Easter Lilies:

A Challenge You Can Master

When it comes to controlling flowering and height of your Easter lily crop, precision is key. Temperature manipulation, graphical tracking and light monitoring are just a few of the tools you will need to make sure your plants are on time and in perfect condition.

By Theo J. Blom and Paul Fisher

By the time you read this article, Easter lilies will have been planted, and flowering and height control are likely the major issues remaining for a successful conclusion of this crop. This year, Easter will be on March 31, 2002, and most plants will be ready to ship (puffy bud stage) between March 11-26, 2002. This early Easter makes for a very tight schedule and means that it is especially important to use the well-proven tools we describe in this article to help you meet flower date and final height specifications.

HITTING YOUR TARGET FLOWERING DATE

There are several key dates in the Easter lily crop cycle — if you hit these intermediate target dates, you will be on track for flowering in time for Easter. The target dates for 2002 are shown in Table 1 below.

Average temperature is the key accelerator for pushing flowering date forward or back (faster flowering occurs as temperature is increased). Some very effective tools can be used to identify the optimum temperature to control timing of each stage:

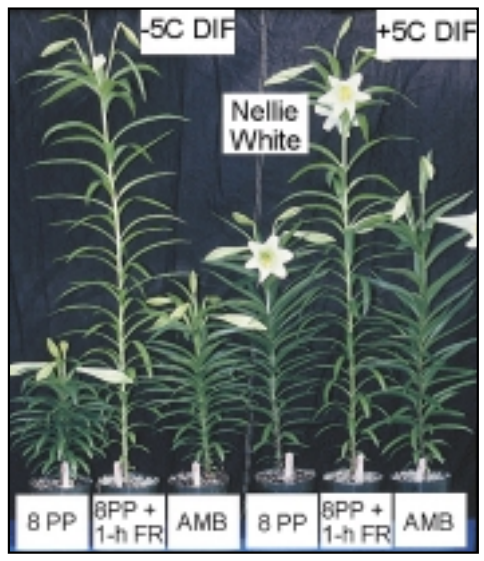
Table 1. Suggested target dates and heights for Easter lilies in 2002. The "Local sales" date is appropriate for growers producing for direct retail sales, whereas the "Big box/wholesale" dates should be used by most growers. These average dates assume that early and late plants will flower in a range up to seven days before or after the average dates shown — move the dates forward or back depending on your market.

	BIG BOX/WHOLESALE	LOCAL SALES
Visible Bud date	Feb. 13, 2002	Feb. 20, 2002
Open Flower date	Mar. 17, 2002	Mar. 24, 2002
Height at Visible Bud	12.5-13.5 in.	
Height at Flower	19-21 in.	

1. ***Emergence*** occurs when the tip of the bulb emerges above the soil line, which should have happened around December 20-25, 2001. Plants should have received six weeks of cooling before emergence to ensure reliable flower initiation and acceptable flower bud count. Maintain 62-65° F soil temperature until flower initiation. Excessive temperature will cause too much unwanted initial stretching and more leaves, while very low temperatures prevent the initiation of a healthy root system and can cause overcooling.

2. ***Flower initiation*** is the stage when flower buds are first visible on a dissected plant using a magnifying glass. The process of initiation starts when shoots emerge above the soil line and continues until the buds have formed microscopically (approximately January 12-20, 2002). At this point, no more leaves are being initiated, and you can start to estimate how many leaves are on each plant. Checking for flower initiation is important because you can set greenhouse temperatures and control crop timing based on how quickly leaves unfold.

3. **Visible Bud** occurs when the immature flower buds can first be seen (overhead view) on the plant without removing ➧



Nellie White Easter lilies grown under a -9° F DIF (day minus night temperature) or a +9° F DIF regime and with either an 8-hour photoperiod (8PP) or 8-hour photoperiod followed by one hour of far-red light (8PP+1-h FR) or ambient conditions in a glass greenhouse. (Photos courtesy of Theo Blom)

leaves. The key tool to control timing of visible bud is leaf counting. To use the leaf counting method:

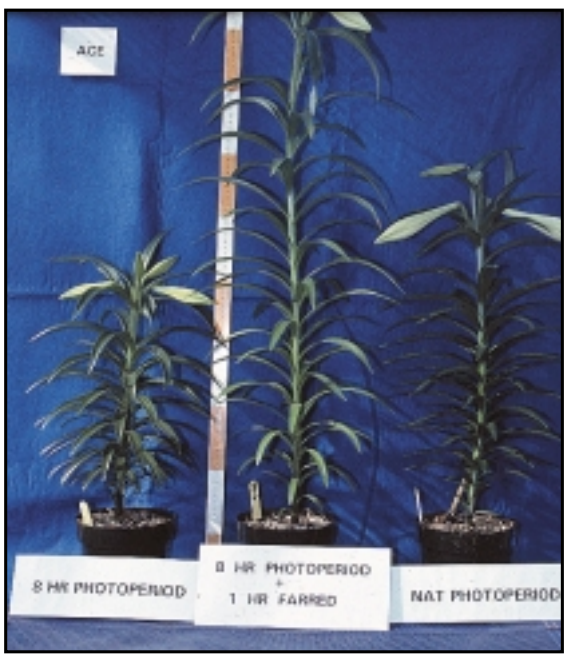
On plants that have initiated flowers, use leaf dissection to count (a) the number of leaves already unfolded, (b) the number of immature leaves that have yet to unfold and (c) the total leaf number (a) plus (b)).

Set a target visible bud date 30-35 days before the flowering date (see Table 1 on page 10, which assumes 32 days), and calculate how many days remain from the date you counted leaves until the target visible bud date.

The warmer the air temperature, the faster the leaves will unfold. Estimate the temperature you will need to reach the visible bud date by unfolding all leaves using this formula:

24-hour average temperature (°C) = target leaf unfolding rate x 10.64 + 1.12
(with the target unfolding rate expressed in number of leaves per day)

For example, if you want to unfold 50 leaves to reach visible bud in 25 days, the target leaf unfolding rate would be two leaves per day, and the target temperature = 2 x 10.64 + 1.12 = 72° F (22.4° C) for an 8/9 case-cooled 'Nellie White'. For larger bulbs or CTF-bulbs, the natural unfolding rate is slightly higher, and thus, a slightly lower temperature can be maintained.



Ace Easter lilies grown under an 8-hour photoperiod (blackout from 4 p.m.-8 a.m.), an 8-hour photoperiod followed by one hour of far-red light at the beginning of the dark period or natural (ambient) light conditions in a glass greenhouse.

While it is possible to predict in advance the average daily temperature necessary to reach visible bud on a desired date, actual greenhouse and plant temperatures seldom exactly equal that desired. Therefore, it is important to repeat the leaf counting process on at least five plants randomly chosen from the crop twice per week until visible bud.

Each time the number of unfolded leaves is counted, one gets a new update on crop development. Temperatures can then be adjusted up or down to keep the crop developing properly. Reaching visible bud at the proper time avoids the problem of having to run excessively cool or warm temperatures during the next stage of lily development, the time between the visible bud and open flower stages.

4. The ***Open Flower*** stage occurs when the plant has an open flower in the retail environment (around Palm Sunday). Most plants are shipped at the puffy bud stage, 1-2 days before the first flower will open. Optimum time for the puffy bud stage is earlier for wholesale/big box suppliers, who will hold plants in a cooler until ready, and later (near Palm Sunday) for local sales, where a "ripe"

plant is delivered directly to the market (see Table 1 on page 10). Remember that there is usually a span of 14 days between when the first lily in a crop is ready to ship until the last plant can be shipped, because of variability in flowering. Assuming you have cooler space to hold early plants, shoot for 50 percent of the crop being ready to ship seven days before your final ship date to bring all of the crop into flower on time.

Easter lilies open their first primary flower bud after it is just over six inches in length. The time it takes for an immature flower bud to reach that length (and an open flower) can be predicted using a model that has an accuracy of ± 2-3 days. You can download this model, called the flower bud meter, from Dr. Heiner Lieth's University of California Davis Web site at http://lieth.ucdavis.edu/Research/dss/bud.htm.

PLANT HEIGHT TRACKING

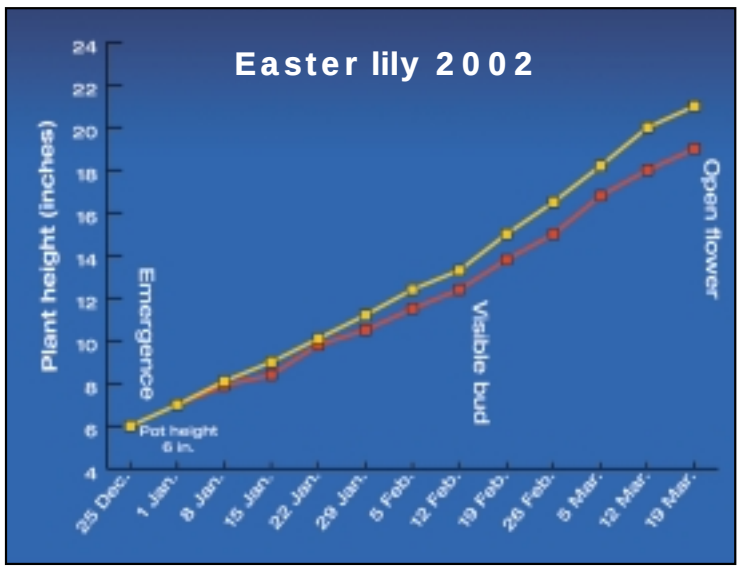
Height control is also crucial to ensure that plants fit into suitable containers for shipping and are balanced, attractive products. Graphical tracking is a technique whereby plant height is measured on 10 plants per crop twice each week, and the average height is plotted onto a graph that also shows target elongation curves. If actual height is below or above the "window" between maximum and minimum curves, then height control measures (e.g., growth regulators or DIF temperature) are necessary.

The target stem-elongation curve for Easter lilies is simple to calculate. The easiest way to develop the curve is to assume that plants double in height from visible bud to open flower. This means the plant height at visible bud, not including the pot, is half the height at flowering (see Figure 1 to the right).

Considering a target total (plant plus pot) height of 21 inches at open flower, plant height at flower will be 15 inches (21 inches minus 6 inches for the pot size). Half of 15 inches is 7.5 inches. Total height at visible bud should therefore be no greater than 13.5 inches (7.5 inches plus 6 inches for the pot equals 13.5 inches).

We now know the height at emergence (pot height of six inches), the total height at visible bud (13.5 inches) and open flower (21 inches). Plot these three points (height at emergence, visible bud and open flower) and connect with two straight lines. Two lines are normally plotted to reflect the desired minimum and maximum final plant height (19 and 21 inches, respectively, in Figure 1 below).

Figure 1. A height graphical tracking chart, assuming a range in the target final height from 19-21 inches, with dates of emergence on December 25, visible bud on February 13 and open flower on March 17.



While creating an Easter lily graphical tracking curve by hand is easy, many growers prefer to use a computer spreadsheet. The computer program UNH FloraTrack for Lilies that includes curves for Easter, Oriental and Asiflorum (LA hybrids) lily species can be obtained from the University of New Hampshire for $125 by contacting Paul Fisher at (603) 862-4525 or Paul.Fisher@unh.edu.

Another approach to height control is to take a yardstick and write onto it the dates through the production cycle. The target heights for each date (see Table 2, to the right) represent the middle of the target graphical tracking curve from Figure 1, page 13. For example, 13 inches up the ruler write the date "12-Feb." You can take this ruler into the greenhouse each week and compare the ruler against plants on the bench. If plants are above or below the target height for the date, growth regulators or other height control actions are needed.

CONTROLLING HEIGHT AND TIMING

Several factors affect elongation and development rate for Easter lily. Understanding each of these options will help you avoid "fighting fires" with a crop that is behind or ahead of schedule and provide you with corrective strategies:

Air temperature. Regulating the difference between day temperature and night temperature (DIF) is a well-established tool for height control. A negative DIF (cooler day than night) produces shorter plants than a positive DIF (warmer day than night). A negative DIF can be achieved by dropping the temperature to 50-59° F starting about 1-2 hours before sunrise and maintaining this cool temperature for 4-6 hours (the "drop" or "dip" method) or for the duration of the entire daylight period. It has been shown that the DIF effect is greatest when low daytime temperatures are maintained during the early morning rather than during the afternoon. DIF temperature affects stem elongation but does not affect time to flowering, which is determined by the average 24-hour temperature over both day and night.

Table 2. Target heights that can be drawn onto a ruler to make a "Height Stick" for comparing against plants in the greenhouse.

DATE	Write the dates at these target heights (inches)
25-Dec	6.0
01-Jan	7.0
08-Jan	8.0
15-Jan	9
22-Jan	10
29-Jan	11
05-Feb	12
12-Feb	13
19-Feb	14.5
26-Feb	16
05-Mar	17.5
12-Mar	19
17-Mar	20

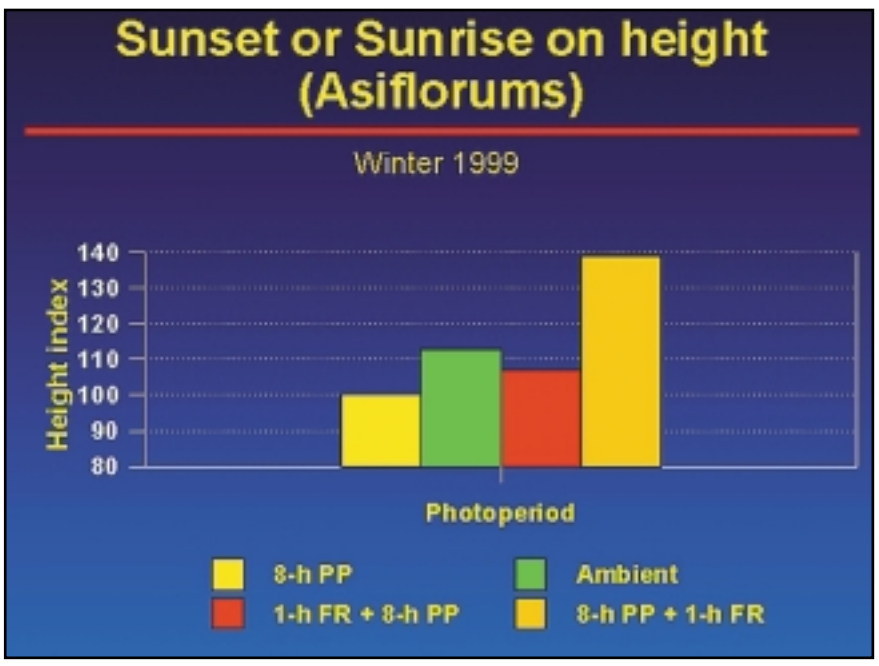
Growth regulators. Growth regulators such as A-Rest or Sumagic are effective as a drench or spray when plants are 3-6 inches tall or as a spray at a later date until visible bud. These products have been proven effective, but a side effect can be premature senescence (yellowing) of the lower leaves, especially with high label rates. Multiple applications at a low label rate are most effective.

Irrigation frequency. Growing a high-quality lily that will perform well for the customer is largely dependent on root health. Most root problems in lilies result from overwatering, which can result in stunted and stressed plants. Although limiting the amount of available water may reduce elongation, running the plant overly dry is also likely to damage roots — a middle path that aims for healthy root growth is the best approach.

Light intensity. Easter lilies are very sensitive to total light energy and will elongate much more under shade or cloudy conditions. Research found that Easter lilies grown in a glass greenhouse under different levels of shade (0-75 percent) from emergence to flowering increased plant height by about one inch for every 10 percent light reduction. This consideration is important when deciding to grow lilies in a glasshouse or a double polyhouse; high light is preferable to grow a compact, high-quality plant.

Light quality. During the 1990s at Vineland Station in Ontario, Canada, we experimented with using black cloth to eliminate twilight as well as ➧

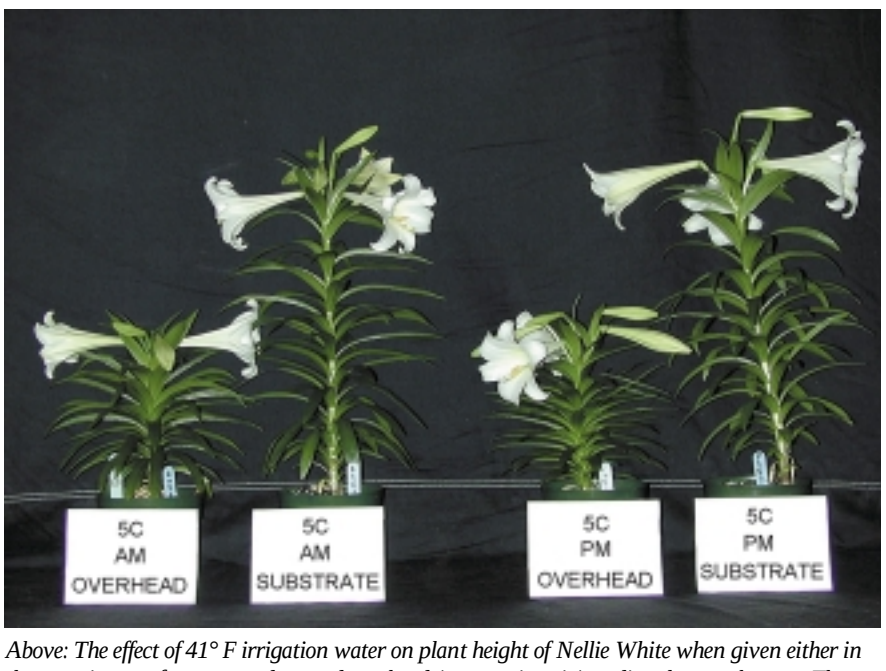
Figure 2. The effects of short days (no twilight and 8-h photoperiod), ambient (with natural sunrise and sunset) , a simulated sunrise (one hour far-red + 8-h PP) or sunset (8-h PP + one hour FR) on plant height. The plant height under 8-h PP was at 100.



trying to determine whether one hour of artificial twilight (i.e., far-red light) at the beginning of the dark period (end of the day) or at the end of the dark period (beginning of the day) would affect height. The use of blackout resulted in a 20-percent reduction in height for 'Ace' and Nellie White compared with ambient (natural photoperiod) conditions, when grown under 0° F DIF (See Figure 2 above). Plants grown under an 8-hour photoperiod using blackout between 4 p.m. and 8 a.m. with one hour of low-intensity, far-red lighting at the beginning of the dark period were double the height of those grown under short days.

When these treatments were combined with either +9° F or -9° F DIF, it was found that the effects of DIF and that of twilight were additive. The shortest plants were obtained under -9° F DIF and short days, and the tallest plants were +9° F DIF under ambient conditions (excluding the one hour of far-red lighting treatments).

Another question that needed to be answered was whether elimination of twilight at the end of the day (sunset) is more effective than at the start of the day (sunrise). This work was done with LA-lilies (or Asiflorums). The results are shown in Figure 2 above. The height of plants grown under blackout (4 p.m.-8 a.m. or 8-hour photoperiod) were indexed to 100.



Above: The effect of 41° F irrigation water on plant height of Nellie White when given either in the morning or afternoon and poured overhead (on growing tip) or directly on substrate. The treatment started at emergence and continued until flowering (once every four days).

Artificial sunrise (one-hour FR plus eight hours PP) increased plant height by 7 percent, but artificial sunset (eight hours PP plus one hour FR) increased plant height by 39 percent compared to eight hours PP. This means that the effect of sunrise is relatively small compared to that of sunset.

For commercial production, using blackout at or just before sunset in combination with negative DIF are complementary tools. Opening black cloth prior to sunrise provides further height control.

Water temperature. This year, an experiment with three different irrigation temperatures, namely 41, 59 and 77° F, was undertaken at Vineland Station. We applied the irrigation solution (nutrients inclusive) either on the growing point (meristem) or the soil surface. In addition to the above combinations, we treated some plants in the morning and others in the afternoon. Plants were irrigated every 4-5 days, whenever irrigation was needed from emergence until flowering. Although both 59° F and 77° F did not show any effects, plants grown with 41° F irrigation water applied overhead were 50-percent shorter than those grown with 41° F water on the substrate or the 59° or 77° F treatments. There was no difference in plant height when irrigation took place either in the morning or the afternoon. Plant height was about one-half compared to any other treatment, while forcing time was similar to the other treatments. During the coming year, we will determine how high the temperature can be while still being effective or how low it can be without causing any bud abortion. In addition, we would like to determine how long "cold water shock" remains effective in controlling plant height.

IN SUMMARY

Plant dissections, leaf counting, bud meters and height graphical tracking are very useful tools for Easter lily growers. The target dates that we have used for specific stages of development may have to be adjusted depending on cooling technique, size of bulb, latitude and market. A number of options have been given to control the plant height of Easter lilies. The use of negative DIF either with or without the use of blackout at the end of the day (remove twilight at sunset) and/or the use of cold water (41-44° F) are management tools to limit the height of Easter lilies. GPN

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