1998 Easter Lily Production

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Easter in 1998 is April 12, a medium Easter date. Keep accurate records this year, and go back and check earlier records, if possible.

Vernalization and Floral Induction. The primary means of influencing flower formation and timing of flowering, is by vernalization, or cold-moist treatment prior to greenhouse forcing. Vernalization accelerates flowering. Temperatures in the range of 38-45F are most effective for 'Ace' and 'Nellie White'. Temperatures below 35F severely reduce vernalization, and bulbs should not be exposed to such low temperatures under normal situations.

Commercial case-cooling. The vernalized bulbs should be potted immediately upon arrival, 110-120 days before Easter. After potting, water-in thoroughly and place in the greenhouse. Maintain 62-64 F early to get roots started.

Home case-cooling. Home cooling is possible only if you have a well maintained, accurately controlled cooler of sufficient size to handle the quantity of bulbs to be forced. The necessary temperatures are given above.

"Pot-cooling," or controlled temperature forcing (CTF). This method has the greatest potential to produce the highest quality plants. On the other hand, pot-cooling is the most labor and physical-plant intensive, and requires a greater attention to detail than the other three methods. Non-cooled bulbs are potted, irrigated, and given up to 3 weeks of 63F to promote root growth prior to the cooling period. The soil must be kept moist, but not wet, at all times. After three weeks, pots are moved to a cooler and held for six weeks at the recommended temperature. Since we have a "medium" Easter this year, the full three weeks can probably be given. If time is short, do not skimp on the cooling, reduce the rooting period instead.

Insurance lighting. I recommend "insurance lighting" only if insufficient cooling is suspected. Lighting is most effective in the period at and just after emergence. Lights should remain on for only the amount of time to make up for lost cold treatment. Any lighting increases the height of a lily crop. Fluorescent lamps have less far-red energy and therefore cause less stretching than incandescent lights. There is no need to sort emergence groups for lighting.

Growing Medium.

Three important characteristics are necessary for a lily potting medium: 1) good drainage, 2) good water holding capacity, and 3) good fertilizer-holding capacity (cation exchange capacity). Although these characteristics can be supplied by both soil based or soil-less media, remember that peat moss and other organic materials such as bark have very little nutrient holding capacity (cation exchange capacity) on a per pot basis. When media components with a high carbon to nitrogen ratio (e.g., bark or other partially decomposed materials) are used, incorporation of slow release nitrogen (0.5 lb. urea formaldehyde per cubic yd.) is recommended to maintain available nitrogen during bark decomposition. Ideally, growing medium should be tested prior to planting, and amended with dolomitic and calcitic lime accordingly. A pH of 6.5 to 7.0 is recommended for soil based mixtures, with soil-less (peat-lite) mixes about 0.3 to 0.6 pH unit lower.

Planting

Full-depth ("standard") pots are strongly recommended. These pots allow better drainage, and therefore reduce root rots. Bulbs should be planted so that the top of the bulb is at least 2 inches below the soil line, with about 1 in. of soil below the bulb. Firm, but do not pack, medium around and over the bulb. Leave a rim for irrigation. Before good height control measures were available, growers used to place gravel in the bottom of the pot to provide weight and stability. This should not be done. This only reduces the height of the soil column and reduces drainage from the pot. Increased root rot could result.

Scheduling

Phase I. Planting to Emergence. In this phase, the bulb is producing roots and becoming established in the pot, and early shoot growth is occurring. Since the bulb and non-emerged shoot are surrounded by the potting mix, soil temperature is the key environmental factor. If bulbs are fully vernalized, warmer soil temperatures (70F) can be used to speed emergence without the danger of "devernalizing" the bulbs.

Phase II. Emergence to Flower Bud Initiation (FBI). After shoot emergence, the plant becomes responsive to air temperatures, and DIF height management can be started. Flowers form (initiate) when the shoot is about 3-5 in. tall (mid-late January, depending on the year). Stem roots form about the same time as FBI.

Phase III. FBI to visible bud (VB). In this phase, flowers continue to grow and develop from microscopic primordia into visible buds about 0.5-1 in. long, and half of the total plant height is gained. Buds "become visible" because the leaves surrounding them grow, and the leaf tips unfold away from the stem apex (meristem)where the buds have initiated. For a 1998 of April 12, a VB date of Feb. 25-

Mar.1 should be strived for, depending on marketing and shipping schedules. All crops should be timed after flower bud initiation by leaf counting, described below:

1. Around Jan 15th to 20th, randomly select to 5 plants of each major lot of bulbs. "Lots" are different cultivars, bulb sizes or sources.

2. Mark with a pen or hole punch the youngest, "unfolded" leaf tip. An unfolded leaf tip is one that has bent away from the "spindle" of younger, vertical leaves. The leaf tip must unfold 45 degrees, not the entire leaf, to be an "unfolded leaf."

3. Starting with the bottom leaves, count all unfolded leaves, up to and including the leaf tip marked in #2. This is the number of unfolded leaves.

4. Now, count the remaining, small leaves ("leaves to unfold"). It will be necessary to use a needle and dissecting microscope of a good hand lens. Continue counting all leaves until the growing point is reached. Tiny buds should be visible. If buds are not present, then the plant is still vegetative and the leaf count should be disregarded. If other plants are also vegetative, wait a few days, and repeat the procedure.

5. Add the number of "unfolded" leaves and "leaves to unfold" to determine the total number of leaves. An example may be as follows:

leaves unfolded:	34
leaves to unfold:	58
total leaves:	92

6. Repeat this for several other plants in each lot, and average the numbers together. These numbers (especially the number of young, folded leaves) are the basis of the leaf counting procedure.

Timing with leaf counting.

Once the number of leaves to be unfolded is determined, the degree of forcing difficulty is established. With many leaves to be unfolded, average forcing temperatures must be higher. To determine correct temperatures to use, count back the number of weeks from Easter that buds should be visible. This is usually 5 to 6 weeks before marketing since it takes 6 weeks to bring a plant into flower from the visible bud stage at 60F night temperature. Once the VB date is established, determine the number of days between the VB date and the date of leaf counting. This is the number of days available to unfold the remaining leaves (as determined in step 4, above). Suppose that leaf counts were made on Jan 20, and the desired date of VB is February 26, allowing 37 days to unfold the remaining leaves. From the example above, there are 58 leaves to unfold. Therefore, to have visible bud (i.e. all leaves unfolded) by February 26: 58 leaves/7 days = 1.6 leaves per day (on average) must be unfolded between Jan 20 and Feb. 26.

To monitor the rate of leaf unfolding, flag 5 to 6 average plants in the greenhouse. With a pen or a hole punch, mark the last unfolded leaf, then count the number of leaves unfolded on the same plant. Record this number. At regular intervals (perhaps every 3 to 5 days) count the number of leaves that have unfolded since the last count. Marking the last unfolded leaf each time makes counting easier. Do not disturb the plants any more than necessary. Mechanical stress reduces growth, and can foul up graphical tracks. Dividing the number of newly unfolded leaves by the number of days gives the daily rate of leaf unfolding since the last count. If the unfolding rate is greater than the required rate, then greenhouse temperatures may be lowered slightly, and vice-versa. **It's critical that immediately after flower initiation has started leaf counting and temperature manipulation must begin immediately after flower initiation has started.** Small temperature increases over a long time period are very effective in increasing the rate of lily development, but short pulses of high temperature are nearly useless and probably detrimental to quality.

Visible bud to flowering.

Easter lily buds flower in 4 to 6 weeks after visible bud, depending on temperature. An average daily temperature of 60F will flower a bud in about 6 weeks, higher temperatures will force the bud faster. Bud sticks are available that help monitor bud development with temperature, and are available through your broker. Buds can be flowered in as little as 4 weeks with even warmer temperatures, but postharvest quality is likely to suffer.

Fertilization.

Lilies are moderate to heavy feeders, and pre-plant fertilizer incorporation of 1 lb. 12-12-12 or similar fertilizer per yard is suggested as a starting point. Low nutrition early in the crop will reduce final plant quality. The best growth comes with a program of both soil-incorporated and regular liquid fertilization of at least 200-300 ppm N. Go higher (400-600 ppm or more) if necessary. **Strongly consider top dressing with nitroform (urea formaldehydre) for additional nitrogen during cold, wet days of early February through mid-March.** If possible, use calcium nitrate as the sole nitrogen source after buds are 0.5 in. long. The extra calcium is important to healthy roots, to bud growth, and for reducing fluoride-induced leaf scorch.

Our work at Clemson indicates that leaf N concentration is much lower in bottom leaves, even in well grown plants. Since lower leaf loss is closely linked to nitrogen loss, close attention to nitrogen fertility is essential!

Finally, watch soluble salts! They come from the growing medium and incorporated fertilizer, from liquid fertilization, and from the irrigation water itself. As the soil mix dries out, the remaining salts become increasingly concentrated. Maintain salts less than 3.5 mmho/cm in a saturated paste extract, or 2.0 mmho/cm in a 1:2 (medium:water) extract. If salts rise above these levels, leaching is needed.

Fertilization and post-production quality

Unlike poinsettia and chrysanthemum, lilies should be fertilized up to the time of packing. Because of generally poor watering practices in the average retail outlet and the potential for water stress, it is probably best to leach lilies just before shipping. Clear water irrigation in the last day or two will accomplish this.

Fungicide Drenches

Plants should be given a preventative fungicide treatment within one to three days of planting for control of the root rot complex. Primary organisms involved in this very serious disease are *Rhizoctonia, Pythium,* and *Fusarium.* Fungicides effective against Pythium and Rhizoctonia must be rotated for effective control, and to avoid plant injury (see below).

At potting:

Terraclor (4 oz/100 gal) and Subdue (° oz/100 gal)

At monthly intervals,

use a mixture of one each from Group 1 and Group 2 below. During alternate months, Banrot 40 WP may be used, by itself, at 6-12 oz/100gal. Banrot has activity against both Rhizoctonia and Pythium.

Group 1 (*Pythium* control)

Banol 65 EC	20oz/100gal
Truban 30 WP	3-10 oz/100gal
Truban 25 EC	4-8 oz/100gal
Terrazole 35 WP	3-10 oz/100gal
Terrazole 25 EC	4-8 oz/100gal

Group 2 (*Rhizoctonia* and *Fusarium* control)

Cleary's 3336-F	1.5 pt/100gal

Height Control

Perhaps the most common causes of excessively tall lilies is low light levels in the greenhouse early in the crop, and uncontrolled high day temperature during sunny periods starting in early March.

A-Rest drenches at 0.25 mg active ingredient per pot are commonly used. In the low light areas of the country where crops are usually tall, two or three A-Rest drenches totaling up to 1 mg may be necessary. Other growers prefer multiple sprays (25-50ppm) resulting in small increases of height control over a longer time period. Growing media with a significant break percentage will absorb A-Rest and make it unavailable for uptake by the plant.

Sumagic. A suggested starting range for Sumagic soil drenches is 0.05-0.15 mg a.i. per pot. Starting ranges for Sumagic sprays are 4-10 ppm, with an application volume of 1 gallon/200sq. ft. bench area. This volume of spray over a certain square footage is very important as Sumagic is absorbed through the stem and roots. A uniform spray is critical for uniform response. **The label rate of up to 30 ppm is way too high for most areas of the country!! Over treatment with Sumagic will lead to highly stunted, unmarkable plants.** *Measure* the height of your crops; keep track of the height on semi-weekly basis to become more familiar with the growth pattern of the crop. Incorporate this into graphical tracking procedures.

Both A-Rest and Sumagic can contribute to gradual and post-harvest leaf yellowing. Drenches are more harmful than sprays.

Photoperiod. Lilies elongate under "long days." Conversely, black clothing 1 hour before sunset, presumably to eliminate the pulse of far-red light at the end of the day that causes stretching, is highly effective for height control.

Negative DIF. Negative DIF is very effective for Easter lilies. Greater height restriction is seen with a greater difference between day and night temperature, i.e., for a given day temperature the warmer the night, the shorter the plants. Most DIF effect is seen in the period just before sunrise, so many growers use a pre-dawn temperature drop later in the spring when it is more difficult to keep daytime temperatures low. Problems are that strong negative DIFs dramatically reduce plant carbohydrate levels and reduce leaf nitrogen level, and appear to have an influence on "catastrophic leaf yellowing" after cold storage before shipping. Focus on maintaining a zero or only slightly negative DIF at the average temperature you need for leaf unfolding. Uncontrolled, high day temperatures late in the crop will stretch the plants. Keep the plants short to begin with.

Lower leaf yellowing and senescence in the greenhouse is due to nitrogen deficiency, root rot, and plant "stress" resulting from high growth regulator applications, large negative DIFs or high temperature forcing. Maintain a fungicide drench schedule throughout production.

Top dressing with urea formaldehyde (nitroform, ° teaspoon in mid-January and mid-February) provides slow release nitrogen during dark weather when liquid feed is impractical. The newest strategy is Promalin or Accel sprays only on the lower foliage at 50-100 ppm. These chemicals are a mixture of benzyl adenine (a cytokinin) and gibberellin A4+A7. Promalin is a 1:1 ratio of BA to GA, and Accel is a 10:1 (BA:GA) ratio. Only lower leaves should be sprayed, or else stretching will result. The chemicals are not mobile in the plants, so complete coverage of the lower leaves is essential. As mentioned above, Promalin is great on Stargazer for minimizing post-cold storage chlorosis as well.

Graphical Tracks

Everyone should be using graphical tracks for height management. They are easy to prepare if you don't have access to specialized crop management software: 1) determine maximum and minimum final height, 2) determine desired visible bud date, 3) note emergence date, 4) since plant height at visible bud is ° the height at flowering, divide them min and max plant height at flowering by 2 to get min and max visible bud height points, 5) plot all this on graph paper with time on the bottom axis, being sure that you only divide the plant height by 2, not the total plant plus pot height!

Cold Storage of Budded Plants

One week or less of cold storage usually has little or no adverse effect only longevity after storage. With three weeks of storage, many buds will not open, those that do open will have poor keeping quality, and overall plant quality will be greatly reduced. Keep foliage dry to reduce Botrytis, a fungicide may be used before plants are put in the cooler.

Since dark-stored lilies no longer photosynthesize, leaf senescence and reduced flower longevity may be due to carbohydrate depletion. Respiration, a carbohydrate-consuming process, continues in darkness, and increases with higher temperature. Thus, carbohydrate depletion is much greater at higher temperatures. We have found that 1 or more weeks of 40F storage reduces plant carbohydrate as much as 4 days of 70F ("normal" shipping conditions). With 'Stargazer', we found that whole-plant Promalin sprays at 100 ppm applied 4-8 hours before placing plants in the cooler are highly effective in reducing post-storage leaf problems. Finally, remove plants in the evening to reduce physiological wilting.

Physolological and Other Disorders

Bud abortion and bud blasting can be caused by many types of stress, including high temperature, dark weather, root loss, extreme over watering or poorly drained soils, and ethylene. The main key is to reduce plant stress and minimize high temperatures early in the crop. Carefully avoid ethylene sources by checking heaters and burner vents. Chronic, low levels of ethylene cause stunted growth on Easter lilies. Have an ethylene test done if problems are suspected.

Subdue injury. A chalky white leaf tip is indication of Subdue injury. Be sure to not exceed label rates for Subdue, as lilies are very susceptible to it.

Floppy Stems. In the "old days" Phosphon-D, the original growth regulator effective on lilies, was implicated with "floppy stems." Current problems being seen are thought to be linked to growth regulators in combination with negative DIF. Indeed, the Sumagic label specifically prohibits using Sumagic in a negative DIF environment, although this is due to concern of overly stunted plants, and not to any known interaction of negative DIF and Sumagic causing floppy stems. The true cause is still unknown.