POINSETTIA HEIGHT CONTROL

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Controlling height is critical in producing a high quality poinsettia crop. Breeding programs resulted in shorter cultivars, but managing height artificially is still critical to a salable crop. Traditionally, height control has been achieved with chemical growth retardants. Increasing concerns about chemicals have led to a renewed interest in non-chemical control. In greenhouse production, one non-chemical method that's economical and easy is daily temperature manipulation to limit stem elongation.

What determines plant height?

Every plant has a growth potential. There are both short and tall growing plants and/or cultivars. The way you manage crop growth and environment affects a plant's ability to reach its potential height. By manipulating factors that influence poinsettia stem elongation, during each developmental stage, you can produce a crop with your desired height.

Basic concepts of plant growth

* **Node number.** The rate at which poinsettia leaves or nodes unfold is determined by average daily temperature. There's a base temperature where little or no leaf unfolding occurs. There's a linear range where leaf unfolding is proportional to a temperature increase. There's an optimal temperature where leaf unfolding occurs at the fastest rate possible. The base temperature for poinsettia leaf unfolding is approximately 45°F. Leaf unfolding increases as average daily temperatures increase from 45°F to 76°F to 80°F. Leaf unfolding doesn't increase as temperatures increase much above 76°F and will, in fact, decrease if temperatures exceed 90°F. Death occurs at constant 100°F.

* **Internode length.** The way that temperature is delivered to a plant during a day/night cycle and the actual temperatures plants are grown under affect internode length.

Internode length increases as day temperature increases, relative to night temperature. The greater the difference between day and night temperature, the more stem elongation occurs. Simply said, poinsettia stems elongate more as the difference (DIF) between day and night temperature increases, in a range from 50°F to 86°F.

Poinsettia stem elongation is most sensitive to early morning temperatures. Dropping temperatures during the first two to three hours dramatically reduces internode elongation; a rapid increase in morning temperature stimulates elongation.

Height management

Leaf number and internode elongation vary in importance during a poinsettia's development. Leaf number is important prior to flower initiation, whereas internode elongation is important after. Bract expansion and color may be more important than internode elongation late in development. It's critical to understand how to manage temperature effectively to promote different growth at various stages.

Cutting and mother shoot management

Mother shoots are important in determining the potential break number following a pinch; it also established the plant height from which lateral shoots develop. You can manage the cutting prior to pinching by promoting leaf unfolding while limiting elongation. The goal is to achieve desired leaf numbers.

Most other mother shoot or cutting growth occurs in August, when the heat makes temperature manipulation difficult; therefore, growers often use growth retardants. More frequent growth regulator applications at lower concentrations result in better height control than infrequent, high concentrations. Frequently, mother shoot height control is ignored; as a result, cuttings are too tall. When this occurs, you'll find yourself trying to decide if you'll settle for a taller finished plant or reduce potential break number by hard pinching the cutting.

If temperature manipulation is possible in August and September, try reducing day temperature as much as possible. Remember, the higher the day temperature relative to the night temperature, the greater the internode elongation. If you can't control day temperatures all day, drop morning temperatures to below night temperature -- starting one hour before dawn, continuing three hours after sunrise -- to reduce stem elongation. Controlling stem elongation with temperature is preferable to chemical control: Repeated growth retardant applications may decrease lateral breaking.

Manage plant and pinch dates to achieve the desired leaf number on a cutting at the desired pinch date. Also, allow enough time for lateral breaks to develop after pinching. This promotes strong growth, large leaves and high bract quality. A shoot should have at least three leaves when flowers initiate.

To figure out your pinching and planting schedule, simply back up from September 20. For instance, if you'd like to grow a five-break crop at 68°F average daily temperature prior to flower initiation, pinch on September 5 and plant cuttings on August 17. Remember, failing to maintain desired average daily temperatures means you'll have to alter your schedule.

New cultivars like Freedom initiate flowers earlier than older cultivars. Anticipate that Freedom plants will probably initiate flowers one week earlier, on September 13.

Number of days required between planting and pinching to produce plants with various break numbers at various average daily temperatures

Final estimated inflorescence number	Average daily temperature (F) 60	63	65	68	71
	No. of days				
4	21	18	16	15	14
5	28	24	22	20	19
6	35	30	27	25	23
7	42	35	33	30	28
8	49	41	38	35	33

Table assumes cuttings had four leaves when planted, pinching removed two leaves, 80 percent of axillary buds developed into breaks, and flower initiation occurs on September 20.
Times based on leaf unfolding rate functions published in: Berghage, R., R.D. Heins and J.E. Erwin, Quantifying leaf unfolding in the poinsettia, Acta. Hort., *272: 243-247*

Pinching techniques

Pinching technique influences total plant height by influencing number of lateral shoots that develop, the way axillary buds develop and final plant shape and height.

We pinch poinsettias to release apical dominance. Growers pinch plants based on cutting size and leaf number. Pinches are hard (more that one inch removed), medium (one-half to one inch removed), or soft (less than one-half inch removed).

Successful pinching removes all tissues causing apical dominance. Recent research shows that young, immature leaves also contribute to apical dominance. So immature leaves on a soft-pinched plant affect a cutting's later lateral shoot development.

A new technique from Rob Berghage and Royal Heins, which proposes removing young leaves after a soft pinch, maximizes potential break number while allowing uniform breaking. Removing immature leaves results in uniform breaking, maximum break number, greater plant width, total height reduction and more inflorescences contributing to the overall flowering canopy.

Number of days to produce a shoot with three leaves after pinching when plants are grown under different daily temperatures

	Average daily temperature (F) 60	63	65	68	71
No. of days	20	18	17	15	14

Times based on: Berghage, R., R.D. Heins and J.E. Erwin, Quantifying leaf unfolding in the poinsettia, Acta. Hort., *272: 243-247.*

Flower initiation

Poinsettias are short day plants; they flower when night length exceeds some critical length. Flower initiation for most cultivars occurs under natural light conditions between September 10 and 25. Each cultivar varies in its critical night length.

It's important to maintain night temperatures below 74°F during flower initiation. Failure to do this usually delays flowering, increases node number and increases overall plant height.

Advantages and disadvantages of pinching techniques

Hard pinch

*** Advantages:** Easy, fast; generally, results in uniform axillary bud breaking.

*** Disadvantages:** Can be used only on plants with desired leaf number. Occasionally one of the upper two shoots will be excessively tall, resulting in an uneven flowering canopy.

Medium pinch

*** Advantages:** More nodes left on the plant than with a hard pinch, which can ultimately cause more breaks.

*** Disadvantages:** Immature leaves left on the mother shoot inhibit internal shoot growth below, resulting in longer uppermost lateral shoots; gives plants an uneven appearance.

Soft pinch

*** Advantages:** More nodes left on the mother shoot. Plants often grow tall and narrow; may be an advantage with limited bench space.

*** Disadvantage:** Tall and narrow plants with more lateral shoots appearing below flower canopy. A smaller percentage of lateral shoots develop into flowering shoots.

Soft pinch and leaf removal

*** Advantages:** Lateral shoot release occurs quickly and uniformly; maximizes number of potential lateral breaks. More lateral shoots contribute to flower canopy, compared to medium- or soft-pinched plants. Yields a more uniform flower canopy balanced with height.

*** Disadvantages:** Labor intensive. Delayed flowering no longer than two to three days on plants where leaves have been removed compared to plants that are soft-, medium- or hard-pinched.

Lateral shoot height management

After flower initiation, most growers' major concern is controlling lateral shoot stem elongation. Early October is the period where plant height can get out of control. Controlling stem elongation then is critical because using growth regulators later in development, (for example, after October 15) reduces bract size. Also, using temperature after October 15 or when plants aren't elongating as rapidly won't impact total plant height as much.

How pinching influences days to flower, height to width ratio, primary stem length and number of flowers

Cultivar	Pinch type	Days to flower	Height: Width*	Stem length (inches)*	No. inflorescences
Annette Hegg Dark Red	soft	48	0.85	8	6.3
	hard	51	0.85	4.4	5.5
	soft + leaf removal	56	0.74	6.7	8.2
Annette Hegg Brilliant Diamond	soft	48	0.79	6.9	6.3
	hard	53	0.68	4.2	5.7
	soft + leaf removal	54	0.67	5.7	8.7
V-14 Glory	soft	66	0.74	6.2	7.6
	hard	78	0.59	4	6.3
	soft + leaf removal	80	0.55	4.5	8.9

*A high height-to-width ratio is an upright plant; a low height-to-width ratio is a broad plant.
**Primary stem length is the length of the uppermost lateral shoot on the mother shoot.
Data extracted from: Berghage, R., R.D. Heins, M. Karlsson, J. Erwin and W. Carlson, 1989, Pinching technique influences lateral shoot development in poinsettia, Journal of the American Society of Horticultural Science, *114(6): 909-914.*

Graphical tracking

All plants with determinant growth have similar shoot elongation patterns. First, there's a lag period, then, rapid elongation. Lastly, elongation slows and finally stops as flowers develop. You can develop a model curve to help you follow your crop's elongation graphically to determine whether it's elongating too rapidly or not enough. This technique, developed by Royal Heins, is referred to as graphical tracking. The "how-to" is shown later.

If pinched to flower initiation in natural light, plants enter the rapid elongation phase at the beginning of October. Older cultivars require both temperature manipulation and growth retardants to control stem elongation. In northern climates, however, many growers can control height with temperature only when growing shorter-growing cultivars such as Freedom.

DIF

Controlling day and night temperatures during the rapid elongation phase is critical. The estimated internode length on Annette Hegg Dark Red plants grown with a day temperature 7°F warmer than the night temperature is 1½ inches. In contrast, if you drop your day temperature so day and night temperatures are equal, estimated internode length is reduced to about one inch. This translates into a 20 percent height reduction.

Internode length reduction is greater when day/night temperatures are changed from a higher day than night to equal day/night temperatures, than when the temperature regime is changed from equal day/night to cooler day temperatures.

Cool mornings

Stem elongation responses to temperature are greatest in the morning. Cool morning temperature drops can greatly reduce plant stem elongation. Conversely, temperature increases in early morning hours can greatly increase stem elongation.

To limit stem elongation, it's critical that temperatures are cool when light first hits the plants. Don't wait until the sun has already risen. The more rapid the temperature change, the greater the stem elongation response.

Final plant height can be reduced markedly by dropping the temperature for only two hours in the beginning of the morning. Height reduction is due to reducing stem elongation; node number, plant width and bract size aren't greatly affected.

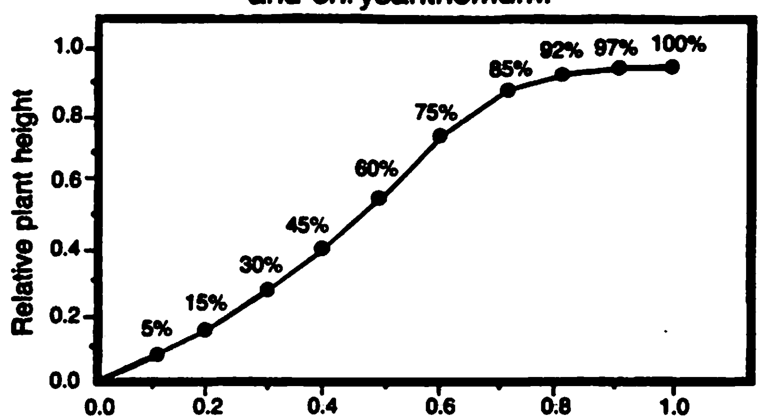
DIF and other environmental factors

Plants' responses to day and night temperature and/or morning temperature drop are greatest under high daylight intensity. Under cloudy conditions, temperature control of stem elongation isn't as effective and growth retardants may be necessary.

Stem elongation response to day/night temperature is also affected by photoperiod. Response to DIF increases as photoperiod length decreases. Therefore, you'll probably get a greater response to DIF during October than September.

Making a graphical track

Figure 1. Growth curve for poinsettia and chrysanthemum.



To make a graphical track, all you need to know is your crop time (from pinch to flower), growth percentages at specific points during crop development (taken from growth curve above) and final desired crop height.

To make a graphical track for a poinsettia crop, start with the above growth curve, which is typical for a poinsettia crop. From the curve and the percentages shown, you can make your own growth curve for any poinsettia crop.

For example we'll use a poinsettia crop we grew at the university, which has an 11-week (77 days) production time from pinch to finish. Pot height is 5.5 inches; cutting height is 4 inches. Final desired height is between 18 and 20 inches, determined by customer specifications.

The growth we're really concerned with is lateral shoot growth after pinching, so we subtract the fixed or constant factors making up total plant height. Leave a window on the final lateral shoot length of 1 or 2 inches.

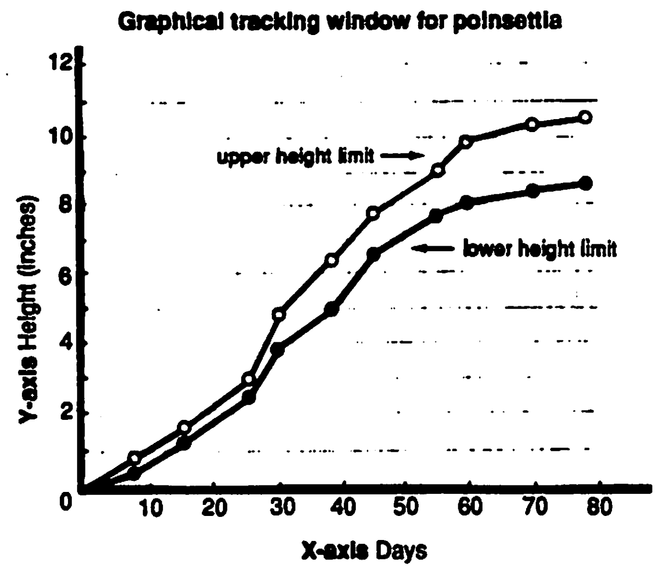
Lateral shoot length = 18 inches − 4-inch cutting height − 5.5-inch pot height = 8.5 inches to 10.5 inches.

In this case, over the 77-day crop time, we want lateral shoots to elongate at least 8.5 inches but no more than 10.5 inches. Lateral shoot lengths are numbers you'll use to calculate upper and lower limits of the tracking window.

Now, to make the graphical tracking window, make two tables—x-axis and y-axis—like the ones on page 29. In both tables, the relative time and relative height columns (black numbers) stay the same for every poinsettia graph. The red numbers are ones you need to fill in: the number of days from pinch to flower on the x-axis table (in our example 77 days) and the lower and upper height limits on the y-axis table (8.5 inches and 10.5 inches).

The blue numbers are ones we calculate; these are the numbers we'll use to create your tracking window. In the x-axis table, multiply time in crop development (expressed as a decimal, not a percentage) by number of days from pinch to flower to get your x-values. In the y-axis table, multiply crop height (taken from the growth curve and expressed as a decimal, not a percentage) by the lower final height limit to get y-values for the lower line of your tracking window. Follow the same procedure with the upper final height limit to get y-values for the upper line of your tracking window.

Use the blue numbers to create a graphical tracking window. On the days represented on the x-axis, measure sample plants (use the same plant over time) and plot their average height (y-value) against the day in crop development (x-value). Points should fall within the tracking window.



X-axis

Time (%)	Calculation (time % as a decimal × days from pinch to flower) ✓RED	Days (X-value) ✓BLUE
0	0 × 77	0
10	0.1 × 77	7.7
20	0.2 × 77	15.4
30	0.3 × 77	23.4
40	0.4 × 77	30.8
50	0.5 × 77	38.5
60	0.6 × 77	46.2
70	0.7 × 77	53.9
80	0.8 × 77	61.6
90	0.9 × 77	69.3
100	1.0 × 77	77.0

Y-axis

Height (% taken from growth curve)	Calculation (height % as a decimal × final height lower limit)	Lower height limit (inches) (y-value)	Calculation (___ × final height upper limit)	Upper height limit (inches) (y-value)
0	0 × 8 5	0	0 × 10.5	0
5	0.05 × 8.5	0.4	0.05 × 10.5	0.5
15	0.15 × 8 5	1.3	0.15 × 10.5	1.6
30	0.3 × 8.5	2.6	0.3 × 10.5	3.2
45	0.45 × 8.5	3.8	0.45 × 10.5	4.7
60	0.6 × 8.5	5.1	0.6 × 10.5	6.3
75	0.75 × 8 5	6.4	0.75 × 10.5	7.9
85	0.85 × 8.5	7.2	0.85 × 10.5	8.9
92	0.92 × 8.5	7.8	0.92 × 10.5	9.7
97	0.97 × 8.5	8.2	0.97 × 10.5	10.2
100	1.0 × 8 5	8.5	1.0 × 10.5	10.5