**What is graphical tracking of plant height?**

Height control of potted flowering crops can be a major challenge. Each year differs with unique weather condition, cultivar, plant vigor, shipping date, and pot-size combinations. Scheduling, temperature settings, and growth retardant decisions for height control therefore cannot be exclusively based on what was done the previous year.

Growers of potted flowering crops know the costs of having a crop finish at an unacceptable size: higher shipping charges, downgrading of product, and lost sales.

Graphical tracking is a simple tool developed to help avoid short or tall crops. It is a grower-management tool where actual plant height or development is compared with desired plant height or development over time. Management decisions are then made based on the information obtained from the comparison. From a mental health point of view, graphical tracking helps avoid the stress of a by-the-seat-of-your-pants growing style.

The technique is to plot plant height onto a graph once or twice each week and make height-control decisions after visually comparing actual and target heights (Figure 1). The small monitoring cost (about 15 minutes in labor per crop each week) for graphically tracking crops rapidly pays for itself in improved quality.

![Graphical Track](image)

**Figure 1** An example graphical track for poinsettia. Height when the crop was pinched was 6.5 inches tall (including the pot). The goal was to finish plant height between 13-16 inches. Growth retardants (Cyocel, “CCC”) were applied when measured plant height was above the target curves.

Graphical tracking helps you clearly see whether your plants are too tall or short at any time in the season and make timely corrections. This tool is being used successfully by many growers, regardless of whether their greenhouse business is large or small, located in the North or South, or low-tech or sophisticated.

**Computer Software for Graphical Tracking**

University of New Hampshire has developed several computer programs to assist with graphical tracking of plant height, soil tests, and pest counts. The goal of our research program on decision-support systems at UNH is to provide crop management tools that incorporate the latest research, are easy-to-use, and are low-cost.

All modules require the spreadsheet program Microsoft Excel (Version 97 or 2000), and an IBM-compatible computer using Microsoft Windows (95 or later). This means the growers can produce multiple high-quality graphs, there is minimal need to train users, and there is little or no need to update the software as you upgrade your computer.

**UNH FloraTrack for Poinsettia** is a computer program for use by poinsettia growers to graphically track the height of their crops. This program is distributed for free at the Paul Ecke Ranch web site (http://www.ecke.com/html/h_points/points_graphica1.html).

There is also another program, **UNH FloraTrack for Lilies** that is for graphically tracking height of Easter, Oriental, and Asiatic lilies. To order (cost $125) use the order form under “Graphical Tracking” at ceinfo.unh.edu/agriculture/documents/flora.htm.

**FloraSoil** and **FloraPest** are UNH programs for graphically tracking nutrient and pest counts. These programs are sold with a low-cost annual license ($49.95 each per year plus S&H), and the order form is also available under “Graphical Tracking” at ceinfo.unh.edu/agriculture/documents/flora.htm.
The **UNH FloraTrack for Poinsettia software**

**UNH FloraTrack for Poinsettia** generates a graph for whatever date and height specifications apply to your crop. You enter the basic information (start and end dates, cultivar, pot size, etc.) in the opening screen (Figure 2), which automatically updates the graph.

You can either use **UNH FloraTrack for Poinsettia** to print out a graph and enter heights by hand, or type the plant heights into the program to become a permanent record. One advantage of using the computer is that if you enter the individual heights of up to ten plants sampled, **UNH FloraTrack for Poinsettia** automatically calculates and plots the average for your sample on the graph. Figure 2 shows red dots that represent the measured crop heights, and three green diamonds representing dates when growth retardants were applied.

**Selecting the Graphical Tracking Curve.**

One option in UNH FloraTrack for Poinsettia is to select the shape of the target curve (Standard Curve, Tall Curve, and Unpinched (Single stem) Curve). You can choose between these different graphical tracking curves depending on your cultivar, growing conditions, and whether the plants are pinched.

The Standard Curve was developed from research of the growth of ‘Annette Hegg Dark Red’ plants grown at an open (14-inch) spacing at constant 68F temperatures.

There are situations where the Standard Curve is not the best curve to use. For example, unpinched plants have a different elongation pattern. Also, ‘Freedom’ varieties tend to stretch late in the production cycle, resulting in a slightly different overall pattern. In this report, we will describe two different curves (a ‘Late Curve’ and an ‘Unpinched Curve’) and help you choose which is the best for a variety of situations.
• For crops grown as a single stem, always use the Unpinched Curve (Figure 3).
  
  o The growth pattern of unpinched plants differs substantially from the Standard Curve. Early plant elongation varies depending on variety, quality of cuttings, whether cuttings are planted rooted or roots, and light and temperature conditions. Thus graphical tracking cannot be started reliably until after the plants have begun to elongate rapidly (about 1” taller than when transplanted).

Figure 3 Target graphical tracking “Unpinched Curve” for single stem plants. Note the long period of straight line growth, followed by a plateau stage near flowering.

• For most pinched crops, use the Standard Curve.
  
  o When in doubt, for most poinsettia crops and cultivars, the Standard Curve (Figure 4) will provide a close guideline to the growth of your pinched crop.

Figure 4 Comparison between Standard and Late graphical tracking curves

• Use the Late Curve for pinched plants that grow quickly after first color.
  
  o We have developed an alternative ‘Late Curve’ for some pinched crops (Figure 4). The Late Curve is lower than the Standard Curve, especially during the middle of the growth period. The Late Curve assumes that plants will elongate more quickly during the second half of the season.
  
  o If you track a crop with the Late Curve, then your aim is to keep plants shorter before first color than you would with the Standard Curve. This means more growth retardant applications or negative DIF temperature early on in production.

  o Situations where you may choose to use the Late Curve are:
    ▪ When growing the “Eckespoint Freedom” cultivar. “Freedom” plants tend to elongate more than other cultivars after first color, so can finish too tall if using the Standard Curve.
    ▪ When growing in a pot size smaller than 5 inches in diameter. Smaller plants tend to require more growth retardant applications early in production. It is therefore very important before first color to keep plants shorter than the Standard Curve would recommend.
    ▪ When you are growing plants at close spacing (e.g. less than 12 inch spacing for 6-inch diameter pots). When the canopy “closes in” around the middle period of production the increased competition for light can cause a rapid burst in elongation.
    ▪ In greenhouses where very positive DIF (average day minus average night) temperature conditions (at least 10F warmer days than nights) will occur throughout the crop.
    ▪ When plants have been pinched and under long days for a longer period (and therefore have more internodes) than is recommended by the plant breeder for your cultivar and location.
A ‘Low-Tech’ tool: The Height Stick

The Height Stick is a simple height control tool that can be used by growers whether or not they are also graphical tracking on a graph. Back in the days before graphical tracking, some growers would record plant height each week by marking the heights onto a stake sitting inside a pot on the bench. The stake would therefore show weekly dates and the heights on those dates for a crop that finished at the target height. The following year, they could reuse the stake as a guideline for the new crop.

We have developed a way to make a Height Stick (Figure 5) that takes advantage of research on graphical tracking - the target heights for each date can be read off the graphical track curve, half way between the upper and lower target lines.

The benefit of making a Height Stick is that you can see very clearly in the greenhouse whether the plants are too tall or short without having to plot the heights on a graph. This means the tool is very quick to use, and can be useful for workers not used to reading information on graphs.

One disadvantage of this method compared with graphical tracking is that it is difficult to see trends in growth rate over time. When you check crop height with the Height Stick, you are only looking at plant height in one point in time - on a graphical track curve you can see whether, for example, a growth retardant is still affecting elongation rate based on whether the crop is growing slowly and back into the window, or is again starting to elongate rapidly.

You will need a different Height Stick for each pot size and cultivar you grow.

The example Height Stick (Figure 5) is suitable for a similar poinsettia crop to that being graphical tracked in Figure 2. As you can see in Figure 2, the target height for this crop on Oct. 8 will be around 11.5 inches. The date Oct. 8 is drawn on the yard stick (Figure 5) at the height of 11.5 inches. This means that if you went out into the greenhouse on Oct. 8 and put the Height Stick on the bench beside the crop, the top of each plant should ideally be at the 11.5-inch mark.

The range in acceptable final heights (in this example 14 to 16 inches) can also be drawn onto the ruler (Figure 5).

UNH FloraTrack for Poinsettia prints out the information in Table 1, which you need to make a Height Stick. You can then take this information and draw the dates onto a ruler. The software does not draw the Height Stick for you, but it does present the dates for each target height as calendar date, weeks after pinch, and production week number (Table 1). The advantage of writing dates on the ruler as weeks after pinch is that you can use the Height Stick for crops of the same cultivar and pot size, but different pinch dates.

To obtain a copy of UNH FloraTrack for Poinsettia

UNH FloraTrack for Poinsettia is distributed for free through the Paul Ecke Ranch web site: (http://www.ecke.com/html/h_points/points_graphical.html).

To order other UNH software, use the order forms under “Graphical Tracking” at the extension web site: ceinfo.unh.edu/agriculture/documents/flora.htm.

You can also contact Dr. Paul Fisher, Dept. of Plant Biology, University of New Hampshire, Durham, NH 03824. Tel. (603) 862-4757, Fax (603) 862-4525, e-mail Paul.Fisher@unh.edu.

Table 1. Information needed to make a Height Stick.

<table>
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<tr>
<th>Target Heights</th>
<th>Calendar Date</th>
<th>Weeks After Pinch</th>
<th>Week Number</th>
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<td>27-Aug</td>
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<td>3-Sep</td>
<td>2</td>
<td>36</td>
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<td>7.5</td>
<td>10-Sep</td>
<td>3</td>
<td>37</td>
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<td>17-Sep</td>
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<td>24-Sep</td>
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Figure 5. An example Height Stick.