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78 Years of Service **2011-2012 Season**

Easter Lily Production

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Special Points of Interest:

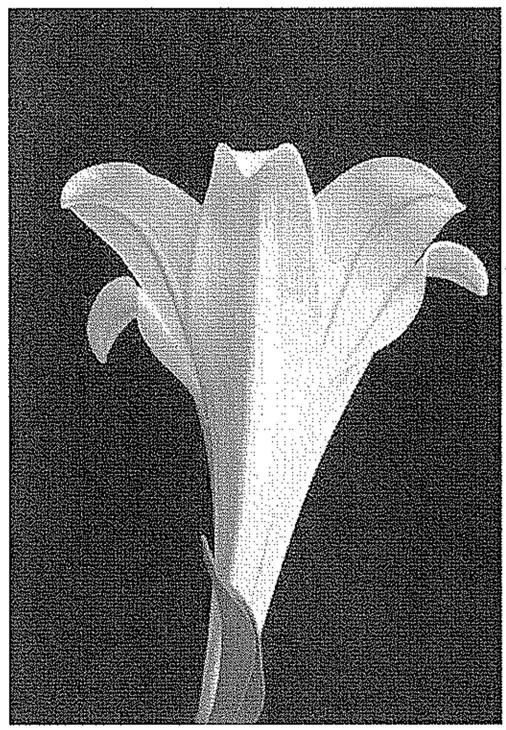
- Comprehensive Easter Lily Production Guide
- Updated USDA sales data
- Production Quick Sheets
- Easter Lily Crop Log
- Fascination Information!
- Easter Lily Bud Meter

EASTER SUNDAY IS April 8, 2012

Inside this issue:

I. Introduction:

The commercial Easter lily (*Lilium longiflorum* Thunberg 1794) is one of the most important flowering potted plants in North America. Easter Lily sales have fluctuated slightly the last few years. In the 15 states that reported sales to the USDA, total numbers of pots sold increased from 2008 to 2009 from 5.85 million to 6.25 million, respectively. Michigan led the survey reporting 1.5 million pots sold. California was second, reporting 844,00 pots sold. Other states reporting to the survey were, FL, IL, MD, NJ, NC, OH, PA, SC, and TX. 2009 reflects a decrease compared to the number sold in 2008 of 6.63 million pots. From 2008 to 2009, total wholesale value increased from $25.3 million to $27.3 million, respectively. 2009 reflects an increase in the total wholesale value from $26.9 million in 2007, even though the number of pots sold declined in the same period. In 2008 to 2009, the average wholesale price per pot increased from $4.33 to $4.39 per pot. 2009 reflects an increase from $4.06 per pot in 2007.



II. Background

The Easter lily is indigenous to the Japanese islands of Ryukyu, Okinawa, Oshima, Takeshima and Kawanabe. In its' native environment the Easter lily grows in humus deposits on coral rocks near the shore.

The Easter lily is a member of the Liliaceae family. Flowers are borne on a terminal inflorescence.

The Easter lily first arrived in England in 1819. Popularity of the crop increased substantially resulting in the development of a commercial lily industry. Early commercial bulb production started on the Bermuda islands until the industry was devastated by viral diseases. Commercial bulb production then occurred in Japan (26 million bulbs per year) until World War II.

Since World War II, commercial bulb production has centered in the United States along a small geographic region of southern Oregon and northern California along the Pacific coast.

The commercial importance of the Easter lily has led to considerable breeding and/or selections. Initial Easter lily cultivars were 'Creole', 'Croft', and 'Estate'. Clark Slocum selected 'Slocum's Ace' (often called just 'Ace') at Langlois in 1935. Ace was the predominant potted plant cultivar in North America during the 1960's—1970's. The cultivar 'Nellie White' is currently (1980's—present) the primary Easter lily grown for potted plant use in North America.

In Europe, cultivars of *L. longiflorum* are grown for cut flower production. Specifically, the cultivars 'White Heaven', 'White Elegance', and 'Snow Queen' are grown as cut flowers. Except for England, few *L. longiflorum* are grown as potted plants.

III. Marketing Period:

Easter lilies are marketed for the Easter holiday season (usually during the week immediately prior to Easter). In general, plants are sold, developmentally, 1 day before the first flower bud opens ("puffy bud stage").

The finished stage at which plants are shipped varies with the intended market. Wholesale producers typically ship plants 1-2 weeks prior to Easter Sunday. In contrast, retail producers flower Easter lilies the week immediately prior to Easter. Schedules in a later section reflect differences in production dates based on forcer type.

Easter Sunday is the first Sunday after the first full moon after the vernal equinox (March 21). Dates for Easter Sunday from 2012-2014 are shown in Table 1.

Table 1. Dates of Easter Sunday from the 2011-2012 season to the 2013-2014 season.

Year	Western	Orthodox
2012	April 8	April 15
2013	March 31	May 5
2014	April 20	April 20

"Easter Sunday is April 8th, 2012."

IV. Cultivars:

The primary potted Easter lily cultivar grown commercially today is 'Nellie White'. Numerous new cultivars have been evaluated yet, none have replaced 'Nellie White'. There are a few numbered cultivars under evaluation, now, that have shown the ability to produce a higher bud count from a smaller bulb circumference.

V. Propagation:

The Easter lily is propagated asexually by scale bulblets from selected 'mother' block propagation stock at the end of September. Two to three years are required to produce a commercial size bulb from a scale bulblet.

Commercial bulbs are harvested in late September and early October for October shipping. Harvested bulbs are sorted into four groups based on bulb circumference in North America: 7/8 (150 per case), 8/9 (125 per case), 9/10 (100 per case), and 10+ (75 per case). Bulbs are packed in a moist peat for shipping. Shipping and storage temperatures should be maintained between 62-65°F before potting. Bulbs should be potted as soon as possible after being shipped to the forcer.

Bulb size affects final plant appearance. Final leaf and flower number increase as bulb size increases from 7/8 to 9/10 bulb grades.

VI. Flower Induction:

Easter lily flowering can be induced by providing an appropriate daylength. Easter lilies are photoperiodically classified as 'long-day plants'. In other words, longer days than nights stimulate flower induction. Easter lilies naturally flower in August in their native habitat.

The long-day requirement for flower induction can be overcome by providing bulbs with a cool and moist treatment similar to a 'vernalization' treatment. Commercial forcing of Easter lilies for Easter is achieved by cooling bulbs for 6 weeks (1000 hrs.) at 42°F. The primary advantages of cooling bulbs versus providing plants with long-day conditions include:

1) Less stem elongation
2) More uniform emergence and leaf number
3) Lower greenhouse space requirement during the poinsettia production period

VII. Cooling/Vernalization Treatment:

It is critical that media around

bulbs be moist during cooling (vernalization) for flower induction to occur. A bulb can only perceive the cooling treatment if it is in moist media.

Bulbs are vernalized at any temperature below approximately 65°F. The optimal temperature for vernalizing Easter lilies is 42°F. Complete flower induction is generally achieved at optimal temperatures (42°F) in 6 weeks (1000 hrs). As temperatures vary (warmer or cooler) from 42°F, the length of time required for complete flower induction increases.

Shipping or holding bulbs at temperatures below 62-65°F can result in 'overcooled' bulbs if bulbs are mature at the time of shipping and if the bulbs receive a 6 week cooling treatment. It is for this reason that bulbs should be shipped and held at 62-65°F to minimize cooling during shipping. Shipping at warmer temperatures can encourage early shoot emergence prior to cooling.

In general, flower induction of Easter lilies is complete after 4 weeks of cooling if bulbs are mature. It is recommended to cool bulbs for 6 weeks to insure that an entire population of bulbs is completely induced since bulb maturity varies within a population and bulb maturity varies from year to year. There is some benefit to cooling bulbs less than 6 weeks if the bulb population is suspected of being mature upon arrival. For instance, flower and leaf number are greater when bulbs are cooled for less than 6 weeks.

In addition to its effects on flower induction, the vernalization treatment affects other aspects of Easter lily morphology and development. Specifically, as cooling treatment length increases: (Figure 1)

1) Shoot emergence occurs earlier

2) Shoot emergence is more uniform

3) Time from shoot emergence until flowering decreases

4) Leaf number decreases

5) Leaf length at the base of the plant decreases

6) Internode length increases

7) Flower number decreases

VIII. Commercial Cooling Methods:

Easter lilies are commercially vernalized using either of these

Figure 1. Effects of the length of the cooling treatment on several developmental and morphological characteristics of *L. longiflorum* Thunb. 'Ace'. Responses are similar for 'Nellie White'.

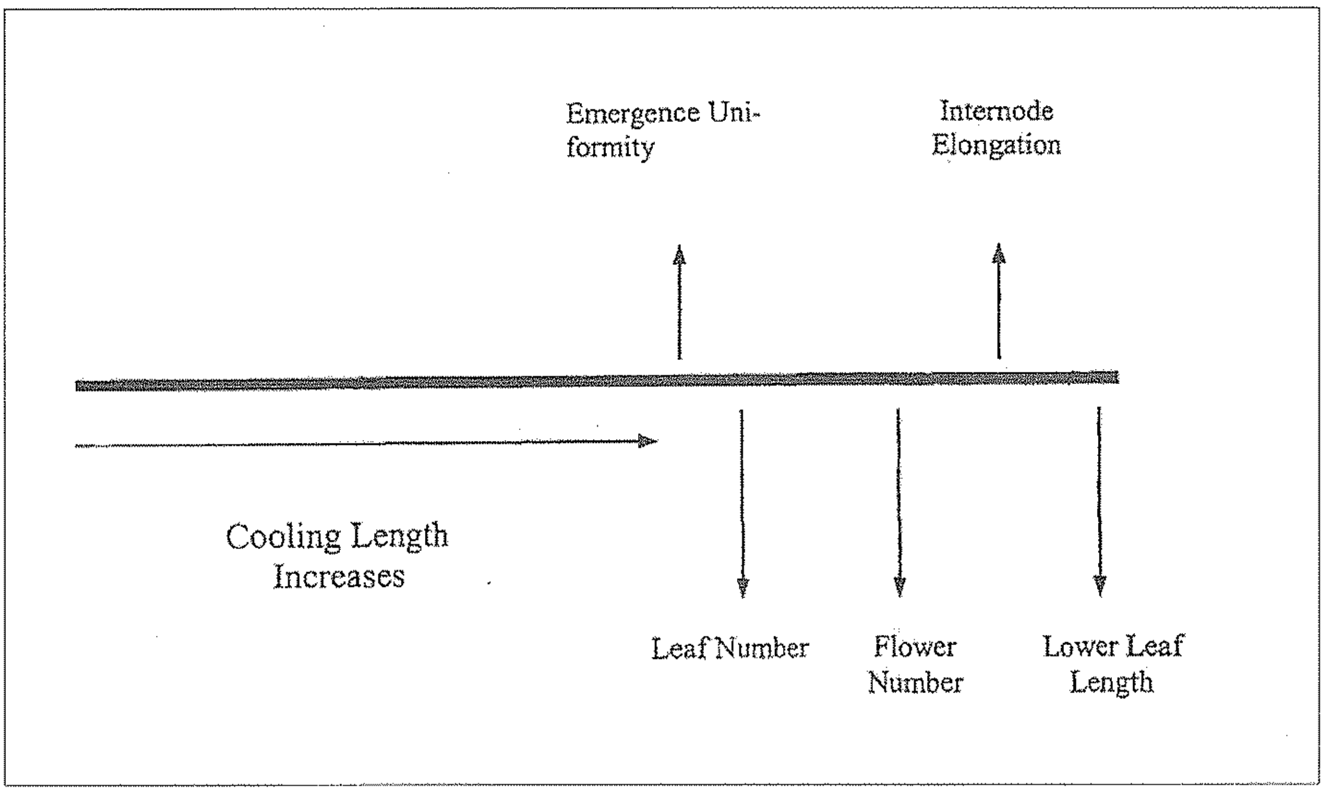


Table 3. Nutrient standards for Easter lily media.

Nutrient	Spurway	Saturated Paste
pH	6.0-6.8	6.0-6.8
Soluble Salts (EC)	<160	<2.5
Nitrates (NO3)	150-250	150-250
Ammonium (NH4)	2-7	2-7
Phosphorus (P)	5-10	15-20
Potassium (K)	50-80	90-120
Calcium (Ca)	125-175	120-140
Magnesium (Mg)	30-40	40-70
Iron (Fe)	0.25	0.25
Manganese (Mn)	0.25	0.25
Zinc (Zn)	0.25	0.25
Boron (B)	0.25	0.25

three cooling techniques:

1) Natural Cooling
2) Controlled Temperature Forcing (CTF)
3) Case Cooling

Natural and CTF cooling occur after the bulb is planted in a pot. Case Cooling occurs in the shipping case prior to potting. Case Cooling is often conducted by the broker (bulb supplier).

The appearance of a finished Easter lily differs depending on the method of cooling used. Easter lilies forced from naturally cooled bulbs generally have the highest leaf and flower number when compared to plants cooled using other cooling methods. Easter lilies produced from bulbs cooled using CTF generally have a lower flower and leaf number than naturally cooled bulbs. Easter lilies produced from case cooled bulbs have the lowest flower and leaf number and shorter lower leaves compared to natural or CTF cooled bulbs. The reduced lower leaf length is likely due to early water stress on the emerging shoots before a well developed root system is present.

Natural and CTF cooling methods require the greatest amount of cooling space. Potting and rooting of bulbs can use time and greenhouse space not available in October when a poinsettia crop may be present. Therefore, some forcers case cool bulbs to reduce early space requirements even though final plant quality is sacrificed. In some instances, case cooled bulbs can sprout before being planted. Refer to the section on the 'Most Common Problems' on pages 14-15 for how to address this problem if it occurs.

IX. Media:

Easter lilies are prone to root rot disease infestations (*Rhizoctonia, Phytophthora* and *Pythium*). Both of these organisms are classified as 'water molds', i.e. they proliferate in continuously wet/moist environments. Because of this, an aerated, loose media is generally preferred to a heavier, less aerated media to limit the potential for root rot infestation. Most forcers grow Easter lilies in a soilless media that is sphagnum peat-based. Some forcers add sterilized soil to their media. The benefits of adding soil to a peat-based media include:

1)Media ability to retain nutrients (cation exchange Capacity), CEC, increases compared to soilless media.

2) Media capillary action is greater, thus, facilitating watering using sub irrigation techniques.

Table 2. Amount of acid (milliliters acid to be added per gallon of water) to neutralize a single bicarbonate of $CaCO_3$ equivalent. Example: Water alkalinity is 280 meq $CaCO_3$. Adjust 100 gallons of water to desired 120 meq $CaCO_3$ by adding (160 (280-120 meq $CaCO_3$) X 0.0037 (85% Phosphoric acid) X 100 (gallons of water to adjust)) = 59.2 milliliters (2.1 ounces) of 85% phosphoric acid per 100 gallons water.

Acid	Milliliters/gallon/milliequivalent $CaCO_3$
Phosphoric (75%)	0.0041
Phosphoric (85%)	0.0037
Sulfuric (93%)	0.0019
Nitric (61%)	0.0062

3) Media is more buffered. In other words, the media is more resistant to rapid changes in pH over time.
Disadvantages to adding soil to soilless media are:
1) The media has less air space increasing the potential for root rot infestation
2) Media weight increases
3) Ammonium may increase to toxic levels when ammonium based fertilizers are used

At no time should perlite be included in an Easter lily media. Perlite contains fluoride. In addition, superphosphate should not be added to the media since it also contains fluoride. High fluoride is associated with 'leaf tip burn' on Easter lilies. However, the incidence of tip burn has greatly decreased now that growers force the cultivar 'Nellie White'. In any case, an initial media pH of 6.0-6.8 is desirable.

Two newer medias that show promise for Easter lily production are coir (coconut hulls) and rice hulls. Both of these media have produced equal or superior crops compared to many existing commercial media. In addition, rice hulls can often be purchased more economically than sphagnum peat. In general, coir or rice hulls are blended with 50-60% sphagnum peat moss to produce a commercial grade media. Both of these materials have greater water holding capacity than most peat-based media. Therefore, you will need to water less if you are used to growing in typical sphagnum-based media.

X. Irrigation Water:

Easter lilies should be watered only when media begins to dry out. Continuously moist media will encourage root rot infestation.

Irrigation water should be as 'clean' as possible. Alkalinity should be adjusted to 120 meq $CaCO_3$ to limit the ability of irrigation water to alter media pH. Most ground water has an alkalinity that is higher than 120 meq $CaCO_3$. Reduce irrigation water alkalinity using the method described in Table 2. Most forcers use regular injection of sulfuric acid to alter water alkalinity. Regular use of phosphoric acid can result in excessive phosphorus in the media resulting in inhibition of some micronutrients. Nitric acid is used by some growers who irrigate using sub irrigation systems.

XI. Nutrition:

Media nutrition standards for Easter lily production are shown in Table 3. In general, Easter lilies are a relatively 'low feed' requiring crop. Because of this, a 150-0-150 or a 200-0-200 ppm (N-P-K) fertilizer regime applied through the irrigation solution on a continuous basis is recommended when an initial charge of P has been added. Alternatively, an application of 300-400 ppm N could be applied every other watering.

Often forcers 'under feed' a lily crop early in development. Under feeding early in development reduces final leaf size (especially lower leaves) dramatically. For this reason, we recommend that the first fertilizer application be at a higher level to increase media nutrition to recommended levels as early as possible. Apply 400-600 ppm nitrogen (N) using a balanced fertilizer immediately after removing induced bulbs from the cooling environment. In addition, a single application of a 'starter' fertilizer early in development will often increase phosphorus (P) to the recommended level. Use fertilizers low in ammonium nitrate, i.e. high in calcium/magnesium nitrate, when growing an Easter lily crop in cool/low light environments to limit the potential for ammonium toxicity. Have a water test done to determine which high nitrate calcium/magnesium fertilizer is best for your water.

Media electrical conductivity (EC) or soluble salts should be low. A high EC 3.5 dS/m (saturated media extract) or 2.0 dS/m (2:1 water:media sample) will increase the potential for root rot infestation by damaging

Table 4. Tissue test standards for nutrient levels in Easter lily leaves.

Nutrient	Acceptable
Nitrogen (%)	2.4—4.0
Phosphorus (%)	0.1—0.7
Potassium (%)	2.0—5.0
Calcium (%)	0.2—4.0
Magnesium (%)	0.3—2.0
Iron (ppm)	100-250
Manganese (ppm)	50-250
Zinc (ppm)	30-70
Copper (ppm)	5-25
Boron (ppm)	20-50

(burning) root tips and providing a 'point of entry' for these diseases.

Test media fertility at least twice each month to insure nutrient and salts levels are in the desired range. If serious problems are suspected a tissue test may also be helpful in defining and solving a nutritional problem. Remember to tissue test only those leaves that are expressing symptoms. Recommended tissue nutrient levels are shown in Table 4.

XII. Height Control:

Easter lily stem elongation can be controlled using day/night temperature regimes or chemical growth retardants. Easter lily stem elongation increases as day temperature increases relative to night temperature. In other other words, as the difference (DIF) between day and night temperature (day temp.-night temp.=DIF) increases, so does stem elongation.

Easter lilies are most sensitive to temperature when stem elongation is occurring most rapidly. Plant stem elongation is most rapid during the end of the night and beginning of the day. A significant amount of the stem elongation can be reduced if temperatures are reduced 5-10°F at the end of the night and the beginning of

Table 5. Recommended growth retardant rates for height control of Easter Lily.

Growth Regulator	Application Rate
A-Rest	Spray: 50 ppm (24.2 fl oz A-Rest/gallon water) Drench– 0.25-0.5 mg active ingredient per pot (50-100 fl oz A-Rest/50 gallons water = drench solution). Apply 4 fl oz/6" pot.
Sumagic	Spray: 3—15 ppm (0.8—3.8 fl oz Sumagic/gallon water). Spray 2 quarts/100 sq. ft. Drench: 0.23-0.5 ppm (0.6-1.3 fl oz Sumagic/10 gallons water = drench solution). Apply 4 fl oz/6" pot.

In contrast, if temperatures are increased during the first 3-4 hours of the day, stem elongahours of the day, stem elongation is increased.

The response of stem elongation to day/night temperature (DIF) increases as:

1) Day length decreases

2) Light intensity during the day increases

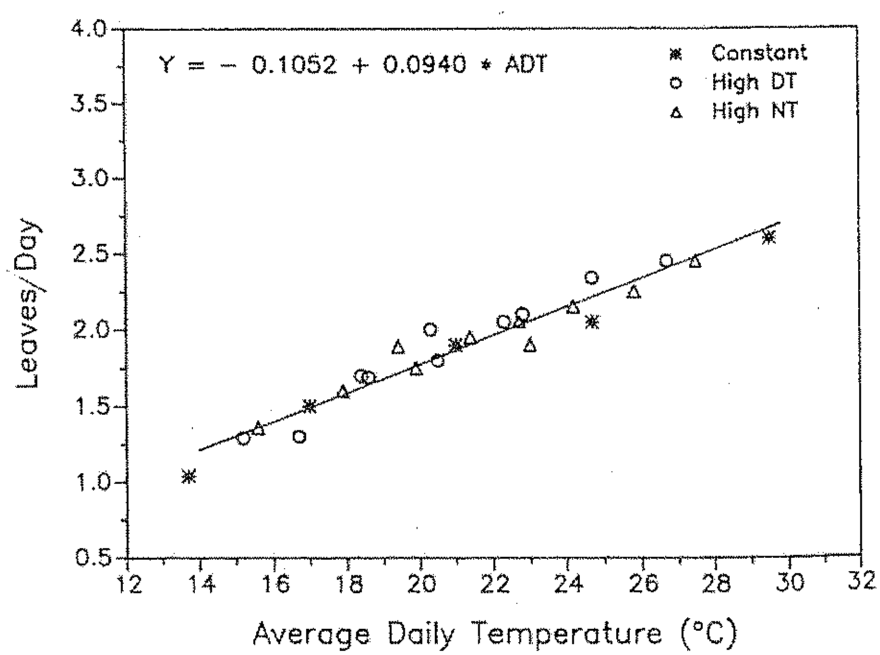
3) The closer to first daylight the temperature is changed

4) The degree in which the temperature is changed between day and night

5) The more plants are spaced

The chemical growth retardants A-Rest and

Figure 2. Effect of increasing average daily temperature on the rate of leaf unfolding of *Lilium longiflorum* Thunb. cv 'Nellie White'.



Sumagic are effective in limiting Easter lily stem elongation. Chemical drench applications are more effective than spray applications (at least twice as effective). However, most forcers spray plants since drenching plants is time consuming and labor costs often exceed the benefit of the increased effectiveness of the chemical. Also, drenching plants relinquishes some of the day to day control that a grower has over stem elongation seen with regular spray applications.

Application of either growth retardant can encourage increased lower leaf drop late in development (March-April) and/or reduced flower number if applied too early, i.e. before flower initiation (last week of January). For this reason temperature control of stem elongation is preferable to chemical control.

The effective rates for both A-Rest and Sumagic are relatively low in concentration. It is critical that the appropriate amount of material be applied! You will require approximately 2 quarts of spray solution to treat 100 sq. ft.

Recommended rates and amounts of growth retardants for spray applications are shown in Table 5.

The most effective way to monitor the rate of stem elongation over time is to use a tool called 'graphical tracking'. Graphical tracking utilizes key target heights at specific stages in lily development to produce a target graph. There is an example of a 'graphical track' for the 2011-2012 Easter Lily crop shown in Figure 3.

XIII. Rate of Development:

The rate of Easter lily development is quantified (measured) by monitoring the rate of leaf unfolding. A leaf is defined as 'unfolded' if the angle between the leaf and the stem is ≥ 45°. When temperatures are in between 50° and 86°F, the rate of Easter lily leaf unfolding is dependent on the average daily temperature plants are grown. Specifically, the rate of leaf unfolding increases linearly as the average daily temperature plants are grown increases from 50° to 86°F (Figure 2).

All the leaves must be unfolded on an Easter lily crop by the specified date of 'visible bud' if a crop is to be on time. 'Visible bud' date is that date when you are able to look down at a plant from above and see flower buds without physically moving any leaves.

Since temperatures are relatively 'set' prior to flower initiation (last week of January) and temperatures after visible bud do not affect the rate of development greatly, timing on an Easter lily crop is primarily dependent on crop temperatures between flower initiation (last week of January) and visible bud. The typical time from visible bud until flower is 32 days. It is very important to realize that the least number of days between visible bud and flowering is 24 days (plants grown at constant 86°F). Therefore, if you have plants that have not reached visible bud 24 days prior to Easter, you should either throw the plants away to save space or grow them for sale for the Orthodox Easter! Either way, the remaining crop should be sorted so it can be treated as one population.

XIV. Light:

Light Intensity (Irradiance):

Light provides the energy necessary for growth through driving photosynthesis. In general, Easter lily plant height increases and flower number and mass decrease as light intensity decreases.

Light intensity (irradiance) does not affect the rate of plant development. People often believe that their plants are developing faster under sunny conditions. The increased rate of development is due to sunlight heating the plant and raising the temperature rather than a direct effect of light on the rate of development.

> "Control lily height first by minimizing DIF."

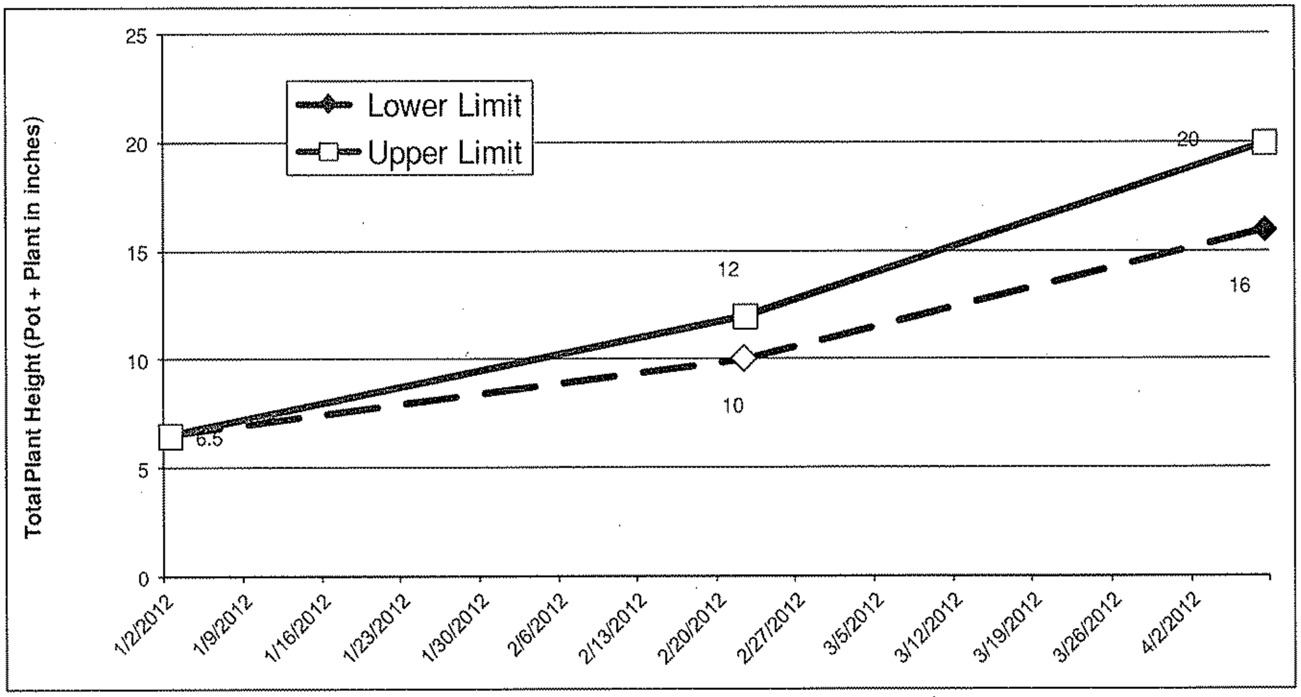
However, the period when irradiance is most critical for Easter lily development is from the visible bud stage until flowering (anthesis). During this time, the plant requires increased carbohydrates for flower bud development. The time from visible bud until flowering is also the time when plants are most crowded on a bench resulting in plant to plant shading. Low light/crowding that results in carbohydrate stress will result in lower leaf and flower bud loss.

It is for this reason that it is recommend to space Easter lilies as much as possible from the visible bud stage until flower.

Fascination Application:

Apply Fascination to lower leaves immediately prior to and after the visible bud date to prevent and/or delay lower leaf loss (Table 7). In addition, a late season application of Fascination (when the flower bud is greater than 8 cm in length) can be done to prolong flowering and reduce leaf yellowing during shipping. Do not apply more than 14 days before placing lilies in the cooler or before shipping.

Figure 3. Example graphical track for a typical Easter lily crop for the 2011-2012 production year.



Notes:

Light Color:

Light color affects Easter lily morphology, or how the plant looks. Light color does not affect how fast the plant develops.

Stem and leaf elongation increase as the proportion of red:far red light decreases. The proportion of red:far red light decreases as plants become more crowded on a bench or when plants are grown below a canopy, i.e. hanging baskets. Additionally, exposing a crop to incandescent lights will increase stem elongation by decreasing the red:far red ratio that plants are exposed to.

XV. Root Rot Management:

Root rot is a 'disease complex' of *Pythium*, *Phytophthora* and/or *Rhizoctonia* spp. that attack and damage roots. All these fungi are water borne organisms that require moist media to proliferate. They spread through the water, by splashing, or by fungus gnats.

Assuming that sterile media is used initially, the cultural management technique that most controls root rot is to allow media to 'dry out' slightly before plants are watered again.

Root rots can also be controlled with chemical fungicides. For instance, Subdue and Banrot are effective in controlling *Pythium* and *Phytophthora* spp. Subdue is the more effective material to control *Pythium*. Cleary's 3336, Banrot, Chipco 26019 and Terraclor are effective in controlling *Rhizoctonia*. Terraclor and Cleary's 3336 are the most effective. In order to control all fungi, fungicides that control **all** fungi must be applied regularly. Apply fungicides each month as a preventative if root rot is a common problem in your facility. Unfortunately, there is evidence for *Pythium* and *Phytophthora* resis-

Table 6. Some materials available for control of different pests on an Easter lily crop. Always check label for suggested rates of use and whether a material is registered for use in your state!

Pesticide	Rate	Aphid	Spider Mites	Thrips
Akari			X	
Aria		X		
Avid	4-8 oz. per 100 gal.	X	X	X
Botanigard 11.3EC	16-64 oz. per 100 gal.	X		X
Celero		X		
Conserve SC	6-22 oz. per 100 gal.			X
Distance	6-12 oz. per 100 gal.			
Endeavor	2.5—5 oz. per 100 gal.	X		
Flagship		X		
Floramite	1 oz. = 1 water soluble bag		X	
Insecticidal Soap 49.5 EC	1-2 gal. per 100 gal.	X		
Marathon II	1.7 oz per 100 gal.	X		
Mesurol	8-16 oz. per 100 gal.			X
Ornazin		X	X	X
Ovation			X	
Pedestal				X
Pylon	2.6-5.2 oz. per 100 gal.		X	
Sanmite WP	4 oz. per 100 gal.		X	
Shuttle			X	
Talstar GH	8-20 oz. per 100 gal.			
Tame		X		
TetraSan			X	
TriStar		X	X	X

tance to Subdue. Do not create your own resistance by applying the same fungicide over and over again—make sure you alternate with fungicides from different families. In addition, there is no documented case of Truban resistance, therefore, always have Truban in your rotation! Fungicide application rates are shown in Table 8.

XVI. Insect Management:

Bulb Mites: The bulb mite (*Rhizoglyphus robini*) can severely damage a lily bulb during development.

Symptoms of bulb mite damage include:

A) Visual presence of mites (magnifying glass required)
B) General stunting of plant growth (reduced height and leaf area)
C) Flower bud abortion
D) Bulb damage (brown areas that are soft)

The rate of mite development is proportional to the temperature bulbs are grown. Mite population increases as media temperature increases.

Control bulb mites by soaking bulbs in a miticide (Kelthane (8oz/100 gallons water) for 10-15 minutes prior to planting. Alternatively, you can drench planted bulbs with a miticide rather than soaking.

If you no longer have a supply of Kelthane on hand, this product may be very difficult to find because it is no longer being manufactured. While many alternative products, such as Cinnimite and others, are currently being tested at the Easter Lily Research Station, there has not been enough data collected to register a replacement for Kelthane. However, based on trials from the

Table 8. Some materials registered for use to control disease organisms on an Easter lily crop. Always check the label for exact rates and whether a material is registered for use in your state!

Disease Organism	Material	Rate
Pythium and *Phytophthora*	Subdue MAX	1/2 oz per 100 gallons
	Banrot	8—10 oz/100 gallons
	Alliete/Alude	See label
	Truban 30 WP	3-10 oz/100 gallons
	Plantshield/ Companion	See label
	Stature WP	1 3/4 oz/100 gallons
Rhizoctonia	Cleary's 3336	8 oz/100 gallons
	Banrot	8—10 oz/100 gallons
	Chipco 26019	See label
	Terraclor 75WP	8 oz/100 gallons
	Medallion	1 pkt/50-100 gallons
	Plantshield/ Companion	See label
	Contrast	3-6 oz/100 gallons
Botrytis	Camelot	48 oz/100 gallons
	Chipco 26019	1-2 lb/100 gallons
	Compass	2-4 oz/100 gallons
	Daconil	See label
	Decree 50 WDG	1—1.5 lb/100 gallon
	Medallion	1 pkt/50-100 gallons
	Phyton-27	10-20 oz/100 gallons
	Rhapsody	1 gal/100 gallons
	Spectro 90 WDG	1—2 lb/100 gallons
	Stature WP	1 3/4 lb/100 gallons
Fusarium Bulb Rot	Cleary's 3336	12-16 oz/100 gallons

Table 7. Fascination is used to reduce late lower leaf yellowing on lilies. The table below gives dilutions to prepare Fascination (BA/GA $_{4+7}$) solutions for the lower and higher rate, as well as, as a late season application to extend postharvest life.

Rate	ml Fascination per 10 gallons water
Lower rate (5/5)	11 ml (.4 oz)
Higher rate (10/10)	21 ml (.7 oz)
Late Season (100/100)	210 ml (7.1 oz)

Research Station the most promising alternative for Fall 2011 is to tank mix Avid and Terrachlor. Avid has shown the best efficacy on mites of the products that have been trialed and Terrachlor is believed to interfere with the primary food source of a mite population. Neither of these products are registered for this use.

Aphids: Aphids also infest Easter lilies. Typically, aphid infestations are located on the upper portion of the plant and concentrate on developing leaves and buds. Signs of severe aphid infestation include malformed flower buds and upper leaves and the presence of aphid casings.

Fungus Gnats: Fungus gnats can also attack/infest Easter lilies. Fungus gnat larvae can damage roots and provide a point of entry for root rot organisms. In addition, adult fungus gnats are capable of spreading *Pythium* spores from pot-to-pot through fecal matter. Determine whether you have a fungus gnat infestation by placing 1/2 of a raw potato (cut side down) on the media surface before going home at night. Fungus gnat larvae will move towards and into the potato piece by the next morning. Control of fungus gnat larvae is only really achieved by drenching pots with an insecticide. In contrast to the larvae, adults will need to be controlled using a spray application.

Insects/pests that infest Easter lilies and effective insecticides for each are shown in Table 6.

XVII. Foliar Diseases:

Botrytis (*Botrytis elliptica*) is a fungal disease that can decrease crop quality in a number of ways. In particular, a botrytis infestation can lead to spotting on foliage and flowers. Advanced *Botrytis* infestation results in loss of foliage and flowers. Initial symptoms appear as small faded spots that turn light brown on the leaves and flowers.

Botrytis infestation is encouraged by cool temperatures and high humidity/wet foliage. The *Botrytis* spore requires a moist surface for at least 4 hours to germinate. Therefore, it is critical to make sure that foliage does not stay wet into the evening. Water as early in the day as possible to insure that foliage has an opportunity to dry.

In order for *Botrytis* to occur in any greenhouse, there must be source of spores or the disease. It is imperative that you clean any dead/decaying plant litter in the greenhouse to eliminate a potential source.

Effective fungicides for *Botrytis* control on Easter lilies are shown in Table 8. Because complete spray coverage is difficult, aerosol type fumigants are preferable to spray application.

XVIII. Miscellaneous Physiological Problems:

Flower Bud Abortion: Flower bud abortion is due to either of four possibilities: exposure to ethylene, low light, bulb mite infestation, water stress.

Ethylene is a plant growth regulator associated with stress responses. Ethylene is released by unit heaters when fuel is incompletely combusted, auto exhaust, and ripening of many fruits and vegetables. Early exposure of Easter lilies results in flower bud abortion. Early flower bud abortion is evidenced by vestigial bud scars in the center of the inflorescence. Late exposure to ethylene results in either late bud abortion or bud malformation or splitting. The solutions for low light/water stress are obvious. It is important to understand that bud abortion symptoms can occur weeks after the actual stress has occurred.

Lower Leaf Loss: Lower leaf loss is due to root rot, high soluble salts, water stress, low light. Lower leaf loss results primarily from root loss (root rot and/or high soluble salts) and/or low light conditions. The solutions for root rot and high soluble salts include leaching with a fungicide for control of *Pythium, Phytophthora* and *Rhizoctonia.*

The solutions for lower leaf loss that occurs because of a water stress is obvious—water when needed. Two solutions for lower leaf loss associated with low light are to 1) space plants and/or 2) apply Fascination to your crop. The time when most lower leaf loss occurs is from visible bud stage until flower. Therefore, spacing/Fascination application must occur at visible bud. If you desire to apply Fascination, spray lower leaves of plants 1 week before and one week after the visible bud date with Fascination (see rate recommendations for Fascination in Table 7). Care must be taken to not apply this material to upper leaves or at higher concentrations because undesirable stem elongation can occur.

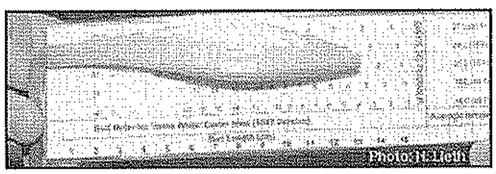
Poor Flower Bud Set: Poor bud set is primarily due to the cooling method that was used, the time bulbs were cooled, too early growth retardant application, and whether plants were stressed or grown at non-optimal conditions between emergence and flower initiation. In general, case cooled lilies will have a reduced bud set compared to CTF or naturally cooled lilies. Overcooled (> 6 weeks) lily bulbs will have reduced flower number as well. Media/air temperature must be maintained between 63-65°F from emergence until flower initiation for optimal bud set. Lastly, growth retardants should not be applied prior to flower initiation if possible.

Reduced Plant/Leaf Size: This problem usually occurs from underfeeding, bulb mite infestation, and/or root rot or high soluble salts. Solutions to these problems are outlined in previous sections.

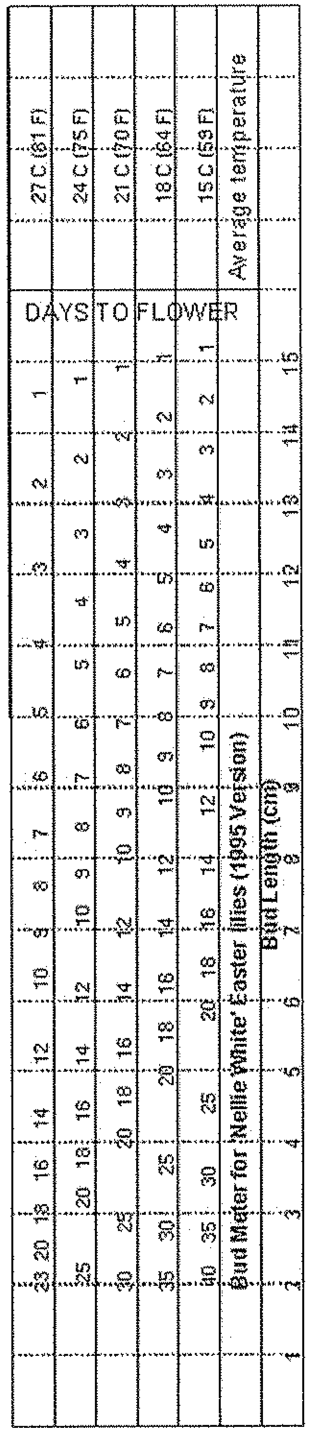
Easter Lily Bud Meter

The Easter lily bud meter was developed to help growers determine how much time will be required before an Easter lily will flower. Place the meter at the base of the flower — not the flower stalk, i.e. where the petal meets the peduncle. Read across to see the number of days required until flowering.

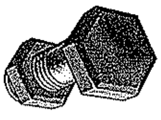
Remember that the least amount of time required from visible bud until flowering is 24 days. In other words, if your crop is not at visible bud 24 days prior to Easter, it will not make it!



Place tapered end of meter at the base of the Easter lily flower bud. Observe where the tip of the bud falls on the meter, which corresponds to the number of days to flower at the specified temperatures (Fisher et al., 1996).



The 'Nuts and Bolts' of Easter Lily Production



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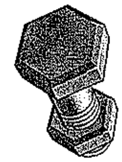

This article outlines the key issues when producing an Easter lily crop. Recommendations are based on experience in working with growers and noticing what works and does not work. Essentially, following the recommendations in this article will take care of almost all of the common issues related to growing this crop.

Prior to Potting:

Upon arrival, open cases and place bulbs in a 65°F environment. If bulbs are placed at temperatures below 60°F and shipping media is moist, bulbs will start the vernalization process prematurely.

Potting Bulbs:

Pot Easter lily bulbs 1 inch from the base of a 'standard' 6-8 inch diameter pot. Drench planted bulbs within 2 weeks with fungicides to control *Pythium* and *Phytophthora* spp. and *Rhizoctonia*. We cycle between a Banrot (8 oz/100 gallons) application one time and a mixture of Cleary's 3336 (8 oz/100 gallons) plus Subdue (1/2 oz/100 gallons) the next time. Unfortunately, there is evidence for *Pythium* and *Phytophthora* resistance to Subdue. Do not create your own resistance by applying the same fungicide over and over again—make sure you alternate with fungicides that have different modes of action. In addition, there is no documented case of Truban resistance, therefore, always have Truban in your rotation! 'Double drench' potted bulbs to insure that the fungicide reaches the base of the pot where the bulb is located. Recently there have been bulb mite outbreaks. Because of this, you may consider drenching with a miticide—remember that none are registered for this use!

Rooting Period:

Place potted bulbs in an environment with a 62-65°F media temperature to optimize root development for 2-3 weeks. Fertilize once with a calcium nitrate based fertilizer at a rate of 400-0-400 ppm (N-P-K) in the irrigation water. Warmer temperatures (>70°F) will decrease rooting. If the shoot emerges from the media, place in a lighted (fluorescent or daylight only) cooler immediately to inhibit further shoot elongation and to initiate the vernalization treatment.

Cooling:

Cool Nellie White Easter lily bulbs in a ventilated environment at 42-44°F for 6 weeks (1000 hours). If bulbs are believed to be mature, bulbs can be cooled for less time to increase bud count. Remember that leaf number will also increase! Monitor temperatures using a soil thermometer to make sure bulbs are at the temperature you think they are!

Bulbs must be in moist media to perceive the cooling treatment. Water bulbs the day before placing them in the cooler and in the cooler if drying occurs. Make sure you place pots in the cooler so they are accessible. Check whether media drying or early sprouting occurs.

If shoots emerge from the media, inhibit further elongation by 1) lighting with daylight or fluorescent lamps (5 μmol $m^{-2} s^{-1}$ (25 footcandles) and/or 2) dropping the temperature for a short period of time (3 days at 36-38°F) periodically. Incandescent lamps will stimulate stem elongation and reduce the effectiveness of the vernalization treatment. Of the two techniques, addition of lights is preferable to temperature dropping.

Post Vernalization to Flower Initiation:

Space potted bulbs 'pot-to-pot' after they are brought out of the cooler. Do not hang plants above an Easter lily crop as it reduces light and increases the proportion of far-red light to red light that the crop receives. High far-red light compared to red content reduces flowering and increases stem elongation.

Drench potted bulbs with fungicides for *Pythium* and *Phytophthora* spp. and *Rhizoctonia* within 3 days after removing from the cooler using the before mentioned materials. The next irrigation should contain 400-600 ppm N and K to raise the media fertility to the recommended nutrient levels as quickly as possible.

Easter lily plants initiate flowers during the last 3 weeks of January. The optimal temperature for flower initiation is 63-65°F. Adjust air temperatures to maintain a 63°F media temperature prior to shoot emergence. After shoot emergence, maintain a 63-65°F air temperature to maintain the shoot tip at the desired temperature.

Do not stress plants in any way during the flower initiation process as flower bud count may decrease. In particular, do not apply chemical growth retardants to control stem elongation, water stress plants or expose plants to excessively high temperatures (>80°F).

Leaf Counting:

Determine the number of leaves

that must unfold before flowering as soon after flower initiation as possible. Specifics of leaf counting are detailed later in this bulletin .

Leaf counting is critical to determine the greenhouse temperatures to grow your crop to insure that it flowers on time. Successfully timing an Easter lily crop is almost entirely dependent on the effective temperature management during the period between flower initiation until visible bud (28-32 days prior to flower); there is little flexibility in timing once a crop reaches the visible bud stage.

Graphical Tracking and Growth Regulators:

An Easter lily crop should be graphically tracked if a desired plant height at flower is necessary or specified by the retailer. Graphical tracking should start when a shoot emerges from the media. A graphical track for the 2010-2011 growing season is shown in the previous article. The only critical information that you need to modify this graph is the date of emergence, desired finishing date, height at flower initiation, height and visible bud and the final desired height.

Do not apply growth regulators unless necessary. Instead, use temperature control. Drop temperatures (about 5-10°F) during the first 4 hours of the day (at dawn). If you have to apply growth retardants, spray A-Rest (25 ppm), or Sumagic (5 ppm) periodically as needed. Remember that application of growth retardants encourages lower leaf yellowing!

Visible Bud to Market:

The period from visible bud to market requires a minimum of 24 days and a maximum of 42 days. In other words, if your plants are not at visible bud 24 days before Easter, you will never make it!

Lower leaf loss occurs during this period and is due to either 1) inadequate light 2) high soluble salts, 3) water stress or 4) root rot. **Therefore, it is imperative that plants are spaced adequately and that they are drenched with fungicides for *Pythium* and *Phytophthora* spp. and *Rhizoctonia* control at visible bud.** It is also critical that there is good air movement within the crop to discourage prolonged periods when media and foliage are moist. Alternatively, consider spraying Fascination (cytokinins) to lower leaves to inhibit lower leaf yellowing 1 week before and again 1 week after visible bud.

Use the Easter lily bud meter (listed in this guide) to determine how many days are required until flowering. Note that the meter should be placed at the base of the bud where the petal meets the pedicel.

The Most Common Problems in Easter Lily Production

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Height Control

Height control on Easter lilies is typically a problem later in the production schedule when 1) day temperatures increase and 2) plants are more crowded. Easter lily height is controlled by either applying a chemical growth retardant (A-Rest or Sumagic) or by reducing the difference (DIF) between day and night temperatures that plants are grown. It is preferable to control elongation by manipulating day and night temperature to reduce DIF. Application of chemical growth retardants can result in some undesirable side effects. A-Rest application can result in increased lower leaf yellowing and loss. In contrast, Sumagic application can increase non-uniformity in a crop and, in some cases, can result in over application and excessive reduction in elongation.

Solution: Track plant height over time using the enclosed graphical track. Alter the day and night temperature in your greenhouse to maintain plant height between the two lines on the track. Remember, that stem elongation is most sensitive to temperatures during the first 3-4 hours of the day. Drop temperatures at this time (no more than 10°F) to reduce elongation. Increase temperatures at this time to increase elongation. If temperature control is not possible, apply a Sumagic spray.

Root Rot

Easter lilies are very susceptible to root rot. Root rot is a root disease complex that usually includes both Rhizoctonia and Pythium. Excessive root rot results in loss of lower leaves, reduced plant height, reduced flower and leaf size. This is most evident later in the crop schedule in March and/or April. In addition, excessive root rot can result in flower bud abortion if it occurs early.

Solution: Control root rot by 1) culturally reducing the likelihood of the disease and 2) drenching with fungicides. I have encountered growers who can control root rot entirely through water and media management. However, most of us will need to apply chemical fungicides. Apply fungicides for BOTH *Pythium* and *Rhizoctonia* control. Rotate fungicides to reduce the chance of resistance. There is significant Subdue resistance evident in greenhouses this past year. Therefore, make sure that your fungicide program includes Truban. There is no documented resistance to Truban as of yet. I suggest the following rotation on a monthly basis starting after potting: 1) Subdue (1/2 oz/100 gallons) + Cleary's 3336 (8 oz/100 gallons), 2) Banrot (10-12 oz/100 gallons), 3) Truban (8oz/100 gallons) + Terraclor (8 0z/100 gallons). If another application is needed, start at the beginning of the rotation again.

Crowding

Plant crowding can significantly decrease crop quality at the end of a production cycle from visible bud until flowering. Typically, stem elongation increases and there is more lower leaf loss. There appears to be a relationship between total light and problems related to crowding where there is more lower leaf loss under low light conditions.

Solution: Space plants if possible. Spacing allows for more light to reach the lower leaves and allows more air movement to limit the possibility of root rot. Recent research has shown that application of Fascination one week before and one week after visible bud to the lower leaves only will reduce lower leaf yellowing. Therefore, if you don't have available room to space, apply Fascination.

Scheduling:

Plants can flower too early or too late when they are not grown at appropriate temperatures between January 26 (flower initiation) and the visible bud date. Inexact scheduling usually occurs because a grower has not counted the leaves yet to unfold and then fails to deliver the correct average daily temperature to achieve the desired leaf-unfolding rate.

Solution: Count leaves around January 26. Determine how many leaves need to unfold per day by the visible bud date. Monitor the leaf-unfolding rate of your crop on a weekly basis. Adjust average daily temperature to achieve the desired leaf-unfolding rate. Articles in this bulletin go through the process in more detail. There is some extra time in this years schedule. Therefore growers can increase their bud count by dropping forcing temperatures to 52-55°F leading up to and during the week of flower initiation. Flower initiation coincides with stem root development. When you see stem roots developing, drop the temperature to increase bud count.

Over or Under cooling:

In general, a lily crop should receive 6 weeks of cooling at 42°F. If lilies are cooled for less time, we say they are under cooled and plants will be taller, have more flowers, be less uniform and take longer to flower. If lilies are cooled for longer than 6 weeks, we say they are overcooled and plants will have fewer leaves and flowers, have short lower leaves, and will flower quicker. If bulbs are cooled at temperatures above or below 42°F for 6 weeks they will be under cooled! If bulbs are immature when you start cooling, it is possible for bulbs to be under cooled even if you cool for 6 weeks at 42°F.

Solution: Prior to cooling, bulbs should be maintained at temperatures above 63-65° F. Once you put plants in a cooler, place a soil thermometer in the media in the cooler and adjust cooler temperature to achieve 42° F. Cool for exactly 6 weeks.

Early Shoot Emergence While in the Case or Cooler:

Shoots can emerge in the case or cooler if dormancy is broken early and stem elongation starts before cooling is complete. This can be a significant problem in dark coolers, with pots tightly stacked so that no light reaches each pot, and for case cooled bulbs sealed in their boxes.

Solution: If you are case cooling bulbs, check the status of shoot emergence on those bulbs on a regular basis. If sprouting starts on CTF or case cooled bulbs before the cooling requirement is met, drop temperatures on a weekly basis for 1-2 days to 36°F to inhibit elongation. Provide fluorescent or daylight in the cooler to inhibit elongation with CTF bulbs. Stack plants/cases in the cooler in such a way as to insure that 1) you can see or check if early shoot emergence is occurring, 2) to allow light to reach the surface of the media with CTF bulbs, and 3) dump a pot or open a case periodically to see if elongation of the shoot is occurring before the shoot breaks through the media surface. This will help you decide whether to drop temperatures periodically to limit shoot emergence. While potting sprouted case cooled bulbs, handle sprouted bulbs carefully to not break the sprout.

Easter Lily Leaf Unfolding

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Leaf counting is a technique used to insure proper timing of a lily crop. Once a lily shoot initiates a flower bud, no more leaves will form. At visible bud, all the leaves have unfolded. Therefore, if you know how many leaves have to unfold on a plant before 'visible bud', you can calculate how many leaves must unfold each day (or week) to reach the visible bud stage by a particular date.

By knowing the number of leaves which must unfold each week and by counting the number of leaves that actually unfolded the previous week, you can determine if your crop is slow, fast or on time. Subsequently, air temperature can be increased or decreased to hasten or slow plant development (leaf unfolding) to have your crop reach the visible bud stage on time and result in a flowering plant when you want it.

The following steps describe how to do leaf counting with a lily crop.

1) Start leaf counting 3-4 weeks after emergence or when plants are 3-4 inches tall. Tear apart a group of plants (usually 5 plants) to see if flower initiation has occurred. You can tell if flower initiation has occurred using a magnifying glass, or a stereo or microscope to see if small buds are visible at the tip of the stem. If no buds are visible, plants are still vegetative. If the first plants examined are still vegetative, a new set of plants is examined 4-5 days later.

2) A minimum of 3-5 plants for every bulb source and bulb size should be taken to leaf count. Count how many leaves have unfolded and how many leaves have yet to unfold on each plant. Unfolded leaves are normally defined as those leaves that are at an angle equal to or greater than 45° with the plant stem. Leaves yet to unfold are defined as those leaves that have an angle of less than 45° with the plant stem. The actual leaf angle is less important than your consistency between countings. A large needle and a magnifying glass will help you remove small scale-like leaves near the shoot tip. The embryo-like flower buds will be present on reproductive plants. An estimate of the bud count can be made on these plants as well!

3) Divide the number of leaves already unfolded by the number of days from shoot emergence until the present date. This will tell you how many leaves have unfolded each day to date to give you a 'benchmark'.

4) Determine the visible bud date listed on pages 18&19.
The visible bud date is normally 28-32 days prior to the expected flower date (often the week prior to Palm Sunday). It takes 30 days from visible bud to flower with a 70° F (21°C) average daily temperature and 35 days with a 65°F (18°C) average daily temperature. Not all plants reach visible bud the same day so give yourself some room for error.

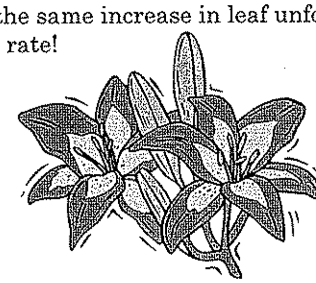
5) Divide the number of leaves that have yet to unfold by the number of days from the day of leaf counting until the expected visible bud date. This number tells you how many leaves must unfold each day for you to reach the visible bud stage on time.

6) If the number of leaves to unfold each day is greater than the number of leaves unfolded each day from emergence until the day of leaf counting, then you need to raise your average greenhouse air temperature to speed up leaf unfolding. In contrast, if the number of leaves to unfold each day is smaller than the number of leaves unfolded each day prior to leaf counting, then you need to decrease your average greenhouse air temperature to slow development.

7) In the greenhouse, mark the last unfolded leaf on several representative plants of each lot and bulb size. You can do this using a variety of ways including marking the uppermost unfolded leaf with a permanent ink magic marker, punching a hole in the uppermost leaf, or by placing a wire hoop above all expanded leaves on the shoot but below the yet unexpanded leaves.

8) Every 3 to 4 days (twice a week) count and record the average number of leaves unfolded, calculate the daily unfolding rate. Determine if your leaf unfolding rate is higher or lower than what you need to have your crop reach visible bud on time. Adjust greenhouse temperatures accordingly.

9) The rate of leaf unfolding is a linear function of the average temperature delivered to a lily crop over time. In other words, the increase in the rate of leaf unfolding resulting from 55° to 60°F increase in air temperature is the same as that when you increase the average daily temperature from 70° to 75°F; Every degree increase in temperature between 50° and 80°F results in the same increase in leaf unfolding rate!



Easter Lily Crop Log 2011-2012 (April 8, 2012)

I. Basic Information:

Arrival Date ______________________

Bulb Source ______________________

Bulb Size ______________________

II. Bulb Inspection and Soil Test:

	Excellent	Good	Fair	Poor
Roots	____	____	____	____
Basal Plate	____	____	____	____
Scales	____	____	____	____

Test media prior to planting bulbs. Attach soil test analysis.

IV. Planting and Cooling Info:

Planting Date ______________________

Cooling Treatment Initiated ______________________

Cooling Treatment Completed ______________________

V. Fungicide Application Schedule:

	App. 1	App. 2	App. 3	App.4
Date	________	________	________	________

VI. Leaf Number and Calculated Leaves per Day:

Total Leaf Number ______________________

Days To Visible Bud ______________________

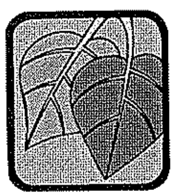
Leaves per Day Needed to Flower ______________________

VII. Final Developmental Data:

Leaf Number ______________________
Flower Number ______________________
First Flower ______________________
Plant Height at Flower ______________________

Regular Wholesale/Retail Lily Schedule (CTF)
2011-2012 Production Year

(WK 41-43) Oct. 10-28, 2011	**1.0) Bulbs Arrive (see info on dipping bulbs)** 1.1) Pot Bulbs, Fertilize with 400 ppm nitrogen from a balanced fertilizer 1.2) Drench with fungicide for BOTH *Pythium* and *Rhizoctonia* 1.3) Grow at 65°F media temperature and watch for sprouting
(WK 44-45) Oct. 31, 2011	**2.0) Start Cooling Treatment (42°F—6 weeks)**
(WK 50-51) Dec. 12, 2011	**3.0) Place plants in greenhouse (62-63°F media temp.** 3.1) Fertilize with 400 ppm nitrogen from a balanced fertilizer
(WK 1-2) Jan. 2-13th, 2012	**4.0) 100% of shoots should be emerged!** 4.1) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*
(WK 3-4)Jan. 16-Jan. 27 2012 (Optional)	**5.0) Drop Temps to 52-55°F to increase bud formation** (check for stem root development or dissect to evaluate the growing point for bud initiation)
(WK 5-6)Jan. 30, 2012	**6.0) Flower initiation is complete** **6.1) Leaf count** **6.2) Change day and night temperature to achieve desired leaf unfolding rate and DIF.** **6.3) Apply growth retardants as needed.**
(WK 5) Jan. 30, 2012	Drench with fungicide for *Pythium*, *Phytophthora* and *Rhizoctonia.*
(WK 7) Feb. 13, 2012	**7.0) Spray Fascination to lower 1/2 of plant**
(WK 8-9) Feb. 20, 2012	**8.0) Visible Bud** 8.1) Space plants if possible 8.2) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia*
(WK 9-10) Feb. 27, 2012	**9.0) Spray Fascination to lower 1/2 of plant.**
(WK 10) March 5, 2012	**LAST VISIBLE BUD DATE!**
(WK 12) March 19, 2012	Apply fungicides for *Pythium* and *Rhizoctonia.*
(WK 13) March 26, 2012	**10.0)Ship Wholesale** Post Harvest application of Fascination prior to storage or shipping, see Table 7
(WK 14) April 2, 2012	**Retail Ready**
April 8, 2012	**Easter Sunday**



Wholesale/Retail Case-Cooled Easter Lily Schedule 2011-2012 Production Year

Case cooled bulbs are usually cooled by the broker. Bulbs arrive and are potted immediately. Emergence and rooting occur simultaneously. In general, case cooled bulbs will have reduced leaf size and flower number compared to CTF or naturally cooled bulbs. Bulbs will typically arrive in early to mid-December. Place bulbs in an environment with temperatures between 62-65°F and pot as soon as possible!

(WK 43-44) Oct. 24-31, 2011	**1.0) Start Cooling Treatment (42°F—6 weeks) for growers that are case cooling their own**
(WK 49-50) Dec. 5–12 (Needs extra week over CTF schedule to allow for rooting)	**2.0) Pot Bulbs and Place plants in greenhouse** 2.1) Fertilize with 400 ppm nitrogen from a balanced fertilizer 2.2) Grow at 62-63F media temperature
(WK 1-2) Jan. 2-13, 2012	**3.0) 100% of shoots should be emerged** 3.1) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia*.
(WK 3-4) Jan. 16-Jan. 27 2012 Optional	**4.0) Drop Temps to 52-55°F to increase bud formation** (check for stem root development or dissect to evaluate the growing point for bud initiation)
(WK 5-6) Jan. 30, 2012	**5.0) Flower initiation is complete** **5.1) Leaf count** **5.2) Change day and night temperature to achieve desired leaf unfolding rate and DIF.** **5.3) Apply growth retardants as needed.**
(WK 5) Jan. 30, 2012	Drench with fungicide for *Pythium*, *Phytophthora* and *Rhizoctonia*.
(WK 7) Feb. 13, 2012	**6.0) Spray Fascination to lower 1/2 of plant**
(WK 8-9) Feb. 20, 2012	**7.0) Visible Bud** 7.1) Space plants if possible 7.2) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia*
(WK 9-10) Feb. 27, 2012	**8.0) Spray Fascination to lower 1/2 of plant.**
(WK 10) March 5, 2012	**LAST VISIBLE BUD DATE!**
(WK 12) March 19, 2012	Apply fungicides for *Pythium* and *Rhizoctonia*
(WK 13) March 26, 2012	**9.0)Ship Wholesale** Post Harvest application of Fascination prior to storage or shipping, see Table 7
(WK 14) April 2, 2012	**10.0 Retail Ready**
April 8, 2012	**Easter Sunday**

October 2011

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10 Bulbs	11 Arrive	12	13	14 →	15
16	17 Bulbs	18 Arrive	19 Fungicide	20	21 →	22
23	24 Rooting	25 65°F	26	27	28	29 →
30	31 Vernalize →					

November 2011

SUN	MON	TUE	WED	THU	FRI	SAT
		1 42-44°F	2	3	4	5 →
6	7	8	9	10	11	12 →
13	14	15	16	17	18	19 →
20	21	22	23	24	25	26 →
27	28	29	30 →			

December 2011

SUN	MON	TUE	WED	THU	FRI	SAT
				1	2	3 →
4	5 Case Cool	6 Arrive	7	8	9	10 →
11	12 Force CTF	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

January 2012

SUN	MON	TUE	WED	THU	FRI	SAT
1	2 Fungicide	3 Emergence	4	5	6	7
8	9	10	11	12	13	14
15	16 Temp	17 Drop	18 Optional	19	20 →	21
22	23	24	25	26	27	28
29 Count	30 Leaf	31 Fungicide				

February 2012

SUN	MON	TUE	WED	THU	FRI	SAT
			1	2	3	4
5	6	7	8	9	10	11
12	13 Fascination	14	15	16	17	18
19	20 **VB Date**	21 Fungicide	22 Ash Wed.	23	24	25
26	27 Fascination	28	29			

March 2012

SUN	MON	TUE	WED	THU	FRI	SAT
				1	2	3
4	5 **Last VB**	6	7	8	9	10
11	12	13	14	15	16	17
18	19 Fungicide	20	21	22	23	24
25 Wholesale	26 Fascination	27	28	29	30	31 →

April 2012

SUN	MON	TUE	WED	THU	FRI	SAT
1 **PALM** →	2 Retail →	3 →	4 →	5 →	6 →	7 →
8 **EASTER**	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

NOTES:

Things to Watch For!

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Rooting In:

Depending on when the bulbs arrive, you may have less time to root bulbs in. Giving them as much time to root up to 2-3 weeks increases bud number. Therefore, pot bulbs as soon as possible upon arrival and make sure media temperature is between 63-65°F to encourage rooting prior to cooling of CTF lilies. Case cooled bulbs should also be potted and rooted as soon as possible to encourage shoot emergence by January 1.

Timing:

With an early Easter, there is little time between when plant initiate flowers (around the last week of January) and the visible bud date. Therefore, it is very important that you leaf count at the end of January to insure that you grow your crop warm enough to have plants flower on time. Remember that plants need a minimum of 24 days from visible bud to flower—optimally you give plants 28-34 days from visible bud to flower. It is very possible that you will need to grow your Easter lily crop at temperatures that are warmer than you typically grow them. This will depend on the leaf number that the bulbs have. In general, those growing an Easter lily crop using smaller bulbs will have an easier time timing their crop this year since leaf number decreases as bulb size decreases.

Heating Costs:

Since it is an early Easter, we will likely be growing the lilies with a warmer average daily temperature from when we pull them out of the cooler until the visible bud date. In general, it will be cheaper to provide this heat during the day if it is sunny versus heating at night. Therefore, some growers may choose to allow day temperatures to be higher. If this is the case, you may have more stem elongation than in the past — higher DIF — and may need to apply more growth retardant and/or make sure you do the morning drop in temperature. Make sure you have a graphical track for your crop and use it to insure your crop height is where it needs to be!

Pests and Diseases:

Since we will be growing at the darkest time of the year and at warmer temperatures, both diseases and pests infestations can spread more rapidly. In particular, warm wet conditions can promote Rhizoctonia. Similar conditions can promote Botrytis. Lastly, both aphid and mite development is very temperature dependent; these pests reproduce more quickly under warm temperatures.

Spacing:

Because of higher heating costs, you may be tempted to grow your lily crop as close as possible to minimize the area you heat. Remember that growing plants close early in development promotes stem elongation. Growing plants close together late in development promotes stem elongation, root rot, lower leaf yellowing, and at times flower bud abortion.

Insurance Policy:

With an early planting date bulbs may be dug earlier. As a result, it may be a good idea to light lilies after they come out of cooling for the first 2 weeks to insure that they are completely induced. Light with 10 footcandles of light from either incandescent or high pressure sodium lights from 10 pm to 2 am.

TRACKING EASTER LILY HEIGHT WITH GRAPHS

Easter lily response to temperature during forcing

Royal Heins, John Erwin, Meriam Karlsson, Robert Berghage, William Carlson and John Beirnbaum

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While average daily temperature influences how fast lilies grow, the difference between day and night temperatures affects the way they look.

Timing and height - how can you control these two vital elements in producing potted plants? At Michigan State we've researched the effects of light and temperature on lily, chrysanthemum and poinsettia timing and height. The result is a system called "graphical tracking" which shows you how to manipulate temperature to get your crops to bloom on time at the height you want.

The key to making this system work is knowing your crop's specific reactions to temperature. Lilies, for example, react differently depending on their stage of development. Before visible bud, their leaf unfolding is directly proportional to increases in average daily temperature. After visible bud, however, this is no longer true. Instead, the higher the initial average daily temperature, the less it helps to increase the temperature further.

While average daily temperatures influences how fast lilies grow, the difference between day and night temperatures affects the way they look. Warm days with cool nights produce tall plants with upright leaves; cool days with warm nights produce short plants with horizontal or downward curling leaves.

What is an "isopleth plot"?

"Isopleth" means "equal quantity."An isopleth plot is a graph that shows how two variables related to a constant quantity of another variable. A contour map which shows lines of equal elevation is an example of an isopleth plot. Our isopleth plots show which day and night temperatures result in the same rate of lily development.

Figures 1a and 1b show combinations of day and night temperature which results in the same rate of leaf unfolding (Figure 1A for a 10-hour day and Figure 1B for an 11-hour day). Figure 2 shows combinations of day and night temperature that result in the same number of days from visible bud to flower.

Graphical tracking is a procedure used throughout development where actual plant height is plotted and compared with desired plant height.

Some of these temperature combinations will produce tall plants (warm days/cool nights) and other combinations will produce short plants (cool days/warm nights).

What can "graphical tracking" do for you?

Graphical tracking is a procedure used throughout development where actual plant heights is plotted and compared with desired plant height.

This article will explain how to construct a graph like the one shows in Figure 3 showing the "tracking window." This "window" represents where your plants should be if they are to bloom on time at the desired height. If their actual measurements do not fall in the "tracking window," you can adjust their development by means of temperature changes - or growth regulator applications.

To construct the "tracking window" graph, draw a graph like the one shown in Figure 3, with height up the side and days to flower across the bottom. Let's assume that you need your lilies ready for shipping by April 1 and the final desired lily height is 22" to 24". (Subtract 6" for the pot, leaving 16-18" actual plant height.) We know from experience that a lily typically doubles in height from visible bud to flower, so visible bud height should be 50% of final height or 8" or 9" (14" to 15" including the pot). Connect your beginning height (0") with these desired minimum and maximum heights at visible bud and flower to form your "tracking window."

From emergence to flower initiation, we recommend growing lilies at 62° to 65°F (17° to 18°C) soil temperature, with constant air temperature a degree or two warmer. Keep day and night temperatures about the same.

Around the beginning of February, you should be able to count the leaves and figure out how many are yet to unfurl.

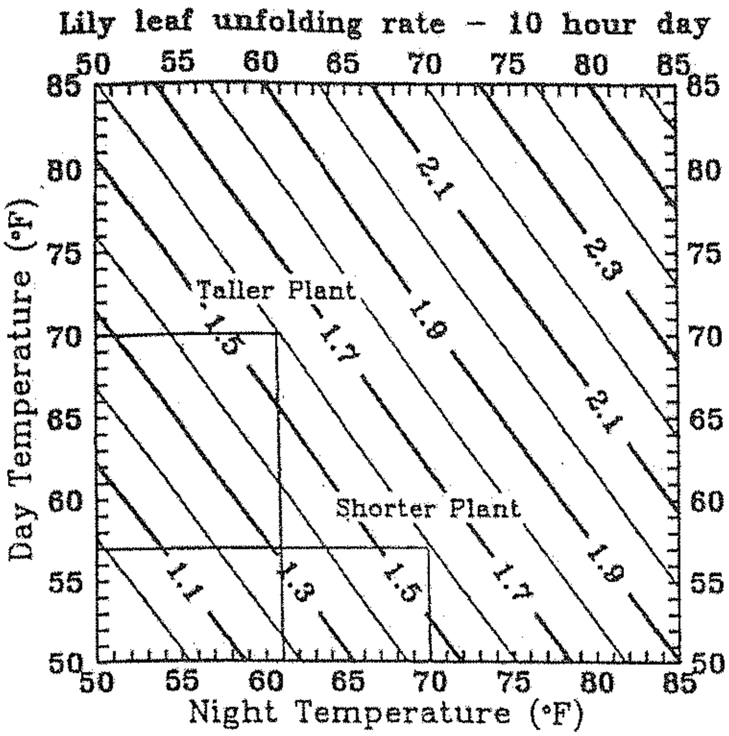

Figure 1a. Isopleth plots of lily leaf unfolding rates for a 10-hour day and a 14-hour night.

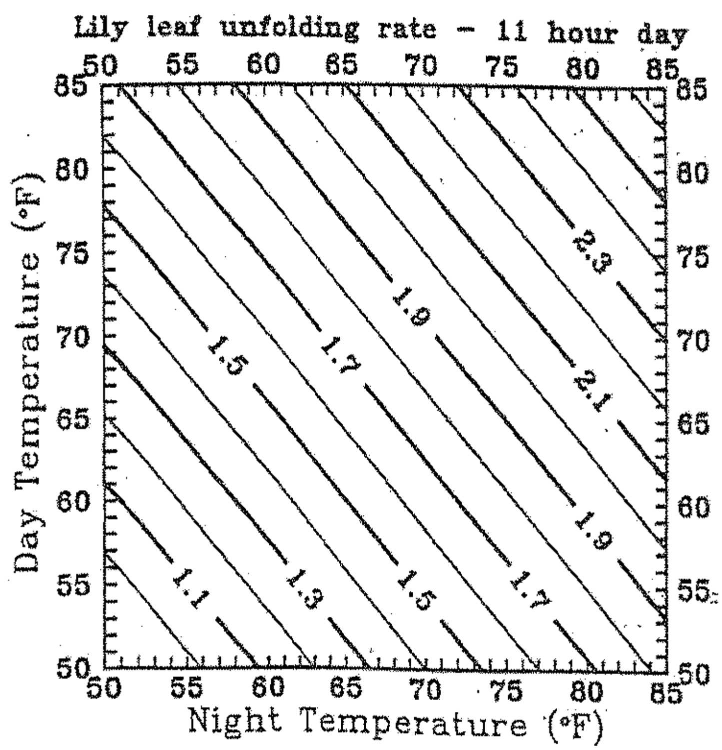

Figure 1b. Isopleth plots of lily leaf unfolding rates for a 11-hour day and a 13-hour night.

Divide the number of leaves yet to unfurl by the number of days before your projected visible bud date to get the number of leaves that must unfurl each day to meet that deadline. Let's assume it's 1.6 leaves.

Check Figure 1a to find all the combinations of day and night temperatures which will unfold 1.6 leaves per day. Pick out a day temperature directly below the point where these lines cross is the corresponding night temperature.

In January and early February, when days are short, use the 10-hour-day graph (Figure 1a); in mid to late February, when the days are longer, use the 11-hour-day (Figure 1b).

Measure the height of your plants every 4 to 5 days to see if they are within your "tracking window." Remember that warm days with cooler nights produce tall plants and cool days with warmer nights product short plants. If you plants are too tall, choose a cooler day/warmer night combination of temperatures; if they're too short, choose a warmer day/cooler night combination.

The more extreme the differences in day and night temperatures, the more extreme the effect in stretching or slowing down the elongation of

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The more extreme the differences in day and night temperatures, the more extreme the effect in stretching or slowing down the elongation of your plants.

After lilies reach visible bud, use the isopleth plot shown in Figure 2, showing number of days from visible bud to flower.

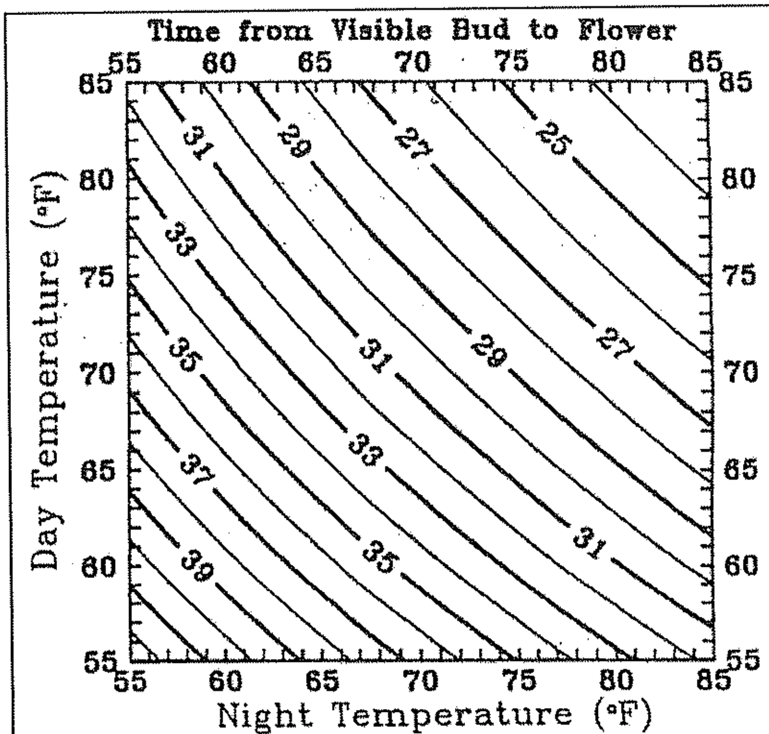


Figure 2. Isopleth plots of time from visible bud to flower for Easter lilies.

your plants. However, as long as you choose one of the combinations along that same 1.6 leaves-per-day line you lilies will stay on your desired growing schedule.

After lilies reach visible bud, use the isopleth plot shown in Figure 2, showing number of days from visible bud to flower. Keep measuring your plants and adjust your temperatures as you did before, if your plants are too tall or too short of the "tracking window."

How does it work?

Figure 4 shows an actual example of graphical tracking in a commercial greenhouse. Before flower initiation, plants were grown at 62°F (16.5°C) both day and night. On January 27, the grower noticed that his plants were getting too tall for the "tracking window" and chose a warmer night/cooler day combination of temperatures (63°F night and 53°F day; 17°C night and 12°C day)/. Stem elongation decreased dramatically.

On February 10, the grower became concerned that the plants would soon drop below the "tracking window," so he adjusted the temperatures in the opposite direction, to 56°F night and 64°F day (13°C night and 18°C day).

This increased the stem elongation while keeping the leaf unfolding rate at a constant 1.3 leaves per day.

On February 17, the grower chose to increase leave unfolding rate to 1.5 leaves per day, by adjusting the temperatures to 65°F night and 60°F day (18°C night and 15.5°C day). He maintained this tempera-ture past visible bug and then increased it twice more to hasten development.

Informed use of the "isopleth plots" and "graphical tracking" allowed this grower to produce his lilies on time, and at the desired height - without the use of growth regulators.

Growth Regulators

Not all lily growers have light and outdoor temperature conditions that allow precise temperature control throughout lily development. If you can't keep your lilies in the "tracking window" by means of temperature control alone, growth retardants may be necessary.

When using the growth retardant A-Rest, keep in mind that its effectiveness decreases under cool day/warm night conditions and increases under warm day/cool night conditions. So if you are combining A-Rest with the shortening effect of cool day/warm night conditions, keep in mind that these temperature conditions reduce the effectiveness and benefit of A-Rest.

These are the tools

Any procedure you apply to your plants - from basic watering on up to these more "scientific" procedures - is just another tool to help you control your crops. Once you understand how a tool works, it can make your work easier - and that goes for "isopleth plots" and "graphical tracking" too.

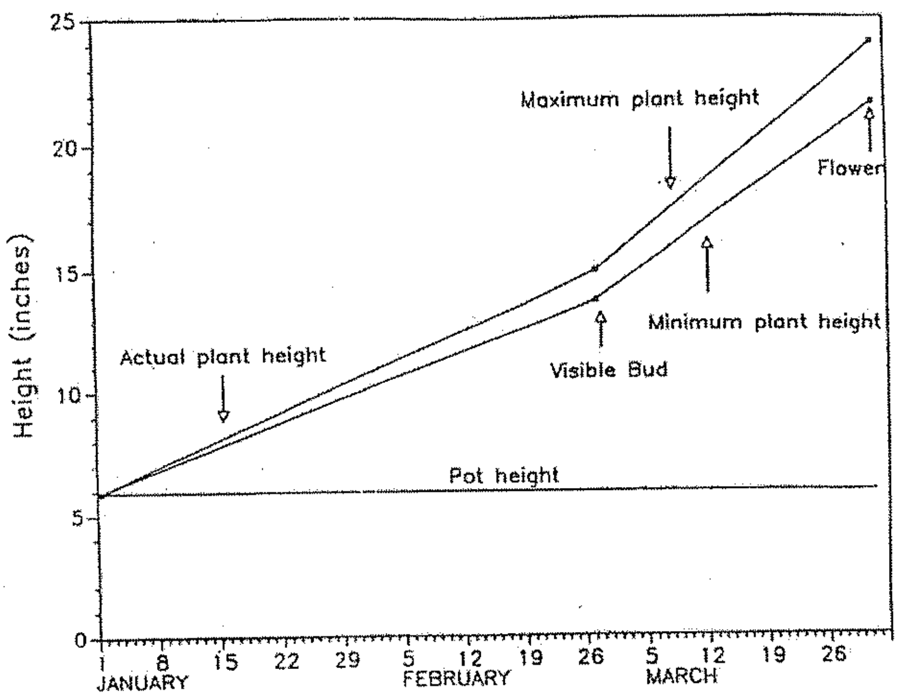
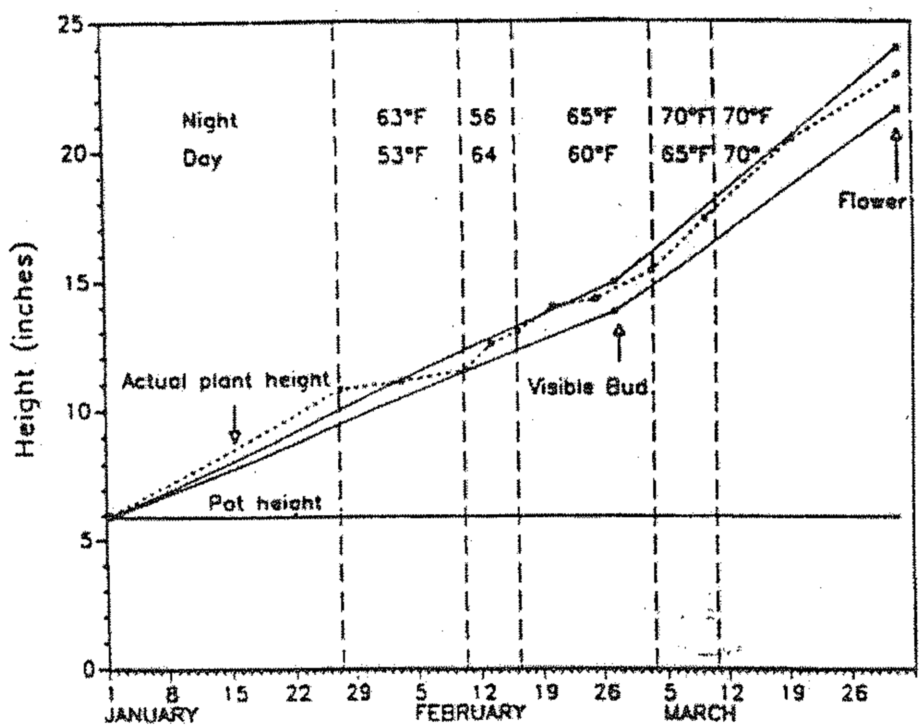


Figure 3. Graphical tracking plot showing the "tracking window" of desired plant height throughout Easter lily development.



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