Easter Lily Leaf Unfolding Technique

Royal Heins, Department of Horticulture, Michigan State University

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 one knows how many leaves have yet to unfold on a plant before the visible bud stage, one can calculate how many leaves must unfold each day (or work) in order to reach the visible bud stage by a particular date. By knowing the number of leaves which must unfold each week and by making a count of leaves which actually unfolded the previous week, one can determine if a crop is slow, fast or on time. Subsequently, the air temperature may be increased or decreased to hasten or delay plant development for proper crop timing. The following describes how to leaf count a lily crop.

1) Leaf counting is usually started 3-4 weeks after emergence or when plants are 3-4 inches tall. The first plants are examined to determine if flower initiation has occurred. 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 estimate the average leaf number of the crop. 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 which are at an angle equal to or greater than 45^0 with the plant stem. Leaves yet to unfold are defined as those leaves which have an angle of less than 45^o with the plant stem. The actual leaf angle is less important than consistency between countings. A large needle and a magnifying glass will help you remove small scale-like leaves near the shoot apex. The embryo-like flower buds will be present on reproductive plants. An estimate of the future bud count can be made on these plants.

3. Divide the number of leaves already unfolded by the number of days from emergence until the present date. This will tell how many leaves have unfolded each day to date.

4) Determine the visible bud date. The visible bud date is normally 30-35 days prior to the expected flower date (often the week prior to Palm Sunday). It takes 30 days from visible bud to flower at 70°F (21°C) and 35 days at 65°F (18°C). Not all plants reach visible bud the same day.

5) Divide the number of leaves which have yet to unfold by the number of days from the day of leaf counting until the expected visible bud date. This figure tells you how many leaves must unfold each day to achieve visible bud at the desired 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 counting, then the average greenhouse air temperature should be increased. 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, the average air temperature should be decreased to slow development.

7) In the greenhouse, mark the last unfolded leaves on several representative plants of each lot and bulb size. Different methods can be used. They include marking each unfolded leaf with a magic marker or hole punch or by placing a wire hoop above all expanded leaves on the shoot but below the yet unexpanded leaves. We recommend the use of a wire hoop.

8) Every 3 to 4 days (twice a week) count and record the average number of leaves unfolded, calculate the daily unfolding rate. Compare the days and determine if the leaf number was higher or lower than that which was necessary for proper timing. 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 is the same as that from 70° to 75°F.

Easter Lily Crop Log 2002-2003 (April 20, 2003)

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:

	Applic. 1	Applic. 2	Applic. 3	Applic. 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 _____

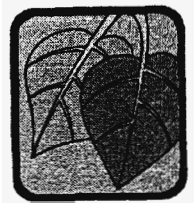
Plant Height at Flower _____

Prefinished Easter Lily Schedule
2002-2003 Production Year

An increasing number of Easter lily growers are purchasing prefinished Easter lily plants. A prefinished plant has already been cooled, the shoot has emerged and, in general, flower initiation has occurred. In some cases flower initiation has not if plants arrive prior to January 28. A schedule for a prefinished crop is presented below. Critical issues that a forcer must contend with when receiving prefinished plants include: the cooling treatment and flower initiation is conducted by someone else thus taking much of the control of flowering out of the forcers hands. In addition, the final leaf number is greatly impacted by the cooling method used and can, therefore, greatly affect the schedule in the forcers facility. It is, therefore, critical that a forcer specify and/or know the exact procedures for cooling in order to minimize any difficulty that may occur during forcing and to maximize final quality. We assume that prefinished product will be sold as a retail crop.

January 28

1) **Flower initiation is complete**
2) **Leaf count**
3) **Change day and night temperature to achieve desired leaf unfolding rate and DIF.**
4) Apply growth retardants as needed.



February 17

1) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

March 12

Spray Fascination to lower 1/3 of plant

March 19

1) **Visible Bud**
2) Space plants if possible
3) Apply fungicides for both *Pythium, Phytophthora* and *Rhizoctonia.*

March 26

Spray Fascination to lower 1/3 of plant

April 13-20

Retail

April 14-16

Flower

April 20

Easter

Wholesale Lily Schedule
2002-2003 Production Year

October 14-21

1) **Bulbs Arrive**
2) Pot Bulbs, Fertilize with 400 ppm nitrogen from a balanced fertilizer
3) Drench with fungicide for BOTH *Pythium* and *Rhizoctonia*
4) Grow at 65-67°F media temperature

November 4-11

1) **Start Cooling Treatment (42°F—6 weeks)**
2) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

December 16-23

1) **Place plants in 65-67°F greenhouse**
2) Pot Bulbs, Fertilize with 400 ppm nitrogen from a balanced fertilizer
3) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia*
4) Grow at 65-67°F media temperature

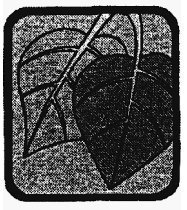
January 3-10

100% of shoots should be emerged

January 20

1) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

January 28



1) **Flower initiation is complete**
2) **Leaf count**
3) **Change day and night temperature to achieve desired leaf unfolding rate and DIF.**
4) Apply growth retardants as needed.

February 17

1) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

March 10

Spray Fascination to lower 1/3 of plant

March 17

1) **Visible Bud**
2) Space plants if possible
3) Apply fungicides for *Pythium* and *Rhizoctonia.*

March 24

Spray Fascination to lower 1/3 of plant

April 14-18

Ship

April 14

Flower

April 20

Easter

Wholesaler Easter Lily Schedule (Early for Storage)
2002-2003 Production Year

October 14-21

1) **Bulbs Arrive**
2) Pot Bulbs, Fertilize with 400 ppm nitrogen from a balanced fertilizer
3) Drench with fungicide for BOTH *Pythium* and *Rhizoctonia*
4) Grow at 65-67°F media temperature

November 4-11

1) **Start Cooling Treatment (42°F—6 weeks)**
2) Drench with fungicide for *Pythium*, *Phytophthora* and *Rhizoctonia.*

December 16-23

1) **Place plants in 65-67°F greenhouse**
2) Pot Bulbs, Fertilize with 400 ppm nitrogen from a balanced fertilizer
3) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia*
4) Grow at 65-67°F media temperature

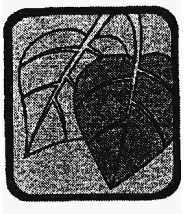
January 3-10

100% of shoots should be emerged

January 13

1) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

January 28



1) **Flower initiation is complete**
2) **Leaf count**
3) **Change day and night temperature to achieve desired leaf unfolding rate and DIF.**
4) Apply growth retardants as needed.

February 10

1) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

March 2

Spray Fascination to lower 1/3 of plant

March 9

1) **Visible Bud**
2) Space plants if possible
3) Apply fungicides for *Pythium, Phytophthora* and *Rhizoctonia.*

March 16

Spray Fascination to lower 1/3 of plant

April 4

Place in cooler for storage (45°F with lights)

April 14-18

Ship

April 14-18

Flower

Retailer Easter Lily Schedule (Normal)
2002-2003 Production Year

October 14-21

1) **Bulbs Arrive**
2) Pot Bulbs, Fertilize with 400 ppm nitrogen from a balanced fertilizer
3) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia*
4) Grow at 65-67°F media temperature

November 4-11

1) **Start Cooling Treatment (42°F—6 weeks)**
2) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

December 16-23

1) **Place plants in 65-67°F greenhouse**
2) Pot Bulbs, Fertilize with 400 ppm nitrogen from a balanced fertilizer
3) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia*
4) Grow at 65-67°F media temperature

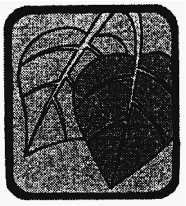
January 3-10

100% of shoots should be emerged

January 20

1) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

January 28



1) **Flower initiation is complete**
2) **Leaf count**
3) **Change day and night temperature to achieve desired leaf unfolding rate and DIF.**
4) Apply growth retardants as needed.

February 17

1) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

March 12

Spray Fascination to lower 1/3 of plant

March 19

1) **Visible Bud**
2) Space plants if possible
3) Apply fungicides for *Pythium, Phytophthora* and *Rhizoctonia.*

March 26

Spray Fascination to lower 1/3 of plant

April 13-20

Retail

April 14-16

Flower

April 20

Easter

Retailer Easter Lily Schedule (Early for Storage)
2002-2003 Production Year

October 14-21

1) **Bulbs Arrive**
2) Pot Bulbs, Fertilize with 400 ppm nitrogen from a balanced fertilizer
3) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia*
4) Grow at 65-67°F media temperature

November 4-11

1) **Start Cooling Treatment (42°F—6 weeks)**
2) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

December 16-23

1) **Place plants in 65-67°F greenhouse**
2) Pot Bulbs, Fertilize with 400 ppm nitrogen from a balanced fertilizer
3) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia*
4) Grow at 65-67°F media temperature

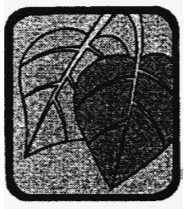
January 3-10

100% of shoots should be emerged

January 13

1) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

January 28



1) **Flower initiation is complete**
2) **Leaf count**
3) **Change day and night temperature to achieve desired leaf unfolding rate and DIF.**
4) Apply growth retardants as needed.

February 10

1) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

March 2

Spray Fascination to lower 1/3 of plant

March 9

1) **Visible Bud**
2) Space plants if possible
3) Apply fungicides for *Pythium, Phytophthora* and *Rhizoctonia.*

March 16

Spray Fascination to lower 1/3 of plant

April 4

Place in cooler for storage (45°F with lights)

April 13-20

Retail

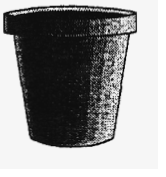
April 16

Flower

Case-Cooled Easter Lily Schedule
2002-2003 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 mid-December.

December 9-16



1) Place plants in 65-67°F greenhouse
2) Pot Bulbs, Fertilize with 400 ppm nitrogen from a balanced fertilizer
3) Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia*
4) Grow at 65-67°F media temperature

January 3-10

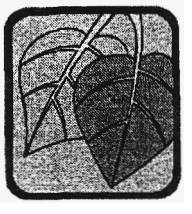
100% of shoots should be emerged

January 20

Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

January 28

1) Flower initiation is complete
2) Leaf count
3) Change day and night temperature to achieve desired leaf unfolding rate and DIF.
4) Apply growth retardants as needed.



February 17

Drench with fungicide for *Pythium, Phytophthora* and *Rhizoctonia.*

March 10-12

Spray Fascination to lower 1/3 of plant

March 17-19

1) **Visible Bud**
2) Space plants if possible
3) Apply fungicides for *Pythium, Phytophthora* and *Rhizoctonia.*

March 24-26

Spray Fascination to lower 1/3 of plant

April 14-18

Ship

April 14-16

Flower, Ship and Retail

April 20

Easter

October 2002

SUN	MON	TUE	WED	THU	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14 Bulbs Arrive	15 Plant	16 Root at 68°F	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

November 2002

SUN	MON	TUE	WED	THU	FRI	SAT
					1	2
3	4 Start Cooling	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 2002

SUN	MON	TUE	WED	THU	FRI	SAT
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16 Stop Cooling	17 Move to Greenhouse!	18 63-67°F Media	19	20	21
22	23	24	25	26	27	28
29	30	31				

January 2003

SUN	MON	TUE	WED	THU	FRI	SAT
			1	2	3 100% Emergence	4 →
5 →	6 →	7 →	8 →	9 →	10 →	11
12	13	14	15	16	17	18
19	20 Drench	21	22	23	24	25
26	27	28 Leaf Count	29 →	30 →	31 →	→

February 2003

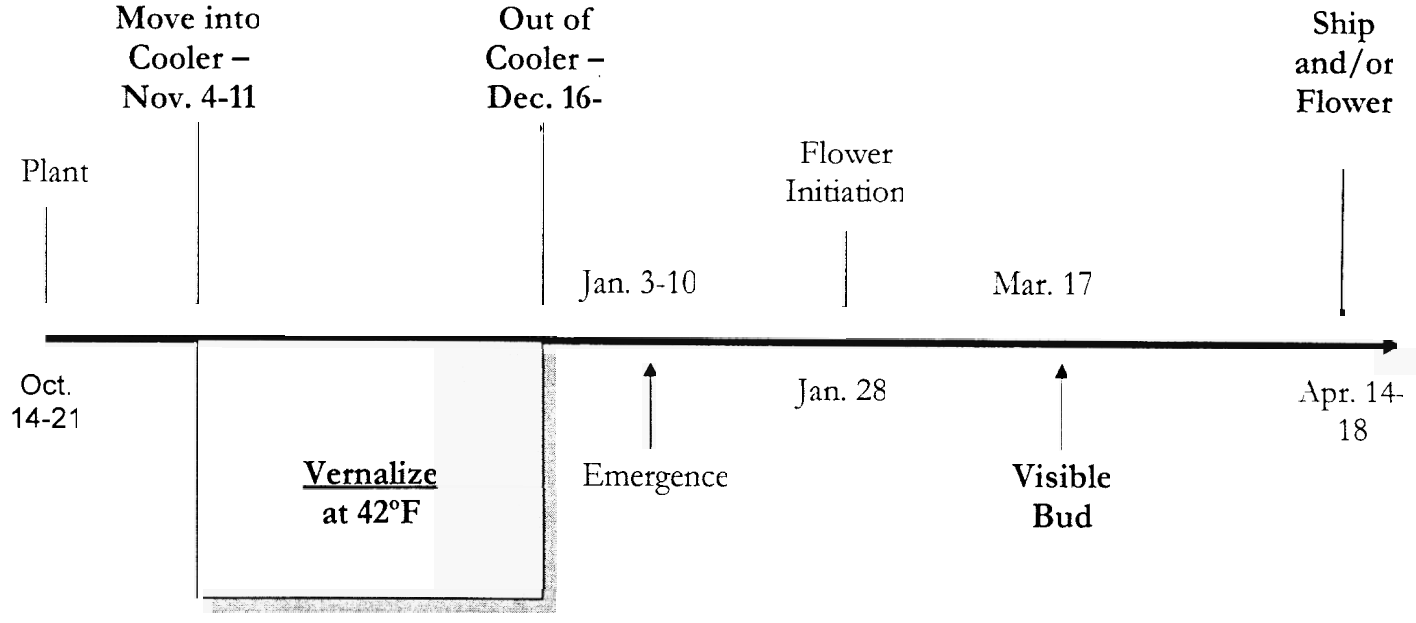
SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17 Drench	18	19	20	21	22
23	24	25	26	27	28	

March 2003

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

April 2003

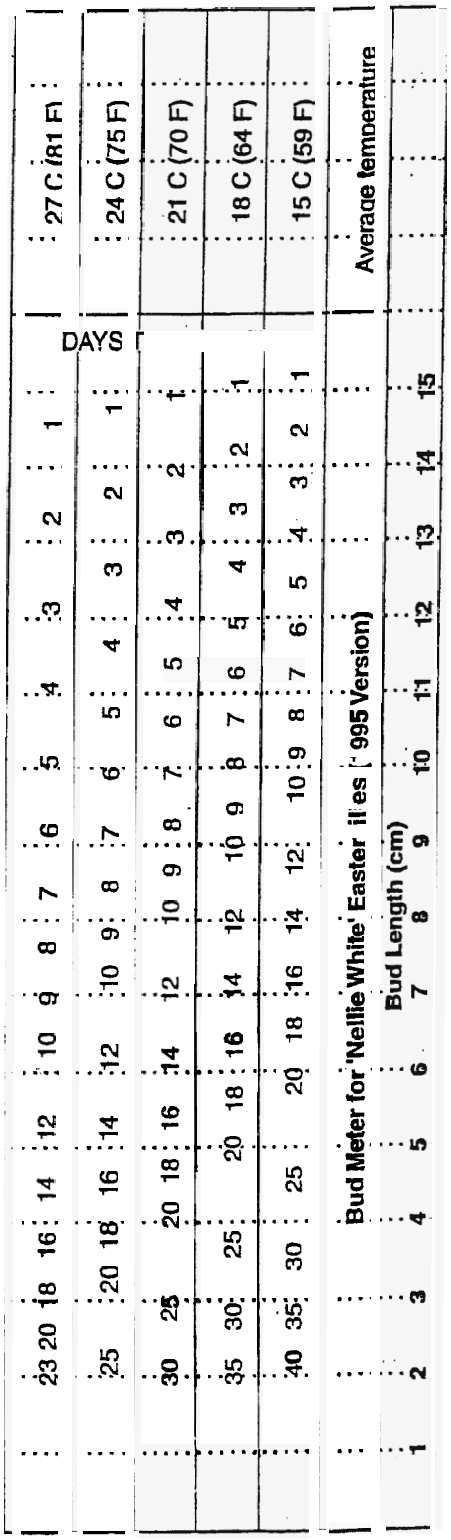
SUN	MON	TUE	WED	THU	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20 Easter	21	22	23	24	25	26
27	28	29	30			



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!

Easter Lily Bud Meter



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).

(continued from page 14—Root Rot)

fungicides. I have come across 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 a week before and a week after visible bud to the lower leaves only will reduce lower leaf yellowing. Therefore, if you don't have the space to space, apply Fascination.

Scheduling:

Plants can flower too early or too late when plants are not grown at appropriate temperatures between Jan. 28 (flower initiation) and the visible bud date. Inexact scheduling usually occurs because a grower has not counted the leaves yet to unfold and then delivered the average daily temperature to achieve the desired leaf-unfolding rate.

Solution: Count leaves around January 28. 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.

Over or Under cooling:

In general, a lily crop should receive 6 weeks of cooling at 42oF. 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 flower 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 42oF for 6 weeks they will be overcooled! 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 42oF.

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

Early Shoot Emergence While in the Cooler:

Shoots can emerge in the cooler if dormancy is broken early and stem elongation starts before cooling is complete. This can be a significant problem in dark coolers and/or coolers in which pots are stacked in such a way that no light reaches each pot. As a result, there can be excessive shoot elongation resulting in a complete loss of product.

Solution: Drop temperatures on a weekly basis for 1-2 days to 36oF to inhibit elongation. Provide fluorescent or daylight in the cooler to inhibit elongation. Stack plants in the cooler in such a way as to insure that 1) you can see if early shoot emergence is occurring, 2) to allow light to reach the surface of the media, and 3) dump a pot periodically to see if elongation of the shoot is occurring before the shoot breaks through the media surface and drop temperatures periodically to limit shoot (pin) emergence.