply than sprays, and require exact metering of volume delivered per pot.

**iii.** Apply directly to the roots / underground portion of the plant. This method is restricted to plants that are potted by the grower such as dahlia tubers. Growth retardants can be applied as a dip or soak in solution to roots, bulbs, corms, tubers, or crowns. An example is a Bonzi dip, which is labeled as a pre-plant soak for freesias. One major problem with bulb soaks noted in research with Easter lilies has been inconsistent results and high plant-to-plant variability in response.

- **How much should be applied?**

**i.** Read the label; do not guess on dosage.

**ii.** Keep in mind that a dosage is the product of [concentration of solution applied] × [volume of solution applied]. If either are incorrect, results could be unpredictable and unrepeatable.

- **How should they be applied?**

**i.** Dips. With some plants it is possible to dip the plant shoot, or underground portion (bulb, corm) into a growth retardant solution prior to potting. This method is labeled and is very effective for applying B-Nine to the shoots of rooted chrysanthemums just prior to potting. This is fairly accurate, if each plant remains in the solution for the same amount of time, and if each plant has approximately the same size shoot/bulb. Unfortunately, this method is not feasible with many of the crops grown.

**ii.** Drenches. Applying a growth retardant in a drench form is fairly easy. Measure out a known amount of chemical, add it to a known volume of water, and apply a known volume of the drench to each pot / plant. Do not apply growth retardant drenches through an irrigation system. It is difficult to attain needed uniformity of delivery and as with A-Rest, "chemigation" (application through any type of irrigation system) is illegal.

**iii.** Sprays. Spray applications can be more difficult to apply evenly. Some chemical labels suggest that you "spray to run-off"; that is, spray each plant until spray visibly begins to drip off of the foliage. Depending on the size of the plant, the sprayer's objectivity, etc., you can get varying amounts of chemical on each plant. It is much safer and more accurate to spray areas not plants. What does that mean? Apply a known volume of spray to a known area (square footage), regardless of how many plants are in that known area. The general recommendation is to apply 1/2 gallon per 100 $ft^2$. This volume is sufficient to comfortably walk 25 feet while spraying a 4 foot-wide bench, thus the basis for the recommendation. If you spray the area evenly, it assures that each pot will receive the same amount of spray (the amount is easy to calculate, too), regardless of how many containers are in the area. Unless you measure out the spray applied to each pot (or calibrate your output rate and time the spray for each pot--attributing for the constant tank pressure change), there is no other way to evenly apply the spray over your plants.

When addressing height control in greenhouse crops, remember to evaluate all possibilities available and base your decisions on cost, quality, and best management practices. If chemical control is the most feasible choice, make applications correctly and accurately. Uniformity and consistency are crucial to attain predictable results. Also remember that growth regulators are treated as pesticides and that it is a violation of Federal Law to use these products in a manner inconsistent with their labels.