The basics on light and

by John E. Erwin, Royal D. Heins, Meriam Karlsson, Robert Berghage, William Carlson and John Bienbaum

The process of flowering an Easter lily consists of two major phases: the programming or cooling phase and the forcing phase. The lily bulb is exposed to cold temperatures to promote bolting and flower induction during cooling. The cooled lily initiates flowers and flowers in the greenhouse during the forcing phase. This article discusses the influence of light and temperature on lily morphology and rate of development during forcing.

Light, quantity and quality

Light quantity and quality influence Easter lily morphology but do not influence rate of plant development.

The three plants in Figure 1 show that light does not influence the rate of lily development. These plants were grown in the same greenhouse at the same temperature but with different photoperiods, varying from two to eight hours (right to left) resulting in at least a fourfold difference in the amount of light which the plants received during forcing. All three plants flowered at the same time; however, their height and appearance were vastly different.

Certainly light has an indirect effect on rate of plant development. Bright, sunny days result in warmer greenhouse air and warmer plant temperatures. Warmer plant temperatures result in faster plant development.

In general, lily plant height and leaf length increase as the light level during forcing decreases. Also, bud abortion increases when the amount of light is low. One may argue the increase in plant height shown in Figure 1 was due to a shortened photoperiod.

We do not believe this is the case based on other experiments. In these experiments, plants grown with four- and eight-hour photoperiods were shortest. Increasing the daylength to longer than eight hours per day increased plant height. Decreasing day-length below four hours also resulted in taller plants. We believe the increased height with longer photoperiods was a plant photoperiodic response. On plants grown with less than four hours of light, the increase in plant height was due to low light.

Light quality also influences Easter lily height at flower. Light sources high in far-red light, such as incandescent lights, increase plant height. Light sources high in red light such as sunlight and fluorescent light result in shorter plants.

The quality of light a lily receives at the end of the day or during the middle of the night is particularly important in determining plant height (Figure 2).

Night interruption lighting with incandescent light for one or two weeks after emergence to ensure proper programming or flower induction (the insurance policy developed by Dr. Harold Wilkins, University of Minnesota) will normally result in minimal increases in final plant height. However, night interruption lighting later than two weeks after emergence may result in significant increases in plant height. Likewise, nighttime light pollution from incandescent lights that are used...

<table>
<thead>
<tr>
<th>Temperature (°F)</th>
<th>Days from visible bud to flower</th>
<th>Decrease from visible bud to flower associated with 5°F temperature increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>42</td>
<td>4 days</td>
</tr>
<tr>
<td>60</td>
<td>38</td>
<td>4 days</td>
</tr>
<tr>
<td>65</td>
<td>34</td>
<td>3 days</td>
</tr>
<tr>
<td>70</td>
<td>31</td>
<td>3 days</td>
</tr>
<tr>
<td>75</td>
<td>27</td>
<td>2 days</td>
</tr>
<tr>
<td>80</td>
<td>25</td>
<td>1 day</td>
</tr>
<tr>
<td>85</td>
<td>24</td>
<td>0 days</td>
</tr>
</tbody>
</table>

Table 1. The effect of temperature on the rate of lily development from the visible bud stage until flower.
to keep chrysanthemums vegetative will increase final lily height. Light pollution from high pressure sodium lamps will also increase plant height due to longer photoperiods. This increase, however, will not be as great as that from incandescent light pollution.

**Effects of temperature on growth**

Temperature influences both the rate of Easter lily development and final plant morphology. The effect of temperature on the rate of lily development differs during different stages.

The rate of leaf unfolding in the Easter lily is a linear function of average daily temperature between 55°F and 85°F (Figure 3). Because the effect is linear, a temperature increase from 55°F to 60°F results in the same increase in the rate of leaf unfolding as an increase in temperature from 80°F to 85°F. While the leaf unfolding rate increases at temperatures above 70°F to 75°F, high temperatures are not recommended due to increased root loss, leaf yellowing and flower bud abortion.

The effect of temperature on the rate of lily development after visible bud is not linear. Instead, increasing temperature has a diminishing effect on accelerating the rate of plant development. The greatest reduction in the time from visible bud until flower occurs is when the temperature increases from 55°F to 70°F (Table 1). Increasing average temperatures above 72°F does not significantly reduce the time from visible bud until flower. Further, average temperatures above 72°F increase the incidence of root loss, leaf yellowing and flower bud abortion.

The Easter lily is thermomorphogenic, which means temperature influences plant morphology. Easter lily morphology is also thermoperiodic. That means plant growth responds differently to day temperature and night temperature. Plant height increases as day temperatures increase from 55°F to 85°F (Figure 4). In contrast, lily height
and a grower might be growing for several other chains. So he has to separately tag and identify all of that chain’s plants. This is going to involve a lot of hand labeling at the time of shipping."

Tim made an interesting point about the Meijer chain—a very large general merchandise and food chain through Michigan and Ohio mostly. At Meijer you pay for bedding plants and pot plants in the garden center area—not at the general checkout counters. Which means that the few people who are working checkout in this area will tend to know products and prices very well—thus minimizing the need for bar coding. The checkout people in this area will know nothing about 95% of the items in the store—but they will know a lot about the 5% of floral.

Also, Tim sees coding as tending to de-emphasize proprietary varieties. To whatever extent the industry has gotten used to Ringo red geraniums or Pink Magic petunias, there will be less of this just because identifying varieties on codes would greatly compound the whole problem. Too bad.

Comments from salesmen

We hear the same thing from several salesmen: A lot of US bedding plants are grown and sold by small local growers and small individual garden centers, and bar coding is too expensive, too complex for this type of retailing today. But you’ve got to face the fact that the mass outlets are handling an increasing part of US pot plants and bedding plants.

To conclude

That’s the way it all looks to us as of September ‘87. Surely this will all change, evolve rapidly. Again, codes are coming. If mass markets are for you, better do some digging here.

Comments from salesmen

We hear the same thing from several salesmen: A lot of US bedding plants are grown and sold by small local growers and small individual garden centers, and bar coding is too expensive, too complex for this type of retailing today. But you’ve got to face the fact that the mass outlets are handling an increasing part of US pot plants and bedding plants.
The influence of day temperature and night temperature on Lilium longiflorum morphology at flower Figure 4: The effect of increasing day temperature from 57°F (14°C) to 86°F (30°C) on Easter lily plant height at flower while maintaining a constant 57°F (14°C) night temperature.

Figure 5: The effect of increasing night temperature from 57°F (14°C) to 86°F (30°C) on Easter lily plant height at flower while maintaining a constant 72°F (22°C) day temperature.

decreases as night temperatures increase from 55°F to 85°F (Figure 5).

Combining the effects of day and night temperature on plant height, we find that the relationship between day and night temperature determines lily plant height—not absolute temperature. Each of the four plants shown in Figure 6 have a night temperature 7°F (4°C) warmer than the day temperature. Although each of the plants flowered at different times, they all flowered at the same height. A convenient way to quantify the relationship is to subtract the night temperature from the day temperature. This number is the difference between the day and night temperature (DIF). Plant height increases as DIF increases (Figure 7).

Leaf orientation, the position of the leaf tip relative to the leaf base, is also strongly influenced by DIF (Figure 8). The relationship between DIF and leaf orientation is similar to that seen with plant height. Leaf orientation increases as DIF increases—leaf orientation is near horizontal when DIF is zero, upright with a positive DIF and curved downward with a negative DIF.

Some leaf chlorosis or yellowing occurs whenever the night temperature is greater than the day temperature, i.e. a negative DIF (Figure 9). The amount of chlorosis depends on how much warmer the night temperature is than the day temperature. The

MULTI-VEYOR

the MULTI-SECTION CONVEYOR SYSTEM

- Each section is 12½ ft long
- Lightweight, portable
- Variable Speed, Reversible
- Plug into any 110v outlet
- Stackable for easy storage
- Use as an assembly line
- Use the length needed for each job

☐ Tell me more about Multi-veyor.

W.L.V. Sales Co.
130-13 Bodman Place, Red Bank, NJ 07701
Phone (201) 747-5805 In Florida (813) 787-2805

GrowerTalks
chlorosis is not persistent and lasts about two weeks. Leaf chlorosis disappears rapidly when the day temperature is raised above the night temperature. Raising the day temperature above the night temperature is not necessary as the plants green up by flowering time.

Figure 9: The effect of growing Easter lilies at either a negative 18°F (10°C) difference, no difference or a positive 18°F (10°C) difference for seven consecutive days following flower initiation.

The response of the Easter lily to DIF is rapid. Both stem elongation and leaf orientation responses to DIF occur within 24 hours and is very obvious after seven days (Figure 9). Not only is chlorosis present after a single day/night cycle with a negative DIF, but so is a change in leaf orientation. Stem elongation has also slowed after one 24 hours.

ARE YOU A FLOWER BULB FORCER WHO WANTS TO EXPAND YOUR PRODUCTION?

If your answer is yes, then the International Flower Bulb Center in Hillegom, The Netherlands, can help you. As part of our foreign extension service, we will assist you on how to grow beautiful cut flowers from Dutch-grown flower bulbs. This season we will again send you FREE technical bulletins from September to April.

Dr. August DeHertogh, from North Carolina State University, who has much experience in forcing flower bulbs, is cooperating and will write 4 special information bulletins on the forcing of flower bulbs as potted plants.

Return this order form for your free subscription!

YES, please send me your free monthly bulletin on forcing.
Information about cut flowers:
I AM INTERESTED IN: tulips, daffodils, Dutch iris, hyacinths, etc. YES/NO lilies, gladiolus, liatris, etc. YES/NO

Information about flower bulbs as potted plants:
I AM INTERESTED IN: hyacinths, tulips, daffodils etc. YES/NO oxalis, calla, freesia, lily etc. YES/NO

Name (please print): .................................................................
Company name: .................................................................
Street address: .................................................................
City: ................................................................. State: ................................................................. Zip: .................................................................
MAIL TO: International Flower Bulb Center, P.O. Box 172, 2180 AD HILLEGOM, The Netherlands
Figure 6: Appearance of Easter lilies at flower when grown under four temperature regimens where the day temperatures were 7°F (4°C) warmer than the night temperatures. Plants grown at higher temperatures flowered earlier than plants grown at cooler temperatures. As plants grown at higher temperatures flowered, they were placed in a cooler until all plants grown at cooler temperatures flowered. The photograph was then taken.

Conclusions
The rate of lily development and plant morphology are affected by temperature. Light influences plant appearance, but not the rate of plant development. By combining our knowledge of how temperature influences the rate of plant development and how DIF influences plant morphology, we can tailor temperatures to precisely control the rate of plant development and plant height.

William Carlson, professor, Royal Heins, associate professor, John Bierbaum, assistant professor and Robert Berglage, John Erwin and Meriam Karlsson, graduate students, are with Michigan State University, East Lansing.

TALSTAR 10WP
INSECTICIDE/MITICIDE

NEW second generation synthetic pyrethroid

TALSTAR is a new, second generation synthetic pyrethroid manufactured by FMC. A broad spectrum chemical compound that will effectively control aphids, whitefly, two-spotted spidermite, mealybug, leafroller, scale and army worm. Written performance guarantee fully backed by FMC.

Catalog No.          Price
31-83141               6-1 lb jars      $50.00/jar

SPECIAL OFFER: Free jar with 12-jar order.

FREE LIMITED EDITION
Send for 184-pg. catalog of insecticide, fungicide, fertilizer CHARTS & FORMULAS plus all greenhouse & nursery equipment & supplies.

Name ____________________________
Street ____________________________
City, State & Zip ___________________

FOR ORDERS, PHONE TOLL FREE — 1-800-4GEIGER

E. C. GEIGER, INC.
BOX 285, DEPT T, HARLEYSVILLE, PA 19438
PHONE: 215-256-6511
FOR ORDERS: 800-440-4437
TELEX (TWX) 510-661-8744 GEIGERINT HARL

GrowerTalks