

Early Easter in 2016 requires attention to details.

Richard McAvoy, Professor and Extension Specialist
University of Connecticut

Easter 2016 falls on an early date, March 27th. This is the earliest Easter date since 2008, and Easter 2008 fell on the earliest date (March 23rd) in 95 years. On average Easter dates as early as March 26th only occur once every 15 years. As with all early Easter schedules, bringing a lily crop in on time will be a special challenge and some time-saving choices will need to be made along the way.

The early date Easter schedule presents one immediate problem. The ideal production schedule requires a full 23 weeks to complete. That means growers will need bulbs in-hand by October 18, 2015 to run a normal forcing program and bring the crop in for the start of the Easter sales season. That is unlikely to happen this year since bulbs typically are not available until late October at best. That means that growers will have to cut corners at certain points in the schedule to hit the early 2016 date. Early Easter's also target early ship dates, typically the week of March 20th or one week before Easter Sunday. This means that growers will need to complete the entire greenhouse forcing program under winter season weather conditions that include low sun angles, cold night temperatures and short-day lengths for much of the crop. Such conditions make it more difficult and more expensive to push the crop if you fall behind schedule.

Here are some tips on how to handle the 2016 Easter lily crop.

The ideal forcing schedule:

With both pot-cooled and case-cooled bulbs the full cropping schedule requires 23 weeks to bring the crop in one-week prior to Easter Sunday. Both cooling methods, call for six-weeks of bulb cooling or vernalization, three weeks of root and shoot development prior to emergence, and 14-weeks forcing in the greenhouse after shoot emergence.

If you need to crimp on time to shorten the ideal 23 week schedule, start by identifying the critical steps as well as the steps that offer the best possible choices for making up lost time.

Let's look at the pot-cooled crop first.

Ideally pot-cooled bulbs (this includes naturally-cooled bulbs) are potted as soon as they arrive, preferably by week 23 on the schedule (Oct 18th) and then held at 60-62F for 3 weeks. The potted bulbs are then cooled for six weeks (40-45F) or until week 14, at which time they are moved to the greenhouse for forcing. During the initial three weeks (starting on week 23) roots develop and the shoot meristem matures. The physiological developments that take place during the initial 3 weeks at 60-62F improve cold perception during bulb cooling (vernalization) and allow bulbs time to mature which helps to produce more uniform shoot development and flower response. However, this is the first place to cut if circumstances force a late start on the 23-week forcing schedule. If this is the case for you, cut the initial three weeks down to two or even one week. This will allow a little time for some root development to begin before cooling. That means you can jump in on the recommended schedule at week 22 or 21 (Oct.25th or Nov. 1st) and still be in pretty good shape the rest of the way. It is important to make sure you get at least one week of pre-chilling bulb development at 60-62F before starting vernalization.

Six-weeks of bulb cooling at 40-45F is the next key step. Ideally this step should start by November 8th or week 20. One thousand-hours or 6-weeks of cooling is recommended as a general rule but lilies will spout and bloom on a reasonable schedule with as little as 4-weeks of cooling. So if you need to make up additional time you can start cooling as late as week 18 (Nov. 22nd) and substitute up to two weeks of insurance lighting to make up for any shortage in cooling hours (up to 2-weeks).

It is important to get the full one thousand hours in since fully cooled bulbs produce fewer leaves before bud. Fewer leaves makes the greenhouse forcing stage shorter as well. However, you have an insurance option to play here. Therefore, count both the time at 40-45F and the insurance lighting into your 1000-hour calculation.

The final production phase is the greenhouse forcing, for pot-cooled bulbs this means 14-weeks in the greenhouse beginning December 20, 2015 for the 2016 schedule. Growers should be very hesitant to short change the greenhouse-forcing portion of the schedule. That is especially true this year, and should be of particular concern to any grower who typically has to push hard to finish on time even with mid-date Easter schedules. Remember, with a very early date Easter it may be hard to force bud development with high temperatures in late February and early March. Therefore, the second place to cheat, if needed, is on the bulb-cooling portion of the schedule. Make sure you expose the potted bulbs to at least 4-weeks of cooling at 40-45F (5-weeks is even better if time permits), then use insurance lighting for up to two weeks, to make up the difference in lost cooling (more on insurance lighting later).

Now let's look at the case-cooled crop. Again, the full ideal schedule calls for 23 weeks from start to finish. Typically case-cooled bulbs are placed in the 40-45F cooler starting on week-23 or October 18th this year. After 6-weeks, bulbs are potted and moved to the forcing greenhouse (at 60-62F) beginning 17-weeks prior to Easter or Nov. 29, 2015. Shoots take longer to emerge with case-cooled bulbs, but should be up by week 14 (Dec. 20). The greenhouse-forcing phase of the schedule is the same as with the pot-cooled crop.

With case-cooled bulbs the critical dates are the onset of bulb vernalization (cooling at 40-45F) and the start of greenhouse forcing. If you cool your own bulbs, you'll know how late you got started. For example, if you do not receive your bulbs until November 1st you will already be two weeks behind schedule. Here's what I recommend if you are two or more weeks behind at the onset. Cool-bulbs for at least 4 weeks then pot and begin forcing. As shoots emerge, immediately begin insurance lighting for up to two weeks. If you are still behind, you will have to make up for lost time during greenhouse forcing but after bud initiation is completed.

If you buy in case-cooled bulbs, it will be important to know exactly how much cooling they received. You want the bulbs on hand so that you can pot and beginning forcing by week 17 (Nov. 29th). If you know or suspect that the 6-weeks of cooling was incomplete, be safe and use insurance lighting. If the bulbs arrive after Nov. 29th, you will have to make up time during greenhouse forcing but after bud initiation.

Greenhouse forcing:

With both pot-cooled and case-cooled lilies, greenhouse forcing starts at the end of the bulb-cooling period. Typically this is 17-weeks before Easter for case-cooled bulbs and 14-weeks before Easter for pot-cooled bulbs. The difference in the two schedules just reflects the stage of shoot development. With pot-cooled bulbs the shoots are either at the soil surface or already emerged as soon as forcing begins (week 14). In contrast case-cooled bulbs, will take up to three weeks to emerge. So either way, the shoots on both crops should be emerging by about week 14 (Dec. 20th).

Once lilies emerge all focus should be on completing vernalization (if you still lack the 1000 hours), optimizing flower bud count and keeping on schedule for the early date Easter in 2016 - in that order. Bud set should be completed in early- to mid-January. During this part of the crop you can use insurance lighting to reach you full 1000-hour vernalization goal but do not attempt to speed development of the crop with high temperatures. Once bud initiation is set you will need to track height to meet production goals, and leaf unfolding rates and bud development to meet targeted sales dates.

Bud initiation begins soon after lilies emerge, and should be completed no later than mid-January in the 2016 crop, when shoots are 3"-5" tall. The development of stem roots coincides with flower bud initiation. During this period, day and night temperatures of 60-65F are desirable (63F is ideal), but it is imperative that temperatures do not exceed 65F until bud initiation is complete. This is important, don't try to catch up with high temperatures at this point in the schedule. If you find yourself short on forcing time in the greenhouse, wait until bud set is complete before attempting to speed up plant development with higher temperatures.

Insurance Lighting:

Insurance lighting refers to night break lighting used to produce a long day photoperiod effect. When applied starting immediately at shoot emergence, the long day photoperiod has the same effect as bulb cooling. It reduces the time to flower as well as the number of leaves and flowers produced. [The reduced flower number is a negative consequence that we accept as a trade-off in order to make the plants flower in a reasonable time frame.] Therefore, insurance lighting can be used to substitute for inadequate bulb cooling. Provide one week of insurance lighting for each week of lost cooling - up to a total of two weeks. For example, if bulbs arrive too late to begin case-cooling on week 23, or if weather conditions prevent you from achieving 1000 hours of natural pot-cooling by week 14 (December 20), you can still start greenhouse forcing on time by providing a week of insurance lighting for each week of lost cooling time. Incandescent, fluorescent, LED or HID lighting in excess of 10 foot-candles from 10 pm to 2 am daily will provide the necessary night break.

It is important that the shoots perceive the long day photoperiod (the insurance lighting) as soon as they emerge. And since lilies do not emerge all at once, growers should gather groups of lilies as they emerge and begin insurance lighting. Gather pots with emerging shoots 2-3 times per week and make note of how long each block receives the insurance lighting. This is preferred since insurance lighting will also cause stretching, therefore excessive lighting of more than two weeks will provide no additional benefit in terms of vernalization and will only serve to produce taller lilies with fewer buds. Note that the insurance lighting period will coincide with lily bud initiation so keep day/night temperatures between 60-65F during this period.

Leaf counting & forcing temperatures:

If you haven't previously use leaf counting, this will be a good year to start. Begin using the leaf counting technique to track lily development as soon as bud initiation is complete. You should be able to start this by week 11 or 10 (Jan. 10-17). This will allow you adequate time to determine if lily development is on track, and if not, to make the necessary adjustments. Don't wait to start leaf counting this year. Too often growers do not realize their crop is behind schedule until after visible buds fail to appear at about week 6.

Run lower average daily temperatures (55-60F) if lilies are ahead of schedule – an unlikely circumstance this season, or higher temperatures (70-75F) if behind schedule. Begin to assess crop development early

so that temperature extremes can be avoided later. Typical leaf unfolding rates vary from approximately one leaf/day at 53F to 1.5 leaves/day at 63F, 2 leaves/day at 72F and 2.5 leaves/day at 82F. Forcing temperatures between 55-70F produce the highest quality lilies and are most fuel-efficient.

Once lilies reach visible bud they will typically flower in 30 days at 70F and 35 days at 65F. Monitor bud development by measuring bud length. Adjust temperature as needed to stay on schedule. A 'bud stick' is a useful tool to gauge the rate of lily bud development and the time needed to finish at a specific temperature. If you don't have a bud stick refer to Table 1 to estimate the rate of bud development. I recommend you assess bud development early and adjust temperatures at that time. In late Easter seasons growers in northern climates often hold off on forcing bud development until the last two weeks, knowing that high natural light and warm weather in early- to mid-April will assist in this effort. But this season, you will have to push in late February and early March for the early sales dates. Ask yourself, what conditions can I expect this time of year? If winter weather patterns are still likely to prevail at your site, start your push earlier.

Table 1. To use this table, measure the length of your lily buds. Move across the table horizontally to the column that lists the temperature you are running in your greenhouse. The number you see is the approximate number of days that it will take for the buds to open at that temperature.

Length of lily buds (inches)	Greenhouse air temperature (24-hour average)				
	59F	64F	70F	75F	81F
	Approximate number of days to flowering at each temperature				
2"	24	20	17	15	12.5
3"	15	13	11	9.5	8
4"	9.5	8	7	6	5
5"	5	4.5	3.5	3	2.5

Uneven temperatures produce uneven crops. Use horizontal airflow to equalize greenhouse air temperatures. If you need to use temperatures above 80F to push lilies at the end, take care to maintain adequate soil moisture and humidity levels or lily development may stall and buds may abort.

Height control: Growth regulators should not be applied until after flower buds have set (early- to mid-January 2016). Use DIF to control lily height during flower initiation. Equal day/night temperatures or cool morning temperatures will produce a DIF effect and keep lilies short. The conventional PGR program uses a single application of A-Rest, Concise, Topflor or Sumagic as needed when shoots are 3-5" tall. The dose used is high enough to provide control through to about week 6. However, many growers have learned to fine tune PGR applications to exert more precise control on the crop and with far better results. A typical program may call for weekly applications as needed to either slow stem stretch with a growth retardant such as Sumagic, or increase stretch with gibberellins such as in Fascination, or to prevent leaf yellowing in closely spaced plants (also with Fascination). Growers that use such programs are successfully applying growth retardants to lilies that are past the visible bud stage.

Even if you are inclined to be more conservative in your PGR practices, split applications are preferred. Split applications produce the most desirable plants. With split applications, use half the normal dose at the first application and then a one-quarter to one-half dose in subsequent applications (depending on the number of applications you plan to use and the amount of control needed). Lilies exposed to high concentrations of

growth retardants have a greater tendency to develop lower leaf yellowing in the later stages of production. Some growers have been applying low concentrations of Sumagic (or similar products) just as the shoot emerges and then following with a second application when the bud initiation period is over. I prefer to allow bud initiation to be completed before altering natural hormone levels in the plant. Plus if you are maintaining 63F day and night, as you should, you already have a zero DIF regime that will limit stretching during this phase. If you still wish to apply PGRs at this time, I recommend the lowest effective dose (1/8th – 1/4th the normal dose). Just apply enough to hold the plant for 7-10 days rather than the typical 3-5 weeks.

Nutrition:

Proper nutrition is also important in early crop development. Inadequate nitrogen early in development leads to small bottom leaves and small leaves limit the potential for subsequent growth. To get plants off to a good start, provide a single application of 400-600 ppm nitrogen at first irrigation as lilies begin to emerge. This will help to stimulate early leaf development. Remember the more leaf area a plant has, the more sunlight the leaves will gather and that translates into greater growth. Phosphorus is also important in early lily development. Older recommendations withheld phosphorus nutrition in lily to avoid leaf scorch caused by fluoride toxicity. (Fluoride is found in phosphorus based fertilizers and some soil amendments). But phosphorus is also important for strong root development. Use a complete fertilizer formulation, such as a 20-10-20, for the initial feed.

After the initial feeding use a 15-0-15 formulation, but if phosphorus was not added to the medium use the 20-10-20 formulation on an alternating basis with the 15-0-15. Fertilizer rates should range from 200-400 ppm. Do not allow medium EC to exceed 3-3.5 mmho/cm based on a Saturated Media Extract. Periodic nutrient testing is advisable during the crop. Testing the nutrient status of young but fully expanded leaves will provide the most accurate picture of lily nutritional status. Leaf tissue nutrient content should fall in the following ranges, 2.4-4% nitrogen, 0.1-0.7% phosphorus, 2-5% potassium, 0.2-4% calcium, 0.3-2% magnesium, 100-250 ppm iron, 50-250 ppm manganese, 30-70 ppm zinc, 5-25 ppm copper, 20-50 ppm boron.

Managing Disease:

Pests and other problems: Before planting, clean bulbs of debris removing any damaged scales, especially scales that show evidence of infection. Once potted, root rots associated with Rhizoctonia, Fusarium, and Pythium are a concern. Drench immediately with Banrot, Pageant Intrinsic, or Empress Intrinsic, broad-spectrum fungicides, or you can treat to control these diseases separately by selecting from the fungicides specifically registered for Rhizoctonia, Fusarium and Pythium control on lily. Materials registered for Rhizoctonia and/or Fusarium include Cleary's 3336, OHP 6672 26GT, 26/36 and many generics such as Pageant Intrinsic and Contrast (Rhizoctonia), and Terraclor (Rhizoctonia). Materials registered for controlling Pythium include Alude, Banol, Subdue Maxx (beware of using mefenoxam exclusively because of widespread fungicide resistance issues with this active ingredient), Segway O, and Truban. Check with manufacturers regarding compatibility when tank mixing fungicides. Fungicides may need to be re-applied later in the crop, check labels for guidance. Preventative biological fungicides (RootShield, Rootshield Plus, CEASE, Actinovate, Mycostop, Companion and Triathlon BA) may be applied at planting for disease suppression and to enhance root growth. Check with company or product labels information for safe time intervals between application of biological agents and chemical fungicides.

Aphids, fungus gnats and bulb mites are a major concern. Many chemicals are listed for aphid control, including: Safari, Flagship, Tristar, Marathon and many generics, DuraGuard, Enstar AQ, Suffoil X, Insecticidal Soap, M- Pede, Kontos, Endeavor, Aria, Mainspring, Rycar and XXpire. Fungus gnats can

be controlled with some of these same chemicals as well as Citation, Distance, Adept, Pylon, insect parasitic nematodes (Nemasys, NemaShield, Scanmask, Entonem) and Gnatrol WDG. Bulb mites, *Rhizoglyphus robini*, represent one of the more troublesome insect pests on lilies and effective management requires an integrated approach. Bulb mites are considered a secondary pest and are commonly associated with decay caused by fungus gnat damage and soil-borne fungal pathogens. The soil dwelling predatory mite, *Hypoaspis aculeifer*, may help suppress bulb mites. Note: Registration of pesticides varies by state so consult and follow labels for registered use. To avoid any potential phytotoxicity or residue problems, spot test before widespread use. (No discrimination is intended for any products not listed.)

Leaf yellowing can develop gradually in the greenhouse or suddenly and severely after lilies are sold. Gradual leaf yellowing can be a sign of chronic stress due to a persistent and unfavorable environmental condition or a telltale symptom of a diseased root system. Improper nutrition, poor media aeration or overwatering, and low light and poor air movement from tight plant spacing, are conditions that are conducive to leaf yellowing.

Sudden and severe leaf yellowing at the end of the crop is most likely to occur on lilies in poor root health and suffering from the poor nutritional and carbohydrate status associated with a bad root system. Prolonged cold storage prior to shipping and poor shipping conditions can also favor sudden, catastrophic yellowing.

To prevent early- and mid-season leaf yellowing (from 7-10 days before visible bud until 7-10 days after visible bud), spray Fascination at 10/10ppm. (Note: Fresco and Fascination are similar PGR formulations, both contain two active ingredients and recommendations are provided in a format that reflects the concentration of each). Apply only to lower leaves and cover thoroughly. To prevent late-season leaf yellowing and post-harvest flower senescence, spray 100/100ppm to thoroughly cover all foliage and buds. To protect leaves from yellowing during shipping or cooling, apply when buds are 3 to 3 ½" long but not more than 14 days before the start of shipping or cooling. Side effects include increased stem stretch so avoid contact with immature leaves during early- and mid-season applications unless increased height is your objective. Growers sometimes spray these compounds at 3-5ppm at 7-day intervals or as needed to increase stem stretch.

Getting Ready to Ship: Lilies require adequate fertilization from planting to finish but high salts in shipping can be a problem. Apply one clear watering right before shipping to lower salt levels and enhance the keeping quality for the consumer.

Good quality lilies can deteriorate rapidly after leaving the greenhouse. Avoid holding sleeved and boxed lilies for long periods of time, especially when temperatures are high in the shipping container. EthylBloc can also be used to increase post-harvest flower life. EthylBloc works by inhibiting the damaging effects of ethylene (a naturally occurring plant hormone that greatly accelerates the onset of leaf yellowing, and flower aging and death). Plants produce ethylene naturally but ethylene can also result from the incomplete combustion of fuels in a greenhouse, shipping, or warehouse environment.

The active ingredient in EthylBloc, 1-methylcyclopropene or 1-MCP, is released as a gas and therefore lilies must be treated in an enclosed environment. A sealed shipping container or truck, or sealed greenhouse can be used to treat plants. Flowers must be fully developed before treatment. To extend flower-life, treat lilies with EthylBloc just prior to harvest, or immediately after harvest, or just prior to

shipping, or upon arrival from a supplier, or just prior to sale. Note that repeat applications are not harmful and are recommended on species such as lily that bloom sequentially over time.

Even experienced growers should anticipate that the 2016 schedule will be a challenge. How big a challenge will depend on when the bulbs arrive and the physiological condition they are in when you start your schedule. You won't know any of this until the digging season is complete. Regardless, anticipate a very tight schedule for Easter 2016 and the need to cut a few corners to make this crop on time. Before the season starts, make sure your insurance lighting system is ready to go and decide where in the schedule you want to cheat for time. Once started, stay on top of crop development by tracking leaf unfolding and bud development. You don't want to fall behind too far or you may not be able to catch up. As was the case in 2008, 2016 is a leap year so you do have one extra day. Good luck and have a profitable Easter in 2016.



Photo 1: With an early Easter in 2016, an early jump on the forcing schedule will be critical. Plant pot-cooled bulbs as soon as they arrive, or begin chilling case-cooled bulbs upon arrival.



Photo 2: Lily crop emergence can be uneven. With pot-cooled bulbs, holding at 60-62F for 3 weeks prior to chilling improves cold perception during vernalization and allows bulbs time to mature which helps to produce more uniform shoot development and flower response. You may not have time for the full 3 weeks this year but at least 1 week of pre-chilling conditioning is critical.



Photo 3: Start leaf counting and track crop progress on the schedule as soon as bud set is complete.



Photo 4a: To keep on schedule track the progress of representative plants throughout the crop by marking individual plants and recording leaf unfolding rates regularly during the greenhouse forcing stage.



Photo 4b: Track the progress height of representative plants throughout the crop by recording the height of individual plants and comparing to target heights on the lily schedule. Adjust your PGR regimen and DIF program accordingly to meet targeted production heights.



Photo 5: Lower leaf yellowing typically begins at about visible bud. Gradual leaf yellowing can be a sign of chronic stress due to a persistent and unfavorable environmental condition or a telltale symptom of a diseased root system. Improper nutrition, poor media aeration or overwatering, and low light and poor air movement from tight plant spacing, are conditions that are conducive to leaf yellowing. Periodic treatments with Fascination or similar products can suppress lower leaf yellowing.

2016 EASTER LILY SCHEDULE

Weeks Prior to Easter	Date	Forcing Method	
		Case-Cooled	Pot-Cooled (CTF)
23	Oct. 18	<i>Bulbs dug, shipped & in hand by mid-Oct. Treat bulbs for mites before cooling begins.</i> Start bulb programming as soon as bulbs arrive but no later than 23 weeks before Easter. <i>Cool at 40-45F for 6 weeks</i>	
			<i>Pot & allow roots to grow at 60-62F for up to 3 weeks</i>
20	Nov. 8	---	<i>Cool at 40-45F for 6 weeks</i>
17	Nov. 29	Pot no later than 17 weeks before Easter Force in greenhouse at 60-62F in pot.	---
14	Dec. 20	<i>Roots visible by week 15 & shoots emerge by week 14. Start fertilizing & keep moist.</i>	Force in greenhouse at 60-62F in pot (no later than 14 weeks before Easter).
13	Dec. 27	1-2" tall. Apply insurance lighting if necessary, just as lilies emerge. Keep lilies moist & use fungicide drench as needed.	
12	Jan. 3	2-3" tall. Bud initiation coincides with stem root development. Run 60-62F-day/ nights until bud set is complete.	
11	Jan. 10	3-4" tall. Apply growth regulator when 3-5" tall. Bud initiation nearly complete, maintain temperature below 65F until done.	
10	Jan. 17	Check for bud set. Begin leaf counting & graphical tracking. Keep greenhouse cool if ahead of schedule.	
9	Jan. 24	5-6" tall. Adjust temperatures as needed. Space lilies to avoid yellow leaves & stretching. Apply Fascination to lower leaves (7 to 10 days before visible bud) if leaf yellowing is evident.	
8	Jan. 31	Check for aphids & root problems. Apply Marathon sometime during weeks 10, 9, or 8. Soil test & if leaf scorch is evident, use calcium nitrate for balance of schedule.	
7	Feb. 7	7-8" tall. Lilies are about half final height. 42 days to sale. Buds can be felt. If buds are visible on early planting run 60F until finish.	
6	Feb. 14	35 days to sale. Buds should be visible no later than 30 days prior to sale. Grade for uniformity as buds become visible.	
5	Feb. 21	Buds 1/2-1" long. Re-apply Fascination if necessary.	
4	Feb. 28	Buds 1-1 1/2", some bending down.	
3	March 6	Buds 1 1/2-2" long. If aphids present, use a total release smoke or aerosol.	
2	March 13	Buds 2 1/2-4" long, some turning whitish. Stop fertilizing just before sale & apply clear water once. Cool lilies at 35-45F to hold. Prior to cold storage, Fascination can be applied to entire plant.	
1	March 20	Ready to sell. Shade lilies once removed from storage. If needed, use EthylBloc prior to shipping.	
0	March 27	Easter 2016	