Facts About Easter Lilies

Derek R. Smith and R. W. Langhans
Department of Floriculture
Cornell University

The Easter Lily Progress Report presented in Bulletin 179 outlined the major problems (controlling flowering time, height, and flower number) when forcing this crop, provided some of the answers, and posed several additional questions for further investigation. During 1960-61 we have tried to answer some of these questions. This report will describe some of the work that has been done.

Temperature Treatments

It was previously pointed out that forcing temperature, particularly at night, had a profound effect upon speed of growth and development, and the flower number. We obtained our highest bud count when a night temperature of 60°and a day temperature of 70° were used throughout the forcing period. Temperatures lower and, more especially, higher than 60N-70D reduced the bud count. Forcing time at 60N-70D was intermediate. Lower temperature (50°) delayed, whereas higher temperature (80°) hastened flowering. We asked the question, "At what *stage*

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of growth does temperature have its greatest effect, and will different temperatures during various stages affect the bud count?"

To answer this the forcing life of the lily was divided into four stages. Ace and Croft lilies were grown at a base temperature of 60N-70D, and groups of 10 plants were removed during each of these stages and placed in greenhouses with automatic controls set to maintain constant night and day temperatures of 50°, 65° and 80°F. The growth responses of these plants were compared with those of control plants grown all the time at 60N-70D. Our choice of stages was not sufficiently detailed for a very precise answer to be given yet, but it was obvious with both varieties that the greatest accelerating effect of high temperature, and the greatest retarding effect of low temperature on the speed of development was obtained between the time the plants were about 6 inches tall and the first flower stage. These effects were particularly pronounced during the 2 weeks before, and the 2 weeks after, the flower buds first became visible. It is fortuate that the use of high temperature during this period does not involve the risk of reduced bud count that would be caused by its use during the early forcing stages, as was pointed out in our earlier report.

Photoperiodic Treatments

In Bulletin 179 it was shown that Croft lilies grown under an 18-hour photoperiod were about twice as tall as those under a 9-hour photoperiod at all temperatures. As with temperature, we asked ourselves *when* photoperiod had its greatest effect on plant height, and whether different photoperiods during growth stages would affect the bud count. As before, the forcing life of both Ace and Croft lilies was divided into 4 stages, and groups of 10 plants (otherwise grown under a natural photoperiod) were placed under photoperiods of 9, 15, and 24 hours. All were grown at a constant day and night temperature of 65°F. As with temperature, it was shown that in almost every case the effect of photoperiod was greatest during the latter stages of forcing. In the case of stem elongation under the longer photoperiods particularly, this effect was most pronounced during the 3 weeks before, and the 2 weeks after the visible bud stage. It is interesting to note that supplementary light may best be used at a time when the grower is able to form an opinion as to whether his plants are going to be tall or short at marketing time and, as we shall point out next, where there is little risk of bud abortion caused by long photoperiods.

Using Croft lilies, the treatments were extended to include photoperiods of 9, 12, 15, 18 and 24 hours, used throughout the forcing period. The plants were grown at a constant day and night temperature of 65°F. The results are shown in Table 1 and Figure 1. It can be seen that flowering height increased progressively with photoperiod, accompanied by a progressive decrease in flowering time and flower number. The reduced number under the longer photoperiods was caused by corresponding increases in the number of aborted buds during the early stages of forcing. Taking all these factors into consideration it appears that 15- and 18-hour photoperiods gave the best results.

At the suggestion of Mr. Charles Beckman of Long Island, the effect of flashing light was compared with that of continuous light, this time using the Georgia lily. It was felt that, if successful, this would provide a more economical use of electricity, and would also remove the argument that possible temperature increases under the black cloth with continuous light were the major cause of increased flowering height. The bulbs were planted on March 31, 1961, and given the treatments listed in Table 2. They were 7- to 9-inch grade, and grown at a temperature of 60N-70D throughout. The duration and intensity of natural daylight was such at this season of the year that there was little height increase with the treated over that of the control plants. What is important to note is that black cloth was pulled over all but the control plants at 5 pm, and removed at 8 am, allowing the plants only 9 hours of natural daylight. Whereas the short-day (9 hour) plants without supplementary illumination grew only 19.2 inches tall, those with supplementary light grew 25.2 to 26.0 inches tall, and the effect of light for only 5 seconds per minute from 10 pm to 2 am produced effects equal to that for 10, 15 and 30 seconds per minute. In addition, all these periods of intermittent illumination produced height effects almost identical with the same period of continuous light. Figure 2 shows representative plants from each treatment.

Thus it can be seen that the stretching period of sup-

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TABLE 1: The effect of photoperiod on the growth and flowering of Croft Easter lilies grown at a temperaature of 65°F. Treatments were started December 14, 1960.

Photoperiod (hrs.)	Forcing Time (days)	No. Flowers	No. Aborted Buds	Flowering Height (ins.)
9	99	4.0	0.1	12.8
12	97	3.5	0.5	19.2
15	93	3.0	0.4	23.2
18	91	3.2	1.0	25.6
24	87	2.5	1.9	26.4
Natural	100	3.3	0.3	13.2

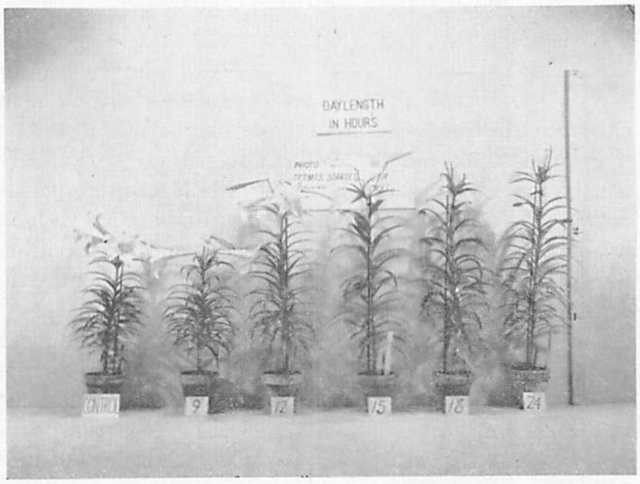

Figure 1: The effect of different photoperiods on the growth of Croft lilies. The treatments were (from L. to R.): control (natural daylength), 9-hr., 12-hr., 18-hr. and 24-hr. photoperiods. Plants were grown at a constant temperature of 65°F.

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TABLE 2: A comparison of the effect of continuous and and intermittent supplementary illumiation on the growth and flowering of Georgia Easter lilies grown at a temperature of 60N-70D. Treatments were started March 31, 1961.

Treatment	Forcing Time (days)	No. Flowers	No. Aborted Buds	Flowering Ht. (ins.)
9-hr. photoperiod	85	5.0	0	19.2
15-hr. photoperiod	79	3.9	0.7	28.8
24-hr. photoperiod	76	3.5	0.2	28.0
Continuous light—10 pm to 2 am	83	4.8	0.3	25.2
Light, 5 sec./min.—10 pm to 2 am	83	4.8	0	26.0
Light, 10 sec./min.—10 pm to 2 am	84	4.4	0.1	24.4
Light, 15 sec./min.—10 pm to 2 am	84	4.6	0.3	25.6
Light, 30 sec./min.—10 pm to 2 am	83	4.5	0.3	25.6
Natural photoperiod	89	5.4	0.2	24.8

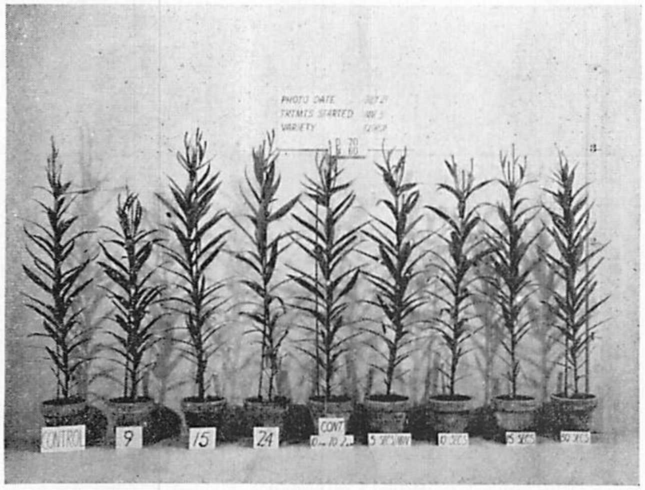

Figure 2: The effect of continuous and intermittent supplementary light on the growth of Georgia lilies. The treatments were (from L. to R.): control (natural daylength), 9-hr., 15-hr. and 24-hr. photoperiods, continuous light 10 pm-2 am, light for 5 secs., 10 secs., 15 secs. and 30 secs. per min. 10 pm-2 am. Plants were grown under a 60N-70D temperature regime.

plementary light is related to the period during the 24-hour cycle when the light is applied, not to the actual duration of continuous light. We have seen that light flashed for approximately 8% of the normal duration a 4-hour period produced an effect equal to that of continuous light during the same period. This points the way to a considerable economy in the use of electricity, although stem elongation is not accompanied by the reduction in flowering time obtained by the use of continuous light for extended periods and due, most probably, to a slight build-up in temperature under the black cloth.

Causes of Bud Blast

In our previous report we stated that, under our conditions, bud blasting was not *directly* related to temperature changes. Extensive efforts to reproduce bud blast with different moisture levels during forcing have not made the picture very much clearer. No more blasting was seen on plants grown continuously in soil at a high moisture tension (restricted moisture level) than was seen on plants grown continuously in soil at a low moisture tension (ample moisture). There was no blasting in either case. With groups of plants completely deprived of water for 15-day periods successively through the forcing season, the only blasting of any commercial importance at all occurred on those lilies which remained unwatered for the 15 days beginning 8 days *before* average visible bud date (0.6 blasted buds per plant), and those which remained unwatered for the 15 days beginning 2 days *after* average visible bud date (0.9 blasted buds per plant). Contrary to findings elsewhere, plants placed under 2 thicknesses of cheesecloth at the visible bud stage produced almost no blasted buds at all. It would seem unwise to conclude much from these preliminary results, but it appears that the Easter lily is most sensitive to water deficiency, and most liable to produce blasted buds as a result of it, during a period extending from 1 to 2 weeks before, and from 1 to 2 weeks after, the flower buds first become visible. The plant appears to be more sensitive to a sudden moisture deficit than to a continuous moisture deficit imposed from planting onwards.

Cold Storage

In a preliminary investigation to re-examine and compare different cold storage techniques, Ace (6-½-7″ grade) and Croft (6½-7″ and 7-8″ grade) bulbs were used. Groups of 10 of each were:

(a) stored in peat-lined polyethylene bags in a refrigerator at 35°F,

(b) stored in peat-lined polyethylene bags in a refrigerator at 45°F, and

(c) first potted, and then placed in a cold-frame with a minimum temperature of 45°F.

These treatments were applied for 2, 4, 6, 8, 10 and 12 weeks, after which the lilies were grown in a greenhouse maintained at 60N-70D. Unstored bulbs were grown as controls. Our results were generally consistent with those of other workers in this field. With few exceptions (in the 2-week treatments), any form of cold treatment, for any period of time, reduced the potential flower number produced by the unstored bulbs. Bud count, node number, and the time necessary for forcing were all progressively reduced with increased length of all 3 types of cold storage.

Table 3 summarizes some of the data gathered from the treatments. It can be seen that the least reduction in bud count occurred with plants given the cold-frame treatment, i.e. the mildest form of cold treatment. But this was at the expense of a slightly longer forcing time in the greenhouse. Unless it was necessary to refrigerate bulbs for, say, a late Easter would it seem not advisable to store them for periods longer than 4 to 6 weeks, on account of the reduction in bud count. In this event, though, our results indicate that it would be preferable to pot the bulbs and grow them for the necessary time in a cold frame, as is often done on the West Coast.

Summary

The work of the past two years has given us the answers to many of the lily forcers' problems, but there are yet more to be solved. We know that forcing time can be controlled by storage treatments and growing temperatures, and that height can be controlled by photoperiod. One of the big questions still unanswered is how to in-

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TABLE 3: The effect of 3 types of cold storage treatment on the growth and flowering of Ace and Croft Easter lilies grown at a temperature of 60N-70D. Treatments were started November 2, 1960.

Variety	Treatment	Treatment Time (days)	Forcing Time (days)	Total Time (days)	No. Flowers	No. Aborted Buds	Flowering Height (ins.)	No. Nodes
Ace 6½-7″	35°F	14	176	190	7.1	0.2	12.4	92
		28	123	151	5.1	0	9.6	56
		42	113	155	4.5	0	10.0	55
	45°F	14	163	177	7.6	0.4	14.8	114
		28	142	170	5.5	0.1	13.6	82
		42	125	167	5.4	0	13.6	72
	Cold Frame	14	162	176	8.2	0.2	14.8	128
		28	138	166	6.9	0	12.4	85
		42	124	166	6.3	0.1	11.2	73
	Control	—	209	209	7.5	0.6	19.2	204
Croft 7-8″	35°F	14	141	155	5.5	0.4	12.4	104
		28	124	152	4.6	0.2	14.8	77
		42	111	153	3.9	0	16.4	75
	45°F	14	140	154	5.9	0	13.6	114
		28	121	149	4.2	0.2	13.6	88
		42	106	148	3.3	0	12.8	77
	Cold Frame	14	135	149	6.1	0	11.6	112
		28	124	152	4.7	0.3	10.8	92
		42	114	156	4.0	0	12.0	82
	Control	—	173	173	8.4	0.2	15.2	162

crease the flower number. Last spring some of our plants produced a bud count that would be desirable (Figure 3), but these plants were unacceptable because it required too long a time for them to flower, and the forcing time was too variable. We hope to find out more about this problem of flower number this year.

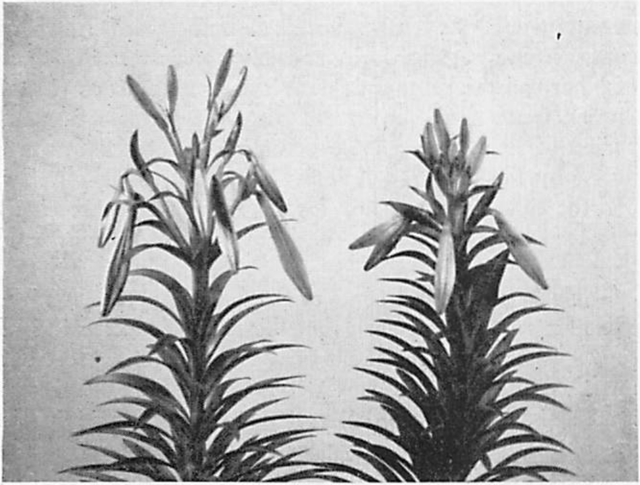

Figure 3: The appearance of (L.) Croft and (R.) Ace lilies which had not received cold storage. Bulbs were planted December 14, 1960, grown at 60N-70D, and photographed on May 8, 1961.