MINNESOTA COMMERCIAL FLOWER GROWERS
BULLETIN

50+ YEARS OF SERVICE

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Special Points of Interest

- Comprehensive Easter lily production guide
- Schedules or Wholesalers and Retailers for both finishing Easter lilies on time or for finishing Easter lilies 1-2 weeks early for placing in coolers!
- Production Quick Sheets
- Easter Lily Log
- New Fascination information!
- Easter lily Bud Meter

INSIDE THIS ISSUE:

Easter Lily Production

John Erwin, Dept. of Horticultural Science, University of Minnesota

I. Introduction:
The commercial Easter lily (*Lilium longiflorum* Thunberg 1794) is one of the most important flowering potted plants in North America. Easter lilies were ranked 4th in wholesale value ($36.7 million in 1999) among potted flowering crops. An anticipated 8,906,000 pots were grown in the 2000-2001 season.

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 inflor-escence.

The Easter lily first arrived in England in 1819. Popularity of the crop increased substan-tially resulting in the development of a commercial lily industry. Early commercial bulb produc-

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Easter Lily 2002-2003 Schedules

Easter 2003 is considered an 'late' Easter. As such, many growers will need to grow with cooler temperatures to insure their crop will not flower too early. The schedules presented for the 2003 season present traditional wholesaler and retailer schedules. In addition, a second schedule is offered for retailers and wholesalers who may want to flower lilies early and store plants in a cooler until marketing time. Lastly, a schedule is presented for finishing a typical 'prefinished' Easter lily crop. All schedules are available starting on page 16.

tion 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 Easter lilies are grown for cut flower production. Specifically, the cultivars 'Arai', 'White America', 'White Fox', and 'White Queen' are grown as cut flowers. Few, if any, Easter lilies are grown for potted plant use.

Recent advances in interspecific hybridization of L. *longiflorum* with other species was lead by efforts of Peter Ascher at the University of Minnesota. Peter's student, Dan Clark has continued this effort. A commercial cultivar resulting from their efforts include 'Dragoon'. Subsequent crosses between *L. longiflorum* and other Asiatic lily types have resulted in the development of numerous new hybrids including the Alliette hybrids.

Although considerable breeding has resulted in an explosion of new cultivars, the commercial white Easter lily still remains the most important potted lily.

"Easter Sunday is late this year! Easter is on April 20th."

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").

When plants are shipped for sale 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 2002-2005 are shown in Table 1.

Table 1. Dates of Easter Sunday from the 2002-2003 season to the 2004-2005 season.

Year	Date
2003	April 20
2004	April 11
2005	March 27

IV. Cultivars:

The primary potted Easter lily cultivar grown commercially today is 'Nellie White'. There have been numerous introductions during the last 20 years. Yet, none have replaced Nellie White. Current breeding efforts have focused on the development of a colored Easter lily. In particular, effort has been spent trying to develop a pink Easter lily.

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 10-11 inches (75 per case). Bulbs are packed in a moist peat for shipping. In general, there are 125 bulbs per crate. 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 approx. 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 at or below 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, i.e. 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 ma-

Figure 1. Effects of length of cooling treatment on several developmental and morphological characteristics of *L. longiflorum* Thunb. 'Ace'.

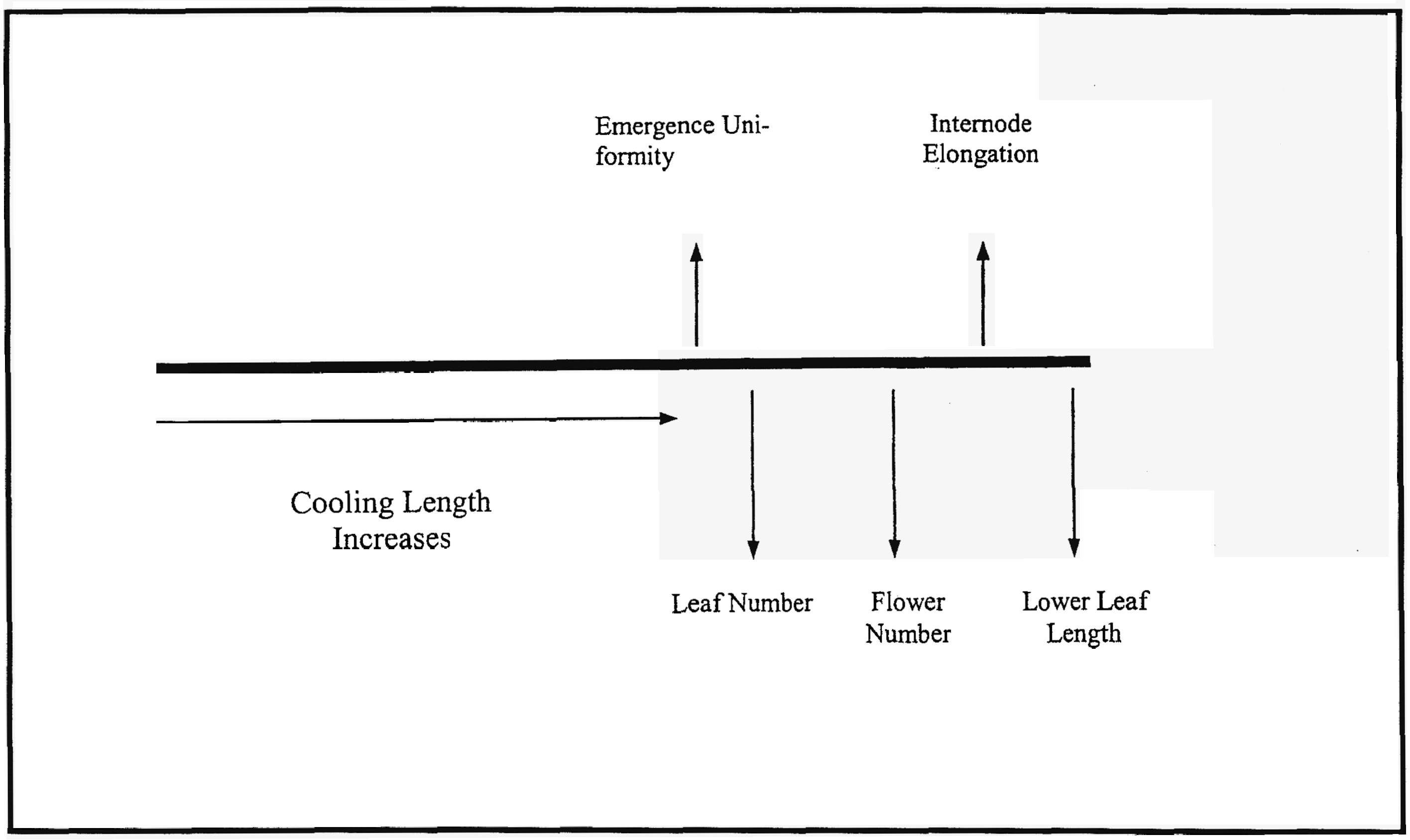


Table 3. Nutrient standards for Easter lily media.

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

ture. We cool bulbs for 6 weeks to insure that an entire population of bulbs is completely induced since bulb maturity varies within a population and 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.

Beyond vernalization 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, and

7) flower number decreases.

VII. Commercial Cooling Methods:

Easter lilies are commercially vernalized using either of 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.

Table 2. Amount of acid to add in milliliters to be added per gallon of water to neutralize a single bicarbonate of $CaCO_3$ equivalent. Example: You 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

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.

VIII. 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.

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 either 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 as more growers now force the cultivar Nellie White instead of Ace. Ace was prone to develop tip burn. In any case, an initial media pH of 6.0-6.8 is desirable.

Two newer media 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 ten be purchased at a 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.

IX. 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.

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

X. 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 levels 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) levels 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 toxic-

Weather (Miracle-Gro), Plantex 15-0-15 High Nitrate Mix).

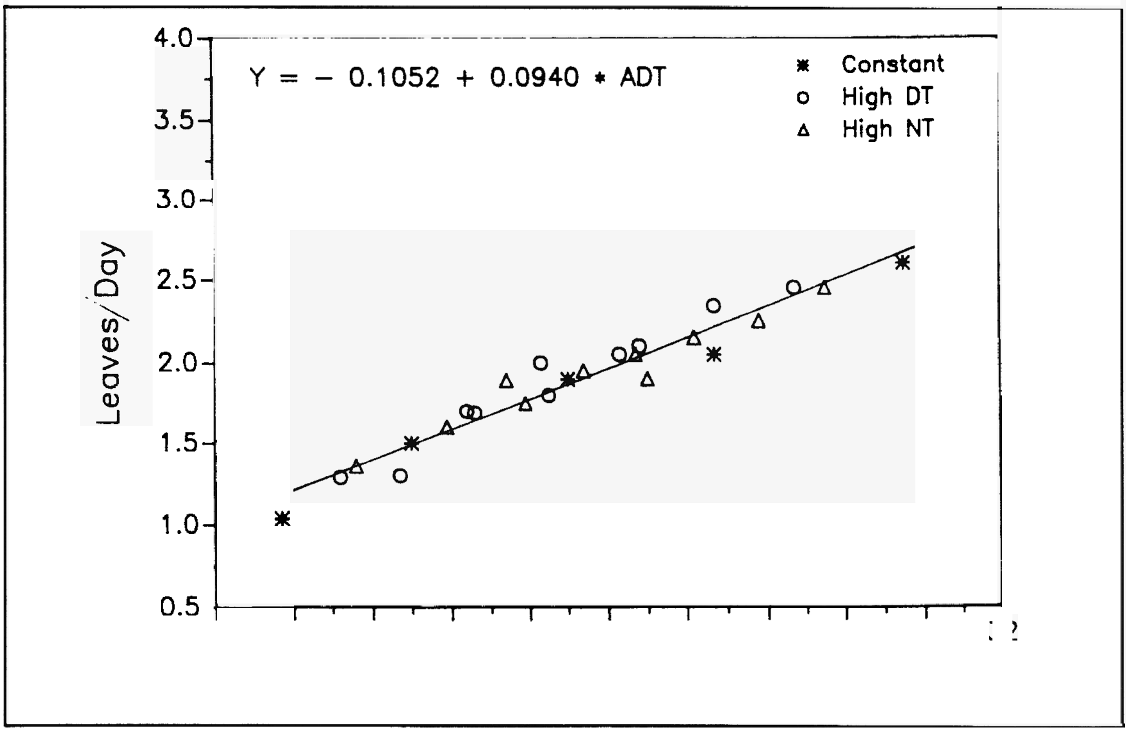
Media electrical conductivity (EC) or soluble salts should be low. A high EC 3.5 dS/m (saturated media extract) or 2.0 dS/m (2:1 water:media sample) will increase the potential for root rot infestation by damaging (burning) root tips and providing a 'point of entry' for these diseases.

Test media fertility at least once 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

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 a.i. per pot (50-100 fl oz A-Rest/50 gallons water = drench solution). Apply 4 fl oz/6" pot.
Sumagic	Spray—2.5—5 ppm (0.65—1.25 fl oz Sumagic/gallon water) Drench-0.15-0.30 mg a.i. Per pot (1.625- 3.25 fl oz Sumagic/50 gallons water = drench solution). Apply 4 fl oz/6"pot.

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



solving a nutritional problem. Remember to tissues test only those leaves that are expressing symptoms. Recommended tissue nutrient levels are shown in Table 4.

XI. 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 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 beginning of the day and at the end of the night. 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 the day (at dawn) for 3-4 hours. In contrast, if temperatures are increased during the first 3-4 hours 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 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 growth 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 January 29. 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 gallons of spray solution to treat 250 small plants. You will need 5 gallons of spray solution to treat 250 large plants.

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

"Control lily height first by minimizing DIF."

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. An example of a 'graphical track' for an Easter lily crop for the 2002-2003 growing season can be seen in Figure 3.

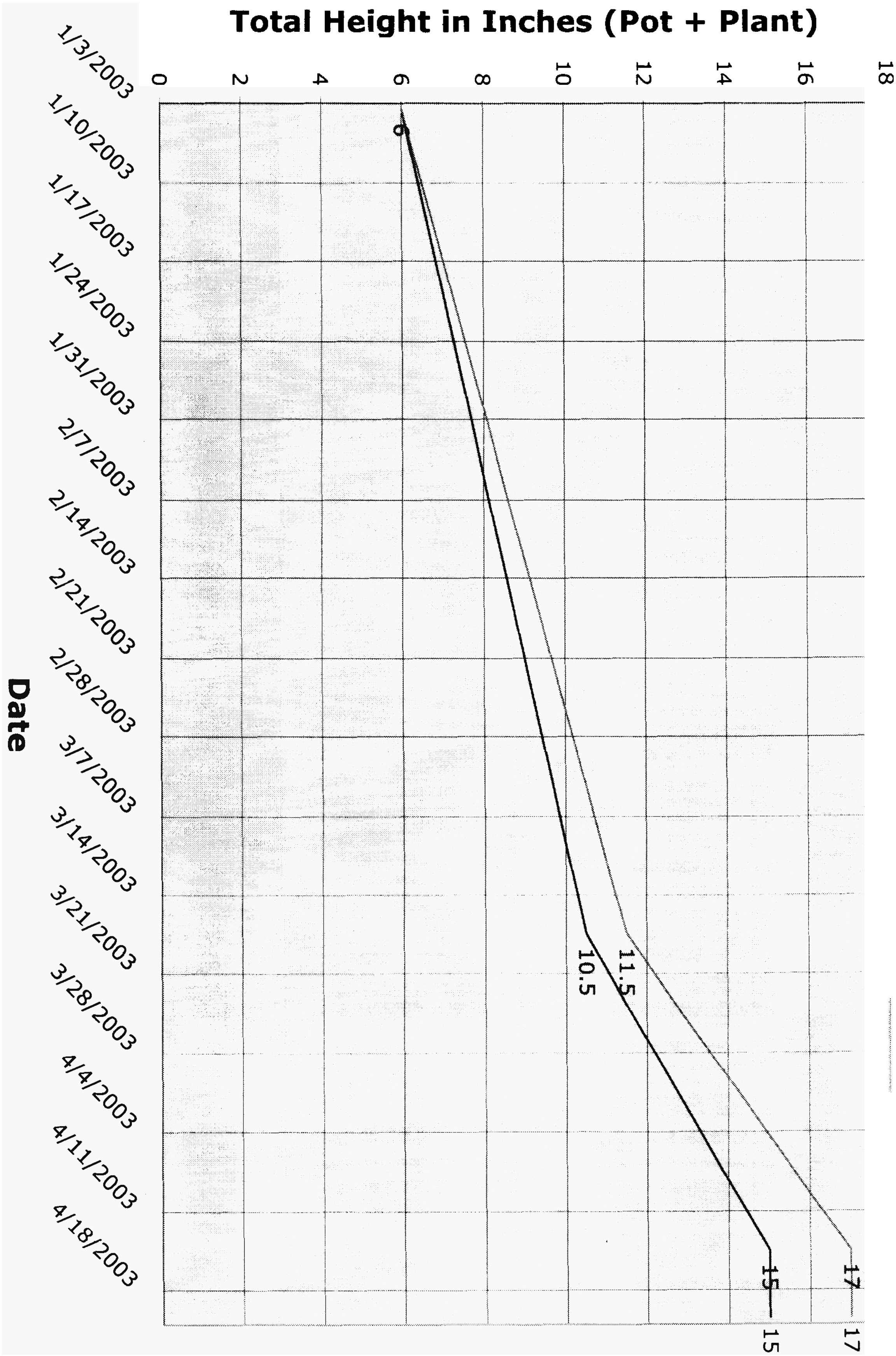
XII. Rate of Development:

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 at. Specifically, the rate of leaf unfolding increases linearly as the average daily temperature plants are grown at 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 (approx. Jan. 23 to 30) and temperatures after visible bud do not affect the rate of development

Figure 3. Example graphical track for a typical Easter lily crop for the 2002-2003 production year.



greatly, timing on an Easter lily crop is primarily dependent on crop temperatures between flower initiation (Jan. 28) and visible bud. The typical time from visible bud until flower is 30 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 Russian Easter!

XIII. 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.

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 we rec-

Pest	Material	Rate
Aphids	Dursban (50WP)	8 oz/100 gallons
	Orthene T & O 75 SP	1/3—2/3 lb./100 gallons
	PlantFume 103	aerosol
	Talstar 7.9 F	2-10 fl oz/100 gallons
	Duraguard 20 ME	1 1/2-3 pt./100 gallons
	Thiodan 50 WP	1 lb./100 gallons
	Tame 30 EC	10 2/3 oz/100 gallons
	BotaniGard 22 WP	1 lb/100 gallons
Fungus Gnats	Gnatrol 6 AS	1-8pt/100 gallons
	Azatin XL 3 EC	8 fl oz/100 gallons
	Talstar 10 WP	6.4—32 oz/100 gallons
	DuraGuard 20 ME	1 1/2—3 pt/100 gallons
	Mesurol 75 WP	1/2—1 lb/100 gallons
	PT 170 X-clude 1.1 L	3-6 pt/100 gallons
	Knox-Out 23 EC	3-6 pt/100 gallons
	PT 1800 Attain 0.4 A	aerosol
Bulb Mites	Kelthane	8 oz/100 gallons (not registered for use)
Shore Fly	Azatin XL 3 EC	10—16 oz/100 gallons
	Precision 25 WP	4 oz/100 gallons
	Distance 11.2 EC	6-12 oz/100 gallons
Spider Mites	Avid 2 EC	4 oz/100 gallons
	Pentac 50 WP	8 oz/100 gallons
	Mavrik P 22.3 F	2-10 fl oz/100 gallons.

ommend spacing Easter lilies as much as possible from the visible bud stage until flower.

Fascination Application:

Application of Fascination to lower leaves immediately prior to and after the visible bud date can prevent and/or delay lower leaf loss (Table 7). Care must be taken to apply Fascination only to the leaves on the lower 1/3 of the plant. Apply two applications of Fascination 1 week before and again 1 week after visible bud to the leaves on the lower 1/3 of the plant only (Table 7).

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.

XIV. 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

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 II	1/2 oz per 100 gallons water (drench)
	Banrot	8—10 oz/100 gallons water (drench)
	Banol	See label
	Truban 30 WP	3-10 oz/100 gallons
Rhizoctonia	Cleary's 3336	8 oz/100 gallons water (drench)
	Banrot	8—10 oz/100 gallons water (drench)
	Chipco 26019	See label
	Terraclor 75WP	8 oz/100 gallons water (drench)
	Medallion	See label
	Terraguard	See label
Botrytis	Captan	See label
	Exotherm Termil	See label
	Chipco 26019	1-2 lb/100 gallons
	Cleary's 3336	6-10 oz /100 gallons
	Zyban	See label
	Ornalin	See label
	Daconil 2787 WP	1 lb/100 gallons
	Decree 50 WG	1—1.5 lb/100 gallons
	Dithane T/O	1.5 lb/100 gallons
Fusarium Bulb Rot	Cleary's 3336	12-16 oz/100 gallons

Table 7. Appropriate dilutions to prepare solutions for the lower and higher rate of application for Fascination (5/5 and 10/10 ppm for Fascination)

Rate	ml Fascination per 10 Gallons Of Water
Lower rate	11
Higher rate	21

with chemical fungicides. For instance, Subdue and Banrot are effective in controlling *Pythium* and *Phytophthora* spp. Subdue is the more effective. Cleary's 3336, Banrot, Chipco 3336 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* resistance 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.

XV. 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 at; 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, drench planted bulbs with a miticide.

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.

XVI. 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 a source of spores of 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 7. Because complete spray coverage is difficult, aerosol type fumigants are preferable to spray application.

XVII. 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 and/or a Fascination application must occur at or around the time of visible bud. If you desire to apply Fascination, spray lower leaves (lower 1/3 of plant) of plants one week before and one week after the visible bud date at the 5/5 or 10/10 rate of Fascination. Care must be taken to not apply this material to upper leaves or at higher concentrations as 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 65 and 67°F from emergence until flower initiation for optimal bud set. Lastly, growth retardants should not be allied 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.